Appendices

Can artistic methods be used to improve the perception of depth in pictures? An investigation into two methods

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Submitted for the Degree of Ph.D. by Research

Awarding body: Cardiff Metropolitan University

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This research was undertaken under the auspices of Cardiff Metropolitan University

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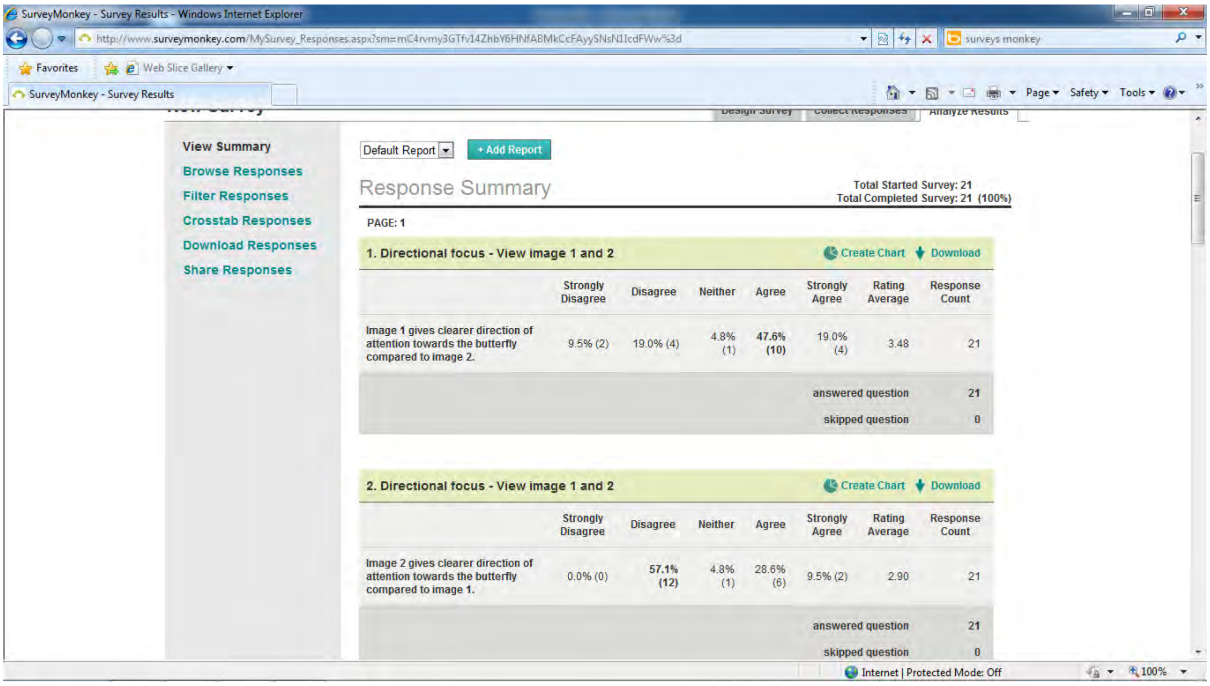
1.1 Questions 1 & 2 survey data



View Summary
Browse Responses
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Default Report | + Add Report

Response Summary

Total Started Survey: 21
Total Completed Survey: 21 (100%)

PAGE: 1

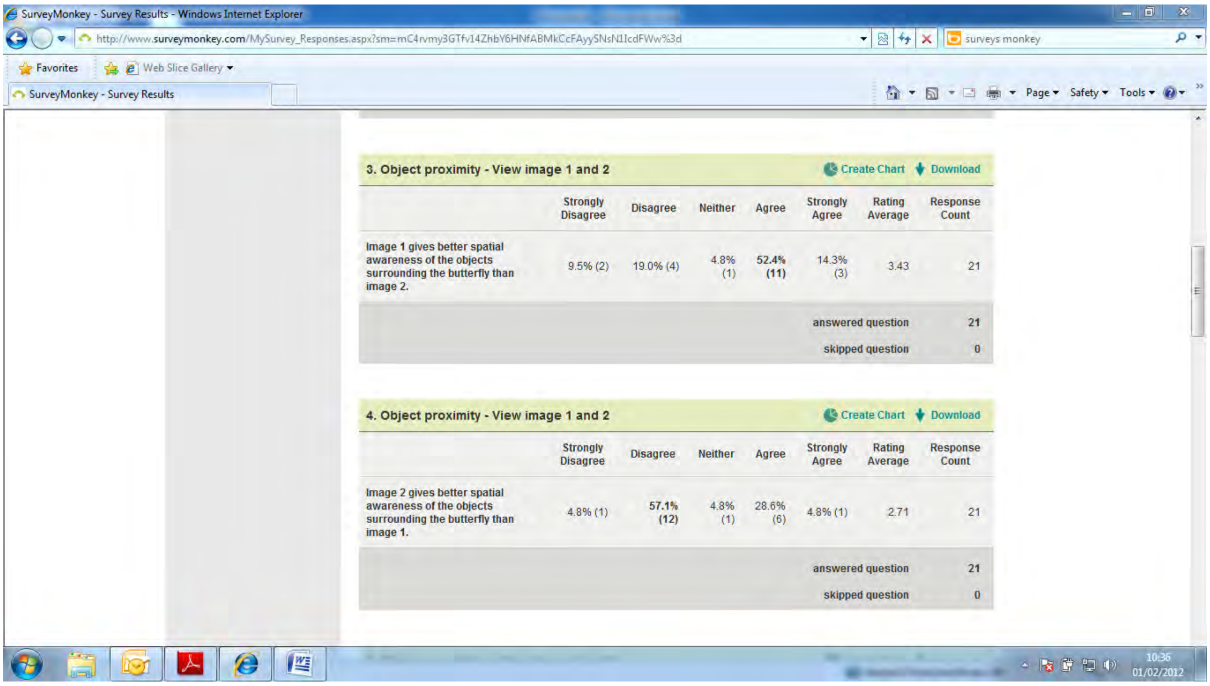
1. Directional focus - View image 1 and 2 — Create Chart | Download

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Rating Average	Response Count
Image 1 gives clearer direction of attention towards the butterfly compared to image 2.	9.5% (2)	19.0% (4)	4.8% (1)	47.6% (10)	19.0% (4)	3.48	21
						answered question	21
						skipped question	0

2. Directional focus - View image 1 and 2 — Create Chart | Download

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Rating Average	Response Count
Image 2 gives clearer direction of attention towards the butterfly compared to image 1.	0.0% (0)	57.1% (12)	4.8% (1)	28.6% (6)	9.5% (2)	2.90	21
						answered question	21
						skipped question	0

1.2 Questions 3 & 4 survey data



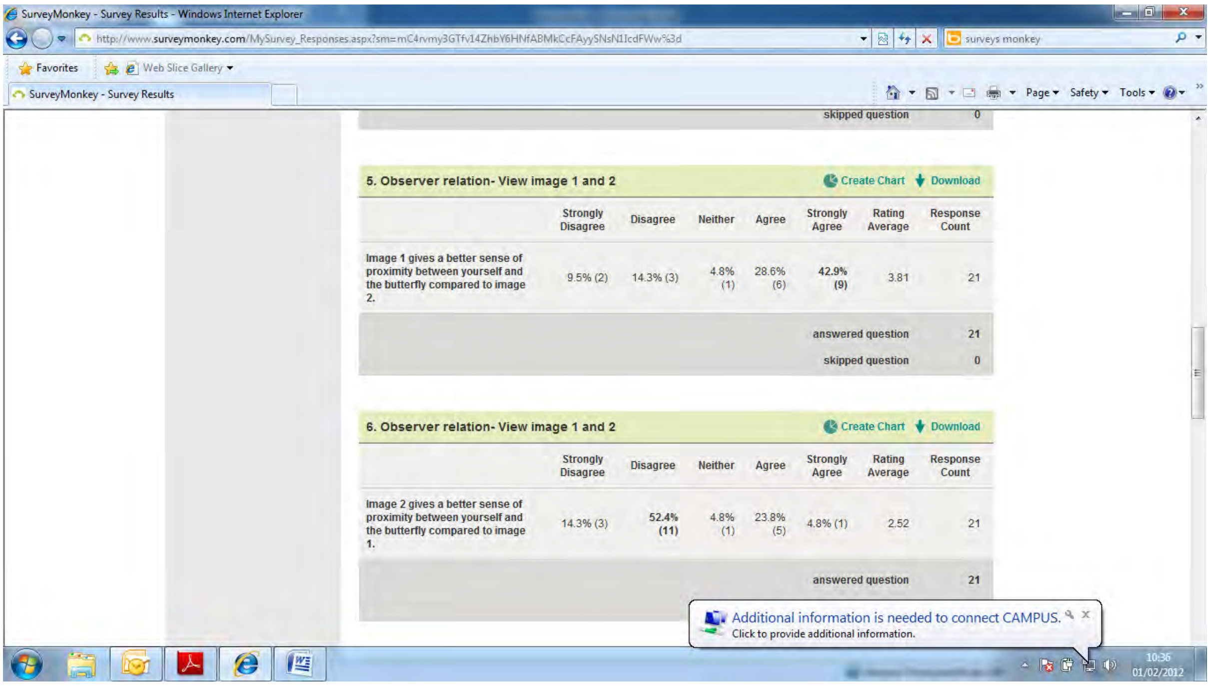
3. Object proximity - View image 1 and 2 — Create Chart | Download

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Rating Average	Response Count
Image 1 gives better spatial awareness of the objects surrounding the butterfly than image 2.	9.5% (2)	19.0% (4)	4.8% (1)	52.4% (11)	14.3% (3)	3.43	21
						answered question	21
						skipped question	0

4. Object proximity - View image 1 and 2 — Create Chart | Download

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Rating Average	Response Count
Image 2 gives better spatial awareness of the objects surrounding the butterfly than image 1.	4.8% (1)	57.1% (12)	4.8% (1)	28.6% (6)	4.8% (1)	2.71	21
						answered question	21
						skipped question	0

1.3 Questions 5 & 6 survey data



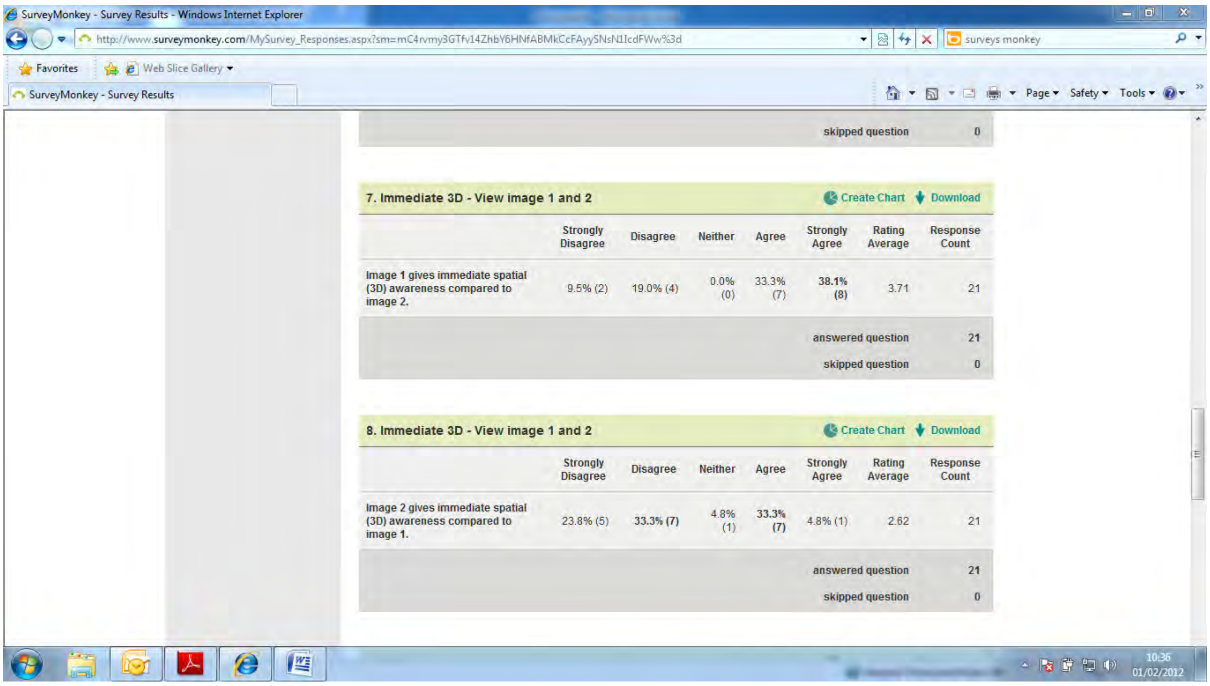
5. Observer relation- View image 1 and 2

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Rating Average	Response Count
Image 1 gives a better sense of proximity between yourself and the butterfly compared to image 2.	9.5% (2)	14.3% (3)	4.8% (1)	28.6% (6)	42.9% (9)	3.81	21
						answered question	21
						skipped question	0

6. Observer relation- View image 1 and 2

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Rating Average	Response Count
Image 2 gives a better sense of proximity between yourself and the butterfly compared to image 1.	14.3% (3)	52.4% (11)	4.8% (1)	23.8% (5)	4.8% (1)	2.52	21
						answered question	21

1.4 Questions 7 & 8 survey data



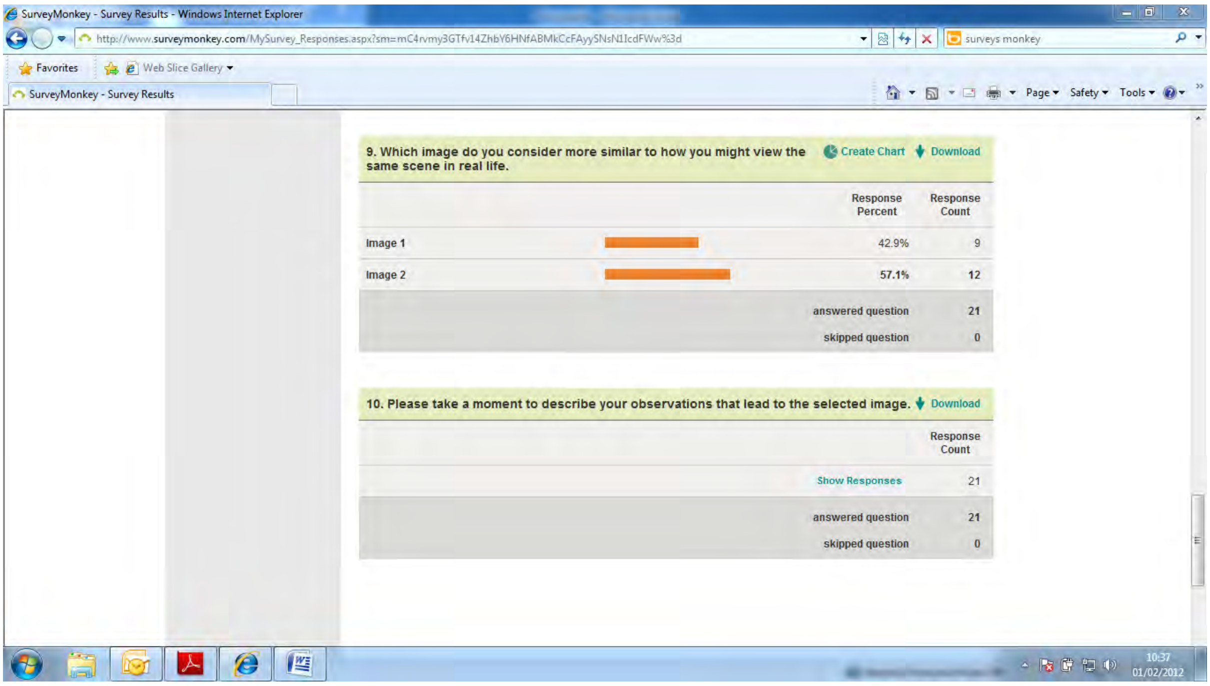
7. Immediate 3D - View image 1 and 2

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Rating Average	Response Count
Image 1 gives immediate spatial (3D) awareness compared to image 2.	9.5% (2)	19.0% (4)	0.0% (0)	33.3% (7)	38.1% (8)	3.71	21
						answered question	21
						skipped question	0

8. Immediate 3D - View image 1 and 2

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Rating Average	Response Count
Image 2 gives immediate spatial (3D) awareness compared to image 1.	23.8% (5)	33.3% (7)	4.8% (1)	33.3% (7)	4.8% (1)	2.62	21
						answered question	21
						skipped question	0

1.5 Questions 9 survey data



9. Which image do you consider more similar to how you might view the same scene in real life.

	Response Percent	Response Count
Image 1	42.9%	9
Image 2	57.1%	12
answered question		21
skipped question		0

10. Please take a moment to describe your observations that lead to the selected image.

	Response Count
Show Responses	21
answered question	21
skipped question	0

1.6 Questions 10 participants transcripts

I belive that image 1 is more alike to how you would view this scene in real life as you have a better awarness of the distance between each object on table than that of image 2.
24/1/2012 13:51View Responses

Image 2 is all in focus, even objects which are in our peripheral vision, in Image 1 backgroud objects are blurred and therefore more realistic.
24/1/2012 13:32View Responses

When I look at the butterfly I can still see the other objects close to and behind it clearly as I would be able to in real life. I would see them as blurry as image 1 represents. It is also a more straight on view in image 2 instead of slanted which I find more realistic.
24/1/2012 13:16View Responses

the butterfly is at more of an angle in image one as opposed to image two. The colours are not as bold, and are softer in image one which give a less 'animation like' feeling to the picture, and a more realistic feeling.
24/1/2012 12:57View Responses

As in real life, the items outside of peripheral vision are blurred and indistinct in image 1, whereas, in image 2, they are crisp and draw your attention away from the item of focus (the butterfly). The colour of the item of focus is also brighter in image 1

compared to image 2 which mimics how we view things in real life. The angling of image 1 also helps to imitate how we would determine the proximity of items in real life, with the butterfly appearing bigger than say the orange in the background, when in reality it isn't.
24/1/2012 12:40View Responses

Because as I am focusing on the direct object (butterfly) rather than the whole picture it is more similar to my visual perception as if i was observing the objects in real life. (my vision is blurred around the other objects not directly looking at).
24/1/2012 12:22View Responses

The background and objects outside of the focus are less detailed and aren't as sharp, and the higher contrast and brighter lighting seem more realistic and emphasise the 3D qualities better.
24/1/2012 10:56View Responses

Because it is much more clearer than image 1.
24/1/2012 10:19View Responses

more full however image 1 seems to be very real as well, it the way how it shows the objects in front. I don't like the background effect as I find it distracting
24/1/2012 9:47View Responses

The objects in image two tend to blend in more with the environment than the objects presented in image one.
17/1/2012 13:38View Responses

Just because it's clearer and not at all fuzzy
17/1/2012 13:16View Responses

image 2 consists of brighter, more vivid colours. Image 1 is fuzzier, with edges of objects slighty blurred, so isnt as realistic.
17/1/2012 12:41View Responses

Image 1 seems more life-like due to 3D effect, object seem more realistic because of this.
17/1/2012 12:20View Responses

The image 2 is more real life compared to image 1. As image 1 shows fuzziness outside of the main focus point of the table. Normally would see all things clear.....
17/1/2012 12:02View Responses

I don't believe the scene in real life is as blury as image 1. Image 2 is a lot more bolder in colour as i think it is in a scene in real life, which lead to my answer being image 2.
17/1/2012 10:44View Responses

Image 2 had a stronger definition which enabled me to see the size and shape of the object clearer and judge the distance between each item better than Image 1. This meant I could pay better attention to detail and how each item in Image 2 related to each other in terms of its distance between itself and either me viewing that item of the butterfly.

17/1/2012 10:25View Responses

Many of the objects that are out of focus in image 1 I don't think would be that way in real vision. The items in image 2 seem to have more clarity and depth compared to image 1.

12/1/2012 13:37View Responses

Just because from looking at image 1, i am focusing on the mug butterfly area as it seems most clear (not as blurred compared to the area of the chair say). So in real life when i focus in on something, the images in my peripheral (not sure how to spell that) are not as lucid as the object i am attending too. Image 2, everything is clear and doesnt represent to me how everything in my field of sight would appear.

12/1/2012 13:12View Responses

I find that image 2 is similar as to how I might view the same scene in real life as the objects within the image are alot clearer and sharper than those that are displayed within image 1. To me, Image 2 is a lot more life like than image 1.

12/1/2012 12:47View Responses

The blurring of the background in image 1 is too obvious making it distracting, it doesn't increase spatial awareness.

12/1/2012 12:09View Responses

Although image 1 does have an immediate 3d type effect, it lacks similarity to reality. It seems as though the effect is created by blurring objects more as they get further away, however this attracts the eye to the blur as this seems so out of place. Image 2 does not have such a striking 3d effect although the shading from the light source provides some depth awaereness, with the clarity of the whole picture allowing the eye to focus on areas with little distraction.

12/1/2012 11:10View Responses

Appendices 2

2.1 Canvas email

Dear psychology student,
A study is currently being carried out to test spatial awareness of a 3D environment using conventional 2D media. We will ask you to look at two variations of the same scene represented using conventional 2D media. During this trial you will be asked to answer a short series of questions about your experience of the two images.

- The study should take about 20-30 minutes
- You are familiar with and make use of various forms of 2D digital media (TV, gaming, cinema)

You will also be asked permission for us to video record interviews and discussions. The study is open to any age and course credits will be awarded to psychology students who participate.

1. Please use the link below to sign up for a session which will be undertaken in the Psychology department.

http://www.supersaas.co.uk/schedule/joebaldwin/Observer_room_-_PDR_reception

2. The timetable slots are assigned on a first come, first served basis – Week 50
3. Enter the Password: **name**
4. Select your preferred day and time slot
5. New reservation and enter your name.

Thank you
Joseph Baldwin
jobaldwin@uwic.ac.uk

2.2 Application for ethical approval to carry out experiments

CMU APPLICATION FOR ETHICS APPROVAL

All Principal Investigators (PI) undertaking a research project which involves human participants should complete and sign this application form.

The document *Guidelines for obtaining ethics approval* gives full details of how to complete this form and is available via the research pages of the CMU website. You should refer to this document in order to avoid unnecessary delays with your application.

As a PI, you are responsible for exercising appropriate professional judgement in this review and for operating within UEC (and any School and professional) guidelines in the conduct of the study.

Participant recruitment or data collection must not commence until ethics clearance has been obtained.

Principal Investigator:	Joseph Baldwin
Supervisor (if student project):	Rob Pepperell, Steve Gill, Darren Walker
School:	Cardiff School of Art & Design
Type of researcher:	Postgraduate Student (no teaching)
Student Number (If applicable):	st10007499 / sm70479
Programme enrolled on:	KESS / PhD
Project Title:	Exploring 'Vision-Space" As A Method Of Modelling Visual Awareness.

PART ONE – ETHICS REVIEW CHECKLIST

ERC1: Will the study involve NHS patients or staff?	No

If **YES**, you do not need to complete Part Two of this form. Instead, an application for ethics approval must be submitted to the appropriate external NHS Research Ethics Committee. Complete Declaration A overleaf and forward a copy of your NHS application plus Part One of this form to your School Ethics Committee for information.

ERC2: Does your research fall ***entirely*** within one of the following three categories: Paper-based, involving only documents in the public domain Laboratory based, not involving human participants or human tissue samples (eg electronics, chemical analysis) Practice-based, not involving human participants (eg exhibitions, curatorial, reflective analysis, practice audit)	No

If **YES**, you do not need to complete Part Two of this form. Instead, complete Declaration B overleaf and send the completed form to your School Ethics Committee for information.

If **NO**, you must complete Part Two of this form and submit your application (Part One and Part Two) to your School Ethics Committee for consideration. **DECLARATION A**	
I confirm that the information contained in this form is correct My research involves human participants and ERC1 indicates I must obtain ethics clearance from the appropriate external health authority ethics committee. Signature of Principal Investigator:	
Date:	

DECLARATION B
I confirm that the information contained in this form is correct My research falls entirely within the categories described in ERC2 and I do not need to take further action to obtain ethics clearance. Signature of Principal Investigator:

Date:	Click here to enter a date.
Brief synopsis of project:	

FOR STUDENT PROJECTS ONLY I confirm that I have read and agreed the information contained in this form	
Name of Supervisor: Click here to enter text.	Date: Click here to enter a date.
Signature of Supervisor:	
School Research Ethics Committee use only	
☐ Considered and supported	☐ Considered and not supported
Name: Click here to enter text.	Date: Click here to enter a date.

PART TWO – APPLICATION FOR ETHICS APPROVAL

Expected Start Date:	12/11/2011		
Approximate Duration:	01/2/12		
Funding Body (if applicable):	Vision –Space is a proprietary technology developed by Perceptual Technology Ltd., who co-sponsor this KESS funded PhD.		
Other researcher(s) working on the project	None		
Does your project require ethical approval from an NREC or other body?	No		
If yes, please name the NREC or other body	Click here to enter text.		
Does your project use Human Tissue?	No		
Has CRB clearance been given?	No	If yes, which organisation holds details of the check[1]?	Click here to enter text.

DECLARATION	
I confirm that the information contained in this form is correct Signature of Principal Investigator:	Date: Joseph Baldwin
FOR STUDENT PROJECTS ONLY I confirm that I have read and agreed the information contained in this form	
Name of Supervisor: Dr Darren Walker	Date: 25/11/2011
Signature of Supervisor: *Dr Darren Walker*	

Research Ethics Committee use only	
Decision reached:	Project approved ☐ Project approved in principle ☐

[1] In cases where a CRB check has been sought by an external organisation, confirmation from that organisation that a satisfactory check has been received is required by UWIC at application stage.

	Decision deferred ☐ Project not approved ☐ Project rejected ☐
Project reference number: Click here to enter text.	
Name: Click here to enter text.	Date: Click here to enter a date.
Signature:	

A – PROJECT DETAILS	
A1 In order to give members of the ethics committee some idea of the nature of your research, please answer the following questions with regard to this project:	
Will you take blood or tissue samples from participants?	No
Will the study involve prolonged or repetitive testing OTHER THAN repetitive training exercises of a type which form part of the participants normal activities (such as athletics or music training)?	No
Are drugs, placebos or other substances (eg vitamins) to be administered to participants?	No
Could the study induce physiological or psychological stress or anxiety significantly greater than the participants are likely to experience in their daily lives?	No
Does the study involve participants who are unable to give informed consent?	No
Will the study involve children? (NB: Projects in professional practice involving those under the age of 18 in a public place (in school or a statutory setting) with the relevant permission are exempt)	No
Is pain or more than mild discomfort likely to result from the study?	No
Will financial inducements, other than reasonable expenses and compensation for time, be offered to participants?	No
Will deception of participants to necessary during the study?	No

A2 Briefly describe the rationale behind your project
This research project explores the viability of Vision-Space (V-S) as a method of modelling human visual awareness. There is limited understanding of how our perception of the world is presented within the mind and how it can be represented in images. Historically, artists have tended to conform to rules based on linear perspective, using these pictorial laws to reproduce approximate scenes. Scientists have also tended to identify with human vision based on the basic role of optics through photography, but there are great limitations of this method: “If we consider a picture to be a surrogate for a scene, we should recognize that it must be an imperfect surrogate” (Hochberg 1962). The comparative study is a good starting point to analyze popular experiential feelings between original Vision-Space images and their normal media equivalent. We will ask observers to look at two variations of the same scene (E.g. butterfly in a room) represented using conventional 2D media. A video will record respondents during each 20 minute observation as they answer 10 Likert

scale questions using an online survey (surveymonkey.com) and two verbal response questions.	
A3 What are the aims of the research?	
To investigate the extent to which Vision-Space technology creates a greater sense of spatial awareness of the 3D environment in a 2D image than conventional imaging media.	
A4 Will you be using an approved protocol in your project?	No
A5 If yes, please state the name and code of the approved protocol to be used[2]	
Click here to enter text.	

If your project does involve the use of an approved protocol, please indicate when answering the following questions, which areas of your study are covered by the protocol

A6 What methods of data collection and analysis will you adopt?
Observers will look at two variations of the same scene represented using conventional 2D media using a display screen. During this trial they will be asked to answer a short series of questions using the Likert scale relating to experience between the two images. The study should take about 20 minutes. T- tests and correlations will be used to analyse the data.
A7 What remuneration (if any) will be offered to participants?
There will be no monetary payment for taking part in the study. It is normal practice for the Psychology department to give course participation credits as a way to make sure that students involve themselves in experiments throughout the year.
A8 From which group(s) will participants be recruited and what sampling method and criteria will be used?
First and second year Psychology student, opportunity sample (male and female).
A9 How many participants will be involved?
Approximately 20 participants
A10 Where and how will the participants be recruited and what method of initial contact will you use?
First and second year Psychology students through Canvas sign up email via Psychology department - http://www.supersaas.co.uk/schedule/joebaldwin/Observer_room_-_PDR_reception
A11 What previous experience of research involving human participants relevant to this project do you have?
I have no previous or associated human research experience but I have been a classroom teacher for 10 years.
A12 **Student projects only** What previous experience of research involving human participants relevant to this project does your supervisor have?
Dr Darren Walker has extensive experience in running experimental studies involving both young and old participants
B – POTENTIAL RISKS
B1 What potential discomfort or inconvenience to the participants do you foresee?
None

[2] An Approved Protocol is one which has been approved by UWIC to be used under supervision of designated members of staff; a list of approved protocols can be found on the UWIC website here

B2 How do you propose to deal with the potential risks?	
N/A	
B3 Do you intend to use a questionnaire to ascertain an individual's level of physical fitness or health before accepting them as a participant? If yes, please give details.	
N/A	
B4 What potential risks to the interests of the researchers do you foresee?	
None	
B5 How will you deal with these potential risks?	
N/A	

C – CONSENT	
C1 Will informed consent be sought from participants?	Yes
C2 IF NO, explain why informed consent will not be sought	
Click here to enter text.	
C3 IF YES, describe how informed consent will be obtained and attach copies of relevant documents	
Participants will be given an information sheet with details of the aims of the study, how and when it will be conducted and how the findings will be used. They will be given a consent form to sign, agreeing to participate in the study and requesting the use of video and online survey data recording.	
C4 If you are using an approved protocol, has the approved wording for participants been included in your Participant Information Sheet?	Choose an item.
C5 If NO, why not?	
N/A	
C6 If there are doubts about participants' abilities to give informed consent, what steps have you taken to ensure that they are willing to participate?	
N/A	
C7 If participants are aged under 18, describe how you will seek informed consent	
N/A	
C8 How will consent be recorded?	
On a paper form, which will then be stored according to data protection guidelines	

D – OTHER DETAILS	
D1 Will participants be informed of their right to withdraw without penalty?	Yes
If no, please detail the reasons	
Click here to enter text.	
D2 How will you ensure participants' confidentiality and anonymity?	
Participants names will not be required for research purposes. They will be identified exclusively by an ID code throughout documentation (except where their names naturally occurred in the speech stream).	
D3 How will issues of data storage be addressed?	
Your name and any other personal details will be kept separately from any other documented research and we will take steps to ensure that no one can identify you from the research findings. Data access will be limited to the researcher in question, myself (Joseph Baldwin), PhD supervisory team, Perceptual Technology Ltd and the external examiner. Should associated lecturers require access at a future date (for example data analysis), this will be permissible only with one of the above named parties in attendance. All data captured will be deleted after analysis unless specific elements are necessary to keep helping justify the rationale for PhD hypothesis.	

This retained data will be stored in a locked cupboard, in accordance with data protection guidelines. Other research data, such as interview transcriptions, will also be coded and stored in a locked cupboard. Data will be used for agreed purposes only and anticipate this to be for 5 years. All participants will be debriefed at the end of their participation.
D4 Are there any further points you wish to make with regard to the proposed research?
All participants will be over the age of 18 and will be able to give informed consent for participation. These students will be first and second year psychology students which I have had no prior involvement with. They have been suggested by Dr Darren Walker as a good, available target group within his department.

NB: When submitting your application, in addition to this form your School Ethics Committee will expect to see copies of the documentation you will use during your project. Depending on what your project entails, this may include:

- Participant information sheet (See Section C)
- Participant consent form (See Section C)
- Parents information sheet (See Section C)
- Parents consent form (See Section C)
- Participant questionnaire (See A6)
- Health questionnaire (See B3)
- Letter to the organisation at which research will take place

Refer to the document *Guidelines for obtaining ethics approval* for further details on which documents you should provide and exemplar forms for your reference when compiling this information.

Date: Tuesday 13 December 2011

Joseph Baldwin
10 Dyfed Avenue
Townhill
Swansea
SA1 6NF

Dear Joseph,

Re: Application for Ethics Approval
Title of project: Exploring 'Vision-Space" As A Method Of Modelling Visual Awareness.
CSAD REC reference number: 11/11/11A

Thank you for submitting your amended application for ethics approval.

I am pleased to confirm that ethics approval for the project has now been granted for an initial period of twelve months. Should your project extend beyond this time, an application for an extension to the approval will be required by CSAD REC.

Please note, your project has been granted ethics approval based on the protocols stated in your application. However, should these change at any point during your study you are required to reapply to CSAD REC for ethics approval.

Best Wishes

Chris Dennis
CSAD REC Administrator

cc. Supervisor

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2.3 Participant information sheet

CMU RESEARCH ETHICS COMMITTEE

CMU

Cardiff School of Art & Design, Western Avenue, CARDIFF CF5 2YB
www.cardiffmet.ac.uk

Participant Information Sheet

Title of project

Spatial awareness of a 3D environment using conventional 2D media

Your participation in the Research Project

Why you have been asked?
You have been asked to participate in the user trial looking at the spatial awareness of a 3D environment using conventional 2D media. The purpose of this document is to let you know what this study will involve in order that you may make an informed decision on whether or not you want to take part.

The study will be run by Joseph Baldwin at the psychology department within Cardiff Metropolitan University (CMU). The results of the study will be used to inform the development of a new 3D environment and may also be published in commercial and academic papers.

By agreeing to take part in this study, you confirm that:

- You are over 18 years of age
- You are familiar with and make use of various forms of 2D digital media (TV, gaming, cinema)

There is absolutely no obligation of any kind to join the study, and CMU will not discriminate in any way against anyone who does not want to take part.

There will be no monetary payment for taking part in the study. It is normal practice for the Psychology department to give course participation credits as a way to make sure that students involve themselves in experiments throughout the year.

What would happen if you join the study?
The comparative study will ask observers to look at two variations of the same scene (E.g. Image of a room) represented using conventional 2D media. A video will record respondents during each 20 minute observation as they answer 10 quick response questions using an online survey and two verbal response questions.

You will also be asked permission for us to video record the study.

What happens if you want to change your mind?
If you decide to join the study you can change your mind and stop at any time. We will completely respect your decision.

Are there any risks?
We do not think there will be any risks due to the study. However if you did feel that there was any stress involved you can stop at any time. Just tell the interviewer that you want to stop.

Your rights
Joining the study does not mean you have to give up any legal rights. In the very unlikely event of something going wrong, the Cardiff Metropolitan University fully indemnifies its staff, and participants are covered by its insurance.

What happens to the questionnaire, interview and video results?
Questions, video and audio recordings of the research will be studied and transcribed. We will then look for reoccurring themes, values and views.

Are there any benefits from taking part?
There are no direct benefits to you for taking part; however this study may help improve the types of products available to you in the future.

How we protect your privacy
Your name and any other personal details will be kept separately from any other documented research and we will take steps to ensure that no one can identify you from the research findings. Data access will be limited to the researcher in question, myself (Joseph Baldwin), PhD supervisory team, Perceptual Technology Ltd and the external examiner. Should associated lecturers require access at a future date (for example data analysis), this will be permissible only with one of the above named parties in attendance. All data captured will be deleted after analysis unless specific elements are necessary to keep helping justify the rationale for PhD hypothesis. This retained data will be stored in a locked cupboard, in accordance with data protection guidelines. Other research data, such as interview transcriptions, will also be coded and stored in a locked cupboard. Data will be used for agreed purposes only and anticipate this to be for 5 years. All participants will be debriefed at the end of their participation.

Please Note: *YOU WILL BE GIVEN A COPY OF THIS SHEET TO KEEP, TOGETHER WITH A COPY OF YOUR CONSENT FORM*

Contact Details

If you want to find out more about the project, or if you need more information to help you make a decision about joining in, please contact:

Mr Joseph Baldwin
Academic associate,
Cardiff School of Art & Design,
Cardiff Metropolitan University
jobaldwin@cardiffmet.ac.uk

VERSION 2 APRIL 2007

2.4 Participant consent form

CMU Research Ethics Committee

Participant Consent Form

CMU Ethics Protocol Number: Participant study ID number:

CMU PARTICIPANT CONSENT FORM

Title of Project:
Spatial awareness of a 3D environment using conventional 2D media

Name of Researcher: Joseph Baldwin

Participant to complete this section. Please initial each box.

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily E.g. Psychology course participation credits. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my relationship with UWIC, or my legal rights, being affected. ☐

3. I understand that relevant sections of any of research notes and data collected during the study may be looked at by responsible individuals from UWIC for monitoring purposes, where it is relevant to my taking part in this research. ☐

4. I give permission for study to be video recorded ☐

5. I agree to the use of anonymous data and quotes in publications ☐

6. I agree to take part in the above study. ☐

7. I agree to be contacted in the future by UWIC researchers who would like to invite me to participate in follow up studies to this project ☐

____
Name of Participant

____
Signature of Participant Date

_____Joseph Baldwin_____________________________
Name of person taking consent

____
Signature of person taking consent Date

When completed, 1 copy for participant and 1 copy for researcher site

Version 2 April 07 (20)

Appendices 3

3.1 Likert data for questions 1-8

first investigation.sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Direct Marketing Graphs Utilities Add-ons Window Help

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	Participant	Numeric	8	2	Participant	None	None	8	Right	Ordinal	Input
2	DFimage1	Numeric	8	2	Directional Focus 1	None	None	8	Right	Scale	Input
3	DFimage2	Numeric	8	2	Directional Focus 2	None	None	8	Right	Scale	Input
4	OPimage1	Numeric	8	2	Object Proximity 1	None	None	8	Right	Scale	Input
5	OPimage2	Numeric	8	2	Object Proximity 2	None	None	8	Right	Scale	Input
6	ORimage1	Numeric	8	2	Observer Relation 1	None	None	8	Right	Scale	Input
7	ORimage2	Numeric	8	2	Observer Relation 2	None	None	8	Right	Scale	Input
8	I3Dimage1	Numeric	8	2	Immediate 3D 1	None	None	8	Right	Scale	Input
9	I3Dimage2	Numeric	8	2	Immediate 3D 2	None	None	8	Right	Scale	Input
10	EOpinion1	Numeric	8	2	Experiential Opinion 1	{.00, no}...	None	8	Right	Scale	Input
11	EOpinion2	Numeric	8	2	Experiential Opinion 2	{.00, no}...	None	8	Right	Scale	Input

first investigation.sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Direct Marketing Graphs Utilities Add-ons Window Help

1 : Participant 1.00

	Participant	DFimage1	DFimage2	OPimage1	OPimage2	ORimage1	ORimage2	I3Dimage1	I3Dimage2	EOpinion1	EOpinion2
1	1.00	4.00	2.00	3.00	3.00	4.00	2.00	4.00	2.00	no	yes
2	2.00	4.00	2.00	2.00	4.00	2.00	4.00	2.00	4.00	no	yes
3	3.00	2.00	4.00	2.00	4.00	2.00	4.00	2.00	4.00	no	yes
4	4.00	4.00	4.00	4.00	2.00	5.00	2.00	5.00	4.00	yes	no
5	5.00	1.00	3.00	2.00	4.00	3.00	3.00	1.00	2.00	no	yes
6	6.00	4.00	2.00	1.00	5.00	2.00	4.00	2.00	5.00	no	yes
7	7.00	4.00	5.00	4.00	2.00	5.00	4.00	2.00	4.00	no	yes
8	8.00	5.00	2.00	4.00	2.00	4.00	2.00	5.00	1.00	no	yes
9	9.00	5.00	2.00	4.00	2.00	5.00	1.00	5.00	2.00	yes	no
10	10.00	2.00	4.00	5.00	4.00	5.00	2.00	4.00	4.00	no	yes
11	11.00	4.00	2.00	5.00	2.00	1.00	5.00	5.00	2.00	no	yes
12	12.00	4.00	2.00	4.00	2.00	4.00	2.00	4.00	1.00	yes	no
13	13.00	2.00	4.00	4.00	2.00	4.00	2.00	4.00	3.00	no	yes
14	14.00	2.00	4.00	2.00	4.00	1.00	4.00	1.00	4.00	no	yes
15	15.00	3.00	4.00	4.00	2.00	5.00	2.00	5.00	2.00	yes	no
16	16.00	5.00	2.00	4.00	2.00	5.00	2.00	5.00	1.00	yes	no
17	17.00	5.00	2.00	4.00	2.00	4.00	2.00	4.00	2.00	yes	no
18	18.00	1.00	5.00	5.00	1.00	5.00	1.00	5.00	1.00	yes	no
19	19.00	4.00	2.00	1.00	4.00	4.00	2.00	4.00	2.00	no	yes
20	20.00	4.00	2.00	4.00	2.00	5.00	2.00	4.00	1.00	yes	no
21	21.00	4.00	2.00	4.00	2.00	5.00	1.00	5.00	4.00	yes	no

3.2 Paired samples tests

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Directional Focus clearer 1	3.4762	21	1.28915	.28132
	Directional Focus clearer 2	2.9048	21	1.13599	.24789
Pair 2	Object Proximity better 1	3.4286	21	1.24786	.27230
	Object Proximity better 2	2.7143	21	1.10195	.24046
Pair 3	Observer Relation better 1	3.8095	21	1.40068	.30565
	Observer Relation better 2	2.5238	21	1.16701	.25466
Pair 4	Immediate 3D 1	3.7143	21	1.41926	.30971
	Immediate 3D 1	2.6190	21	1.32198	.28848

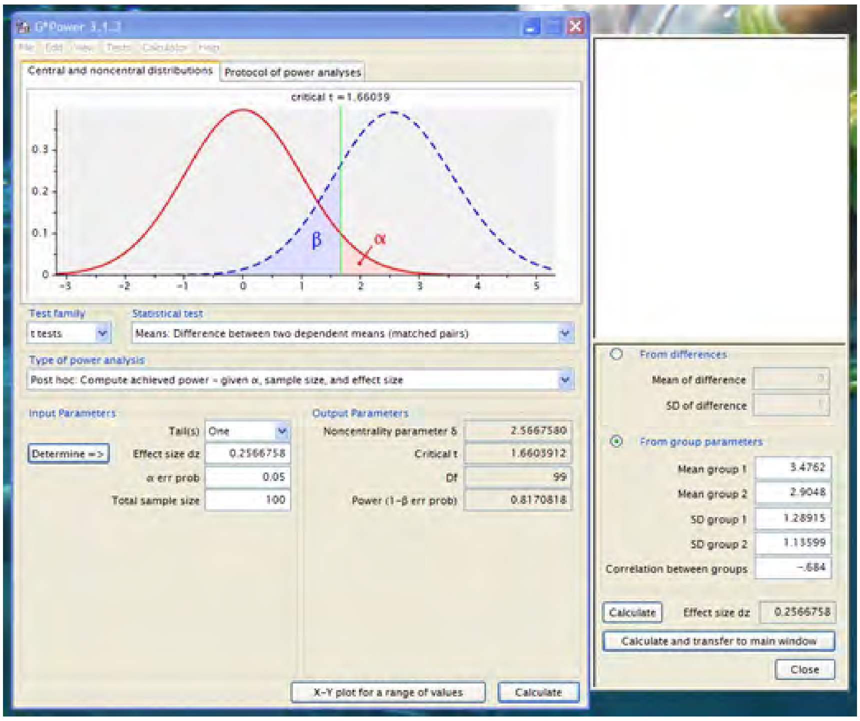
Paired Samples Correlations

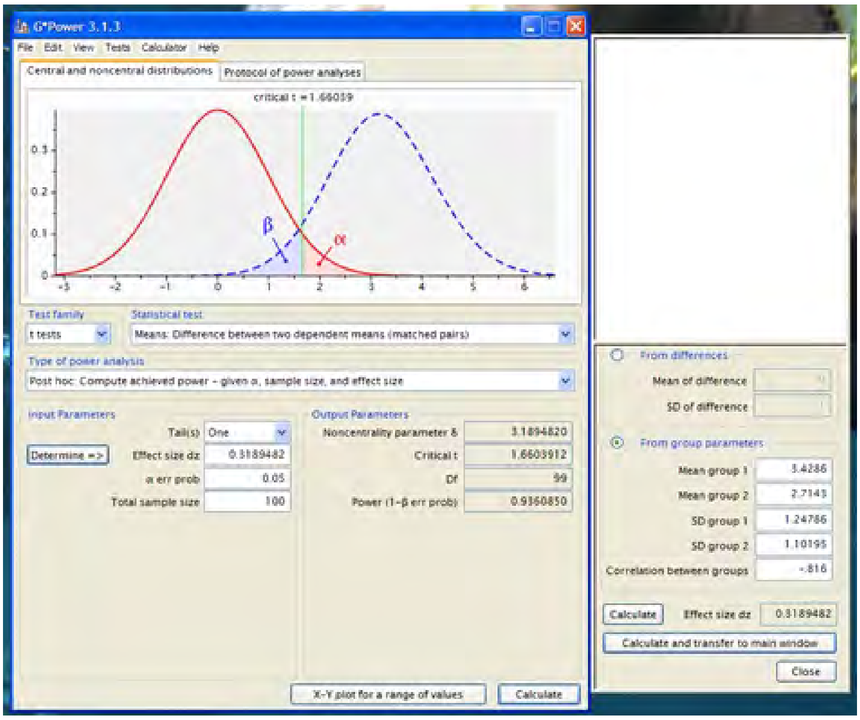
		N	Correlation	Sig.
Pair 1	Directional Focus clearer 1 & Directional Focus clearer 2	21	-.684	.001
Pair 2	Object Proximity better 1 & Object Proximity better 2	21	-.816	.000
Pair 3	Observer Relation better 1 & Observer Relation better 2	21	-.823	.000
Pair 4	Immediate 3D 1 & Immediate 3D 1	21	-.514	.017

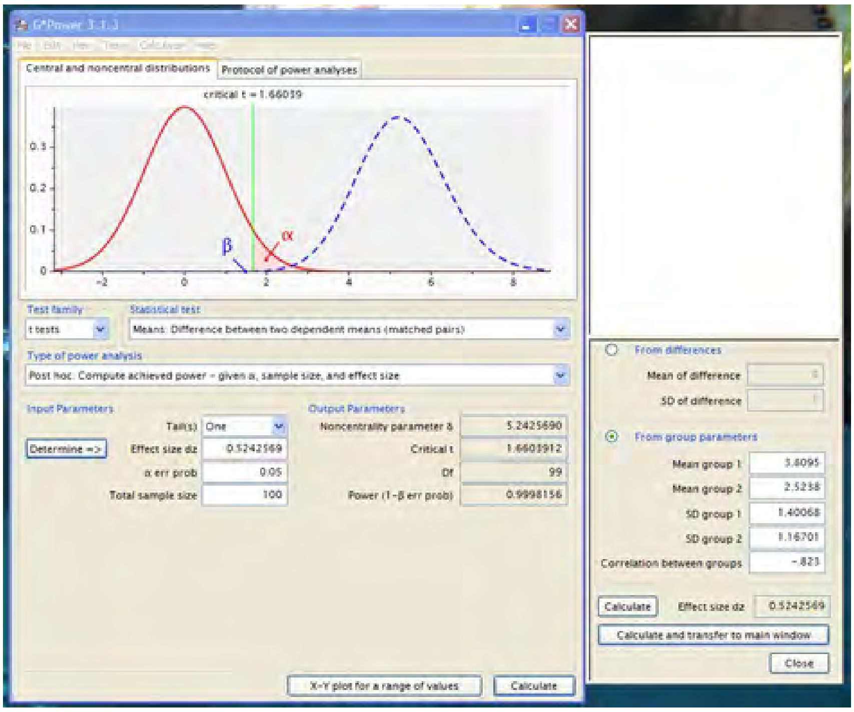
Paired Samples Test

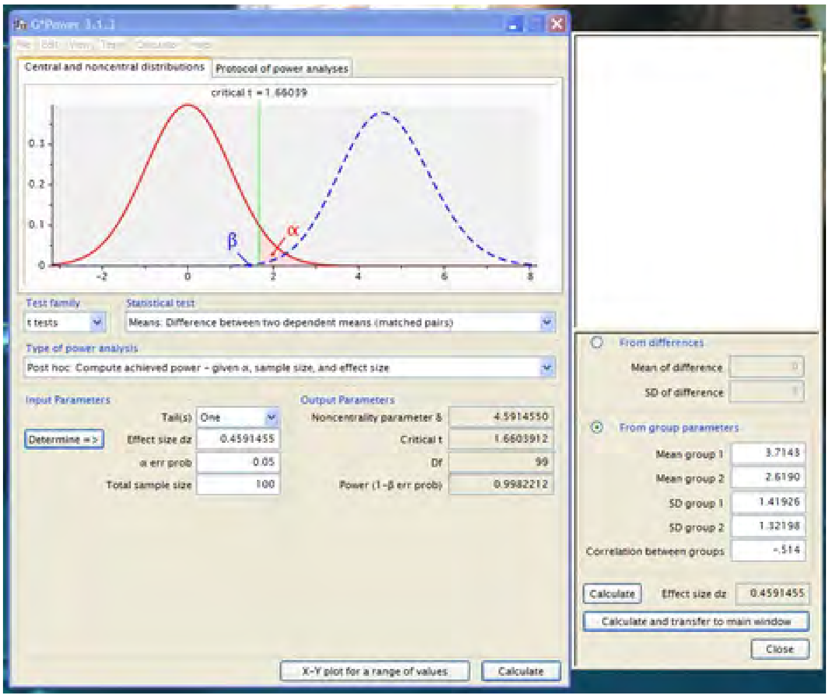
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Directional Focus clearer 1 - Directional Focus clearer 2	.57143	2.22646	.48585	-.44205	1.58490	1.176	20	.253
Pair 2	Object Proximity better 1 - Object Proximity better 2	.71429	2.23926	.48865	-.30501	1.73358	1.462	20	.159
Pair 3	Observer Relation better 1 - Observer Relation better 2	1.28571	2.45240	.53516	.16939	2.40204	2.402	20	.026
Pair 4	Immediate 3D 1 - Immediate 3D 1	1.09524	2.38547	.52055	.00938	2.18109	2.104	20	.048

3.3 Cohen effective size results






G*Power 3.1.3
Central and noncentral distributions
Protocol of power analyses
critical t = 1.66039
Test family
t tests
Statistical test
Means: Difference between two dependent means (matched pairs)
Type of power analysis
Post hoc: Compute achieved power – given α, sample size, and effect size
Input Parameters
Tail(s) One
Determine =>
Effect size dz 0.5242569
α err prob 0.05
Total sample size 100
Output Parameters
Noncentrality parameter δ 5.2425690
Critical t 1.6603912
Df 99
Power (1-β err prob) 0.9998156
From differences
Mean of difference
SD of difference
From group parameters
Mean group 1 3.8095
Mean group 2 2.5238
SD group 1 1.40068
SD group 2 1.16701
Correlation between groups -.823
Calculate
Effect size dz 0.5242569
Calculate and transfer to main window
Close
X-Y plot for a range of values
Calculate


G*Power 3.1.3
Central and noncentral distributions
Protocol of power analyses
critical t = 1.66039
Test family
t tests
Statistical test
Means: Difference between two dependent means (matched pairs)
Type of power analysis
Post hoc: Compute achieved power – given α, sample size, and effect size
Input Parameters
Tail(s) One
Determine =>
Effect size dz 0.4591455
α err prob 0.05
Total sample size 100
Output Parameters
Noncentrality parameter δ 4.5914550
Critical t 1.6603912
Df 99
Power (1-β err prob) 0.9982212
From differences
Mean of difference
SD of difference
From group parameters
Mean group 1 3.7143
Mean group 2 2.6190
SD group 1 1.41926
SD group 2 1.32198
Correlation between groups -.514
Calculate
Effect size dz 0.4591455
Calculate and transfer to main window
Close
X-Y plot for a range of values
Calculate

3.4 Chi-square test of association

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
BothTypes	21	.5714	.50709	.00	1.00

Chi-Square Test

Frequencies

BothTypes

	Observed N	Expected N	Residual
Vision-Space	9	10.5	-1.5
Normal RGB	12	10.5	1.5
Total	21		

Test Statistics

	BothTypes
Chi-Square	.429[a]
df	1
Asymp. Sig.	.513

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 10.5.

Appendices 4

4.1 Question 2 Likert data

Answer scale - Very high (vh)| high (h)| moderate (m)| low (l)| very low (vl)

Answer scale - Very high (5)| high (4)| moderate (3)| low (2)| very low (1)

	Q2				Q2		
Participant	V-s	DOF	Shadless		V-s	DOF	Shadless
VDS1	h	m	l		4	3	2
VDS2	h	m	h		4	3	4
VDS3	vl	m	h		1	3	4
VSD1	m	h	vl		3	4	1
VSD2	h	vh	vl		4	5	1
VSD3	vh	m	l		5	3	2
DVS1	m	l	l		3	2	2
DVS2	h	h	h		4	4	4
DVS3	m	vh	vh		3	5	5
DSV1	h	m	h		4	3	4
DSV2	h	l	l		4	2	2
DSV3	l	h	vh		2	4	5
SVD1	m	h	vl		3	4	1
SVD2	m	h	h		3	4	4
SVD3	h	h	h		4	4	4
SDV1	m	m	l		3	3	2
SDV2	h	h	m		4	4	3
SDV3	l	vh	m		2	5	3

4.2 Question 4 Likert data

Answer scale - Very high (vh)| high (h)| moderate (m)| low (l)| very low (vl)

Answer scale - Very high (5)| high (4)| moderate (3)| low (2)| very low (1)

	Q4				Q4		
Participant	V-s	DOF	Shadless		V-s	DOF	Shadless
VDS1	m	m	h		3	3	4
VDS2	m	m	h		3	3	4
VDS3	m	l	h		3	2	4
VSD1	h	vh	l		4	5	2
VSD2	h	vh	l		4	5	2
VSD3	vh	vh	h		5	5	4
DVS1	h	vh	vh		4	5	5
DVS2	vh	vh	m		5	5	3
DVS3	h	vh	h		4	5	4
DSV1	m	h	h		3	4	4
DSV2	l	l	vh		2	2	5
DSV3	m	h	vh		3	4	5
SVD1	l	h	vl		2	4	1
SVD2	h	h	vh		4	4	5
SVD3	m	m	vh		3	3	5
SDV1	m	m	vh		3	3	5
SDV2	l	l	h		2	2	4
SDV3	m	vh	h		3	5	4

4.3 Question 6 Likert data

Answer scale - Very high (vh)| high (h)| moderate (m)| low (l)| very low (vl)

Answer scale - Very high (5)| high (4)| moderate (3)| low (2)| very low (1)

	Q6				Q6		
Participant	V-s	DOF	Shadless		V-s	DOF	Shadless
VDS1	m	m	l		3	3	2
VDS2	l	m	h		2	3	4
VDS3	vl	m	h		1	3	4
VSD1	m	vh	vl		3	5	1
VSD2	h	vh	vl		4	5	1
VSD3	vl	h	l		1	4	2
DVS1	m	h	l		3	4	2
DVS2	l	vh	vh		2	5	5
DVS3	l	h	m		2	4	3
DSV1	l	m	h		2	3	4
DSV2	m	m	h		3	3	4
DSV3	l	m	h		2	3	4
SVD1	h	h	l		4	4	2
SVD2	l	m	m		2	3	3
SVD3	m	l	h		3	2	4
SDV1	l	m	vh		2	3	5
SDV2	l	h	vh		2	4	5
SDV3	l	m	h		2	3	4

4.4 Question 7 Likert data

Answer scale - Very high (vh)| high (h)| moderate (m)| low (l)| very low (vl)

Answer scale - Very high (5)| high (4)| moderate (3)| low (2)| very low (1)

	Q7				Q7		
Participant	V-s	DOF	Shadless		V-s	DOF	Shadless
VDS1	m	m	h		3	3	4
VDS2	l	m	vh		2	3	5
VDS3	l	h	m		2	4	3
VSD1	h	vh	l		4	5	2
VSD2	vh	vh	m		5	5	3
VSD3	m	m	l		3	3	2
DVS1	h	vh	l		4	5	2
DVS2	l	h	h		2	4	4
DVS3	l	h	m		2	4	3
DSV1	h	m	l		4	3	2
DSV2	l	h	h		2	4	4
DSV3	vl	vh	l		1	5	2
SVD1	l	h	vl		2	4	1
SVD2	h	m	m		4	3	3
SVD3	l	l	h		2	2	4
SDV1	vl	l	h		1	2	4
SDV2	l	l	h		2	2	4
SDV3	l	m	vh		2	3	5

4.5 Question 8 Likert data

Answer scale - Very high (vh)| high (h)| moderate (m)| low (l)| very low (vl)

Answer scale - Very high (5)| high (4)| moderate (3)| low (2)| very low (1)

	Q8				Q8		
Participant	V-s	DOF	Shadless		V-s	DOF	Shadless
VDS1	h	l	vh		4	2	5
VDS2	vl	h	vh		1	4	5
VDS3	l	m	vh		2	3	5
VSD1	h	vh	l		4	5	2
VSD2	l	h	l		2	4	2
VSD3	l	m	vl		2	3	1
DVS1	m	vh	vl		3	5	1
DVS2	h	m	vh		4	3	5
DVS3	vl	m	h		1	3	4
DSV1	m	l	h		3	2	4
DSV2	l	h	m		2	4	3
DSV3	vl	h	vh		1	4	5
SVD1	m	m	l		3	3	2
SVD2	l	m	m		2	3	3
SVD3	l	m	h		2	3	4
SDV1	m	h	m		3	4	3
SDV2	m	l	vh		3	2	5
SDV3	vl	m	vh		1	3	5

Appendices 5

5.1 Question 2 One-way ANOVA

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

Focus	Dependent Variable
1	SRD
2	SRB
3	iDOF

Descriptive Statistics

	Mean	Std. Deviation	N
SRD	3.3333	.97014	18
SRB	3.6111	.91644	18
iDOF	2.9444	1.34917	18

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Focus	Pillai's Trace	.181	1.771[b]	2.000	16.000	.202	.181
	Wilks' Lambda	.819	1.771[b]	2.000	16.000	.202	.181
	Hotelling's Trace	.221	1.771[b]	2.000	16.000	.202	.181
	Roy's Largest Root	.221	1.771[b]	2.000	16.000	.202	.181

a. Design: Intercept
 Within Subjects Design: Focus

b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Focus	.893	1.811	2	.404	.903	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept Within Subjects Design: Focus

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Focus	Sphericity Assumed	4.037	2	2.019	1.561	.225	.084
	Greenhouse-Geisser	4.037	1.807	2.235	1.561	.227	.084
	Huynh-Feldt	4.037	2.000	2.019	1.561	.225	.084
	Lower-bound	4.037	1.000	4.037	1.561	.228	.084
Error(Focus)	Sphericity Assumed	43.963	34	1.293			
	Greenhouse-Geisser	43.963	30.713	1.431			
	Huynh-Feldt	43.963	34.000	1.293			
	Lower-bound	43.963	17.000	2.586			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	Focus	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Focus	Linear	1.361	1	1.361	.794	.385	.045
	Quadratic	2.676	1	2.676	3.069	.098	.153
Error(Focus)	Linear	29.139	17	1.714			
	Quadratic	14.824	17	.872			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	586.741	1	586.741	577.927	.000	.971
Error	17.259	17	1.015			

Estimated Marginal Means

Focus

Estimates

Measure: MEASURE_1

Focus	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	3.333	.229	2.851	3.816
2	3.611	.216	3.155	4.067

3	2.944	.318	2.274	3.615

Pairwise Comparisons

Measure: MEASURE_1

(I) Focus	(J) Focus	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	-.278	.341	1.000	-1.184	.628
	3	.389	.436	1.000	-.770	1.548
2	1	.278	.341	1.000	-.628	1.184
	3	.667	.352	.227	-.269	1.602
3	1	-.389	.436	1.000	-1.548	.770
	2	-.667	.352	.227	-1.602	.269

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.181	1.771[a]	2.000	16.000	.202	.181
Wilks' lambda	.819	1.771[a]	2.000	16.000	.202	.181
Hotelling's trace	.221	1.771[a]	2.000	16.000	.202	.181
Roy's largest root	.221	1.771[a]	2.000	16.000	.202	.181

Each F tests the multivariate effect of Focus. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

5.2 Question 4 One-way ANOVA

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

Location	Dependent Variable
1	SRD
2	SRB
3	iDOF

Descriptive Statistics

	Mean	Std. Deviation	N
SRD	3.3333	.90749	18

SRB	3.8333	1.15045	18
iDOF	3.8889	1.18266	18

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Location	Pillai's Trace	.436	6.182[b]	2.000	16.000	.010	.436
	Wilks' Lambda	.564	6.182[b]	2.000	16.000	.010	.436
	Hotelling's Trace	.773	6.182[b]	2.000	16.000	.010	.436
	Roy's Largest Root	.773	6.182[b]	2.000	16.000	.010	.436

a. Design: Intercept
 Within Subjects Design: Location
b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Location	.360	16.365	2	.000	.610	.632	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.
a. Design: Intercept
 Within Subjects Design: Location
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Location	Sphericity Assumed	3.370	2	1.685	1.509	.236	.082
	Greenhouse-Geisser	3.370	1.219	2.764	1.509	.238	.082
	Huynh-Feldt	3.370	1.264	2.667	1.509	.239	.082
	Lower-bound	3.370	1.000	3.370	1.509	.236	.082

Error(Location)	Sphericity Assumed	37.963	34	1.117			
	Greenhouse-Geisser	37.963	20.726	1.832			
	Huynh-Feldt	37.963	21.487	1.767			
	Lower-bound	37.963	17.000	2.233			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	Location	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Location	Linear	2.778	1	2.778	2.335	.145	.121
	Quadratic	.593	1	.593	.568	.461	.032
Error(Location)	Linear	20.222	17	1.190			
	Quadratic	17.741	17	1.044			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	733.352	1	733.352	558.686	.000	.970
Error	22.315	17	1.313			

Estimated Marginal Means
Location

Estimates

Measure: MEASURE_1

Location	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	3.333	.214	2.882	3.785
2	3.833	.271	3.261	4.405
	3.889	.279	3.301	4.477

Pairwise Comparisons

Measure: MEASURE_1

(I) Location	(J) Location	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.500*	.185	.046	-.992	-.008
	3	-.556	.364	.435	-1.521	.410
2	1	.500*	.185	.046	.008	.992
	3	-.056	.454	1.000	-1.260	1.149
3	1	.556	.364	.435	-.410	1.521
	2	.056	.454	1.000	-1.149	1.260

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.436	6.182[a]	2.000	16.000	.010	.436
Wilks' lambda	.564	6.182[a]	2.000	16.000	.010	.436
Hotelling's trace	.773	6.182[a]	2.000	16.000	.010	.436
Roy's largest root	.773	6.182[a]	2.000	16.000	.010	.436

Each F tests the multivariate effect of Location. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

5.3 Question 6 One-way ANOVA

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

Inclusion	Dependent Variable
1	SRD
2	SRB
3	iDOF

Descriptive Statistics

	Mean	Std. Deviation	N
SRD	2.3889	.84984	18
SRB	3.5556	.85559	18

iDOF	3.2778	1.31978	18

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Inclusion	Pillai's Trace	.573	10.739[b]	2.000	16.000	.001	.573
	Wilks' Lambda	.427	10.739[b]	2.000	16.000	.001	.573
	Hotelling's Trace	1.342	10.739[b]	2.000	16.000	.001	.573
	Roy's Largest Root	1.342	10.739[b]	2.000	16.000	.001	.573

a. Design: Intercept
 Within Subjects Design: Inclusion
b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Inclusion	.635	7.257	2	.027	.733	.785	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.
a. Design: Intercept
 Within Subjects Design: Inclusion
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Inclusion	Sphericity Assumed	13.370	2	6.685	4.875	.014	.223
	Greenhouse-Geisser	13.370	1.466	9.123	4.875	.025	.223
	Huynh-Feldt	13.370	1.569	8.519	4.875	.022	.223
	Lower-bound	13.370	1.000	13.370	4.875	.041	.223
Error(Inclusion)	Sphericity Assumed	46.630	34	1.371			
	Greenhouse-Geisser	46.630	24.915	1.872			

	Huynh-Feldt	46.630	26.681	1.748				
	Lower-bound	46.630	17.000	2.743				

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	Inclusion	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Inclusion	Linear	7.111	1	7.111	3.914	.064	.187
	Quadratic	6.259	1	6.259	6.760	.019	.285
Error(Inclusion)	Linear	30.889	17	1.817			
	Quadratic	15.741	17	.926			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	510.296	1	510.296	1126.087	.000	.985
Error	7.704	17	.453			

Estimated Marginal Means
Inclusion

Estimates

Measure: MEASURE_1

Inclusion	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	2.389	.200	1.966	2.812
2	3.556	.202	3.130	3.981
3	3.278	.311	2.621	3.934

Pairwise Comparisons

Measure: MEASURE_1

(I) Inclusion	(J) Inclusion	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-1.167*	.246	.001	-1.819	-.514
	3	-.889	.449	.193	-2.082	.304
2	1	1.167*	.246	.001	.514	1.819
	3	.278	.441	1.000	-.894	1.450
3	1	.889	.449	.193	-.304	2.082

2	-.278	.441	1.000	-1.450	.894

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.573	10.739[a]	2.000	16.000	.001	.573
Wilks' lambda	.427	10.739[a]	2.000	16.000	.001	.573
Hotelling's trace	1.342	10.739[a]	2.000	16.000	.001	.573
Roy's largest root	1.342	10.739[a]	2.000	16.000	.001	.573

Each F tests the multivariate effect of Inclusion. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

5.4 Question 7 One-way ANOVA

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

Spatial	Dependent Variable
1	SRD
2	SRB
3	iDOF

Descriptive Statistics

	Mean	Std. Deviation	N
SRD	2.6111	1.14475	18
SRB	3.5556	1.04162	18
iDOF	3.1667	1.15045	18

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Spatial	Pillai's Trace	.375	4.802[b]	2.000	16.000	.023	.375
	Wilks' Lambda	.625	4.802[b]	2.000	16.000	.023	.375
	Hotelling's Trace	.600	4.802[b]	2.000	16.000	.023	.375

	Roy's Largest Root	.600	4.802[b]	2.000	16.000	.023	.375

a. Design: Intercept
Within Subjects Design: Spatial
b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Spatial	.788	3.811	2	.149	.825	.902	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.
a. Design: Intercept Within Subjects Design: Spatial
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Spatial	Sphericity Assumed	8.111	2	4.056	2.764	.077	.140
	Greenhouse-Geisser	8.111	1.650	4.915	2.764	.089	.140
	Huynh-Feldt	8.111	1.805	4.494	2.764	.084	.140
	Lower-bound	8.111	1.000	8.111	2.764	.115	.140
Error(Spatial)	Sphericity Assumed	49.889	34	1.467			
	Greenhouse-Geisser	49.889	28.054	1.778			
	Huynh-Feldt	49.889	30.682	1.626			
	Lower-bound	49.889	17.000	2.935			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	Spatial	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Spatial	Linear	2.778	1	2.778	1.562	.228	.084
	Quadratic	5.333	1	5.333	4.610	.046	.213
Error(Spatial)	Linear	30.222	17	1.778			
	Quadratic	19.667	17	1.157			

Tests of Between-Subjects Effects

Measure: MEASURE_1 Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	522.667	1	522.667	666.400	.000	.975
Error	13.333	17	.784			

Estimated Marginal Means
Spatial

Estimates

Measure: MEASURE_1

Spatial	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	2.611	.270	2.042	3.180
2	3.556	.246	3.038	4.074
3	3.167	.271	2.595	3.739

Pairwise Comparisons

Measure: MEASURE_1

(I) Spatial	(J) Spatial	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.944*	.297	.016	-1.732	-.157
	3	-.556	.444	.685	-1.736	.624
2	1	.944*	.297	.016	.157	1.732
	3	.389	.451	1.000	-.809	1.587
3	1	.556	.444	.685	-.624	1.736
	2	-.389	.451	1.000	-1.587	.809

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.375	4.802[a]	2.000	16.000	.023	.375
Wilks' lambda	.625	4.802[a]	2.000	16.000	.023	.375
Hotelling's trace	.600	4.802[a]	2.000	16.000	.023	.375
Roy's largest root	.600	4.802[a]	2.000	16.000	.023	.375

Each F tests the multivariate effect of Spatial. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

5.5 Question 8 One-way ANOVA

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

Comfort	Dependent Variable
1	SRD
2	SRB
3	iDOF

Descriptive Statistics

	Mean	Std. Deviation	N
SRD	2.3889	1.03690	18
SRB	3.3333	.90749	18
iDOF	3.5556	1.46417	18

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Comfort	Pillai's Trace	.397	5.266[b]	2.000	16.000	.017	.397
	Wilks' Lambda	.603	5.266[b]	2.000	16.000	.017	.397
	Hotelling's Trace	.658	5.266[b]	2.000	16.000	.017	.397
	Roy's Largest Root	.658	5.266[b]	2.000	16.000	.017	.397

a. Design: Intercept

Within Subjects Design: Comfort

b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Comfort	.838	2.818	2	.244	.861	.949	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Comfort

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Comfort	Sphericity Assumed	13.815	2	6.907	4.083	.026	.194
	Greenhouse-Geisser	13.815	1.722	8.023	4.083	.032	.194
	Huynh-Feldt	13.815	1.898	7.279	4.083	.028	.194
	Lower-bound	13.815	1.000	13.815	4.083	.059	.194
Error(Comfort)	Sphericity Assumed	57.519	34	1.692			
	Greenhouse-Geisser	57.519	29.272	1.965			
	Huynh-Feldt	57.519	32.262	1.783			
	Lower-bound	57.519	17.000	3.383			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	Comfort	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Comfort	Linear	12.250	1	12.250	6.457	.021	.275
	Quadratic	1.565	1	1.565	1.053	.319	.058
Error(Comfort)	Linear	32.250	17	1.897			
	Quadratic	25.269	17	1.486			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	516.463	1	516.463	783.658	.000	.979
Error	11.204	17	.659			

Estimated Marginal Means

Comfort

Estimates

Measure: MEASURE_1

Comfort	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound

1	2.389	.244	1.873	2.905
2	3.333	.214	2.882	3.785
3	3.556	.345	2.827	4.284

Pairwise Comparisons

Measure: MEASURE_1

(I) Comfort	(J) Comfort	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.944*	.338	.037	-1.842	-.047
	3	-1.167	.459	.063	-2.386	.052
2	1	.944*	.338	.037	.047	1.842
	3	-.222	.489	1.000	-1.520	1.076
3	1	1.167	.459	.063	-.052	2.386
	2	.222	.489	1.000	-1.076	1.520

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.397	5.266[a]	2.000	16.000	.017	.397
Wilks' lambda	.603	5.266[a]	2.000	16.000	.017	.397
Hotelling's trace	.658	5.266[a]	2.000	16.000	.017	.397
Roy's largest root	.658	5.266[a]	2.000	16.000	.017	.397

Each F tests the multivariate effect of Comfort. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

Appendices 6

6.1 Question 3 Transcribed participant descriptions

Q3: Look directly at your preferred fixation for each image, then describe any observations linked to your focus being directed.

DVS1:
Umm, my eyes are drawn here, but it's not necessarily the banding on the balloons I think. It's the contrast between the black, the white, and the red. Again, cos all this is blurred out on the left it's kind of, a bit invisible.

I think again here, I am down here. Again it's more to do with the, the colours between the red and, the banding, and the clarity here.

Err, I think this one because everything is in focus, I am drawn to this area, but I don't think anything is necessarily pulling me towards it, I think that it's in the centre.

DVS2:
I am looking at that (area of placed fixation) and it's the gap between these two, these two balloons there, that's sort of drawing me into that area.

And similar, been drawn to this bit here (left hand side of image), and it's this section there (wall gap) that's sort of drawing me into that dot.

And with this one it this lower circle (below, left of fixation), and I think it's this big sort of orange gap (centre image), it's quite prominent in my sight, I'm looking at that and I'm automatically being drawn into this section down here. Probably more so this one than that other one because it was bigger.

DVS3:
So it was these dots, and it was mainly when I moved my eyes up and past these lines the dots seemed to change, they seem to come in and out, so when I move my eyes in and out they seem to change the dots.

It was this I highlighted, and again for the same reason but as not as prominent as previously, because of the blurring, when I move my eyes round they don't, the dots don't seem to move as much.

Again it's the dots, but they are not moving as much as the first image I don't think.

SDV1:
Umm, I would say this sort of area over here, just because the intensity is straight onto your eyes, because it is not blurred, it does not make you want to wonder, cos its all sharp all the way through there, too the outside of the image.

More to right here because on the left you have a blurry image so you, I tend to focus away from that and veer more to right where it is more clear and distinct.

And again, even though it's a different type of blurry around here, I am still focused in this sort of area around here, because of the sharpness of the colours and the bands.

SDV2:
Umm, the targets are helping move my focus to certain points.

Umm, the blur on the left is making me focus over to the right, over here basically.

Umm, the same here, the blurring of the lines is making me look for the sharp area.

SDV3:
Ok, so, these are big, so that suggests that they are close to me. These balloons here are occluded by these balloons and these balloons which suggest that they are behind those, but they occlude the wall which suggests that they are closer to me like. So basically those things are.... well this is different now init!

This is blurry here now, so the things that are closer to me, if I, If I'm focused, if my focus is behind then the things closer to me should be blurry, these are, these are more acutely focussed, this is blurry and this is blurry. So it's, yep, you get me don't you!

This does the same thing but the blur here is too blurry, (err, highlight OK) this is, this is too blurry, errr, this is too blurry, and this is, this is kinda equally blurry as this. So you lose that, so the blurriness here is equally blurry to these blurs.

VSD1:
The, the fact that this is out of focus, kind of soft focus sort of draws my eyes more to the right hand side. Umm, this bit here feels like it's in quite sharp focus, but it, I think the receding focus and increasing focus here means that my eyes are more drawn to around here.

Ok, again, now my eyes are going all over the place trying to make sense of all this. So you know, I kind of flip from here too here, too their too here, ok to here and here. But still kinda drawn to that central bit, I think to do with the position of the balloons.

Umm, this is a bit like the first one in the sense that you have this soft focus on the left hand side. But err, again the right hand side is more err, more in focus, but it draws me to this part of the image here again, so I can, the soft focus round here.

VSD2:
Ok, it's interesting because actually this one at the back, umm here, does appear, especially round here to be, err stand out more, the thing I see first. And then it draws my attention round this side of it. Umm, because these are sort of pixulated it sort of indicates that they are behind, but not very clear.

These all melt into one here, so there is no definition. Again though, this one at the back seems to, because there's this umm, sort of differentiation here between the ones in front and behind draws my eye to that. Where's all the others just still, yer that looks, this one looks further away actually and that's why I'm drawn to that.

Now these are good because these are all fuzzy, so it instantly indicates that their, out of my focal range but they are there, and actually puts this one in front, and these actually start standing out as well so this one gives it a real nice depth. What's interesting is that this one is obviously miles away compared to this one.

VSD3:
So, my focus is around, well this balloon, and probably this side at least, because this is all blurred here, so basically kind of makes you think. And this is clearer so your eyes go towards that, and, yes.

Umm, in this image there isn't really any kind of directioned focus, but because of the position of this balloon and cos it is kind of, quite central, and to the front your focus I suppose is towards, towards this one.

And then this image again, umm, so these balloons here are all blurred, there all blurred these balloons, but they're not, but they're not as blurred as the previous picture, the one before last. Umm, but your focus is still drawn towards this side of the screen because it's much clearer round here.

SVD1:
Umm, so all the lines here are pretty well defined, so its, there's not much differentiation between each of the balloons. (So you can highlight as well. I don't think there is much to highlight. OK that's good).

Umm, here it's obviously more fuzzed on these images and the lines are much more defined here, so I suppose you are more naturally drawn to the more focused balloons.

And likewise, we've got fuzzy balloons this side, and more defined balloons on the top right, so, umm, it helps the user focus on the more defined balloons.

SVD2:

OK then I need to talk now, and say why I'm being directed here, is it? (Yes, if that's your focus). I don't know, I guess it's because it's in the middle I suppose. And it's, err, I don't know, ha aha. It's a very clear image in the middle, so it's easy to look at (good).There you go.

Umm, I'm still here, but it's less clear, it's more blurry, so I'm looking at the outsides as well, but I don't know why.

And that one looks the same as the first one to me, it's the same reasons, because it's a clearer image.

SVD3:
The central balloon, and the edges are all nice and crisp around there, and then I work away around. I'm quite liking drawing over things. Using the rest of the image, but start in the centre, and then work out.

Then this aggravates cos it's gone all fuzzy. The edges are not crisp and that's a little aggravating, ha aha. And that's the same then with the rest of them as you work out, until you get to that side where they start. (Is that helping?) It's repeating where I started with the first picture, and then I'm thinking, O that's annoying their not.

And then this is blurry, so I'm checking where I started from the first fixation, and then this isn't right because these are blurry, and that's a little off-putting until you get to this side where they become crisp again. So I always start at this point, and work around anti clockwise I suppose.

DSV1:
OK, I am looking at the central balloon here (central balloon), and it stands out because there are two balloons immediately behind it, so I guess it gives it depth, the image depth.

I am looking at this image again, the central balloon, and again it stands out because it is the only balloon which you can see in full compared the other balloons either side and also to the side of the image.

I am looking at the balloon directly behind the central balloon, that's drawing my in because of it depth and the fact that the central balloon is immediately in front of it.

DSV2:
Umm yes, so it's here. Umm, I think it's mainly the middle one because it's the first one I looked at, but umm now I'm wondering actually, I don't know if maybe it should be there. But that's not very helpful. Just cos that one is clearer. I wonder if it should have been there, just because it's not so much blurry.

And then in this one I put it there, but I think that's because it's the centre again, but actually it is difficult to direct the focus, because there all clear, none of them are blurry. That's why that one was low as well.

But then this one I put it there because that's the one that actually clearer. Kind of that side of the image, because the other side is all blurry. So yes, this side, kinda this side, maybe a bit there as well, umm, yes, yes.

DSV3:
I think the middle top balloon actually umm, actually blends in slightly, into the sky, with the crisp line, was creating me to look more at that image.

This image here is much more umm clearer, much crisper, much cleaner edge on it. Defiantly catches my eye being in the centre of the screen.

This one here is much more blurred. I didn't realise when I started to look at these that they were different. Umm, the blurred line defiantly takes away the focus from this central balloon, and starts to make you look at areas that look slightly more crisp, I think down here.

VDS1:
Umm, so this one I look at mainly, I think because these are blurred over here, are all blurred it makes you look towards the ones more in focus because there easier to look at, and easier on the eye probably.

And similar again with these, though because this one is clearer I think I look at that one a little bit more. Umm, again because these are all blurred over here, and that one is very slightly, I tend to focus on the ones that aren't blurred.

Umm, this one I just look in the middle because there all nice and clear, so I just look straight at the one in front of me really.

VDS2:
Umm, I think these, the way that theses point, there almost like arrows telling me where to look, to here.

Yes, same sort of principle again, (I'm really rubbish with this mouse) but probably pointing it more towards here this time.

Here, (am I supposed to draw a circle. You're highlighting anything and giving a description, what bits help). Umm, yes, that brick wall is sticking out quite a lot.

VDS3:
I'm not sure what it is about this image. The lines here, the kind of the, lack of clarity around these lines here, kind of draws your eye inwards.

Umm, again there is something going on this side where you got these unclear lines which is making my focus go over here, umm where the lines are more clear (like the first one? Yes).

OK, all of the lines, the lines are much, much clearer in this image, umm but I'm drawn to over here. I don't know if it's that shape there that is particularly nice. Or the way that the lines are, are stylised there, but my eyes are drawn to that line there.

6.2 Question 5 Transcribed participant descriptions

Q5: Look directly at your preferred fixation for each image; then describe any observations that help you determine the different balloon locations.

DVS1:
So again, my focus is kind of over here, because this the clearest area I think, and I can kind of tell the locations because the striping's on the balloons weren't overlapping, were overlapping.

Umm, again here is kind of similar. Actually no I think my focus is here. I think because these are the strongest bandings and they are in focus and their overlapping and see their different. You can still tell the locations even though this is kind of obscured a bit but not so much that you can't tell they are there.

Umm, this is obviously really clear again. I think this is why my focus always goes towards the middle, but everything is quite clear; I think that the red brick helps to highlight everything as well, because you can see the edges.

DVS2:

Ok, so the wall itself is actually quite a big influence for me, because I can tell that's in the background. It's almost like a point of reference for everything else. The stripes going along this edge make this one prominent and everything else seems to be around that one.

This corner down here is slightly more confusing than everything else. Umm, I think it's probably because these stripes and these stripes are all going in the same direction even though the ball above it, balloon sorry, appears further behind.

Umm, whereas this corner, these three balloons here on the right hand side, it's easier to differentiate there distance from one another, umm, because there's more of a circular motion on the lines. Whereas this corner, they seem to be quite vertical.

DVS3:
Umm, It's this balloon, and this balloon, you can tell that there in the, in the front and that there clearly behind. Umm, and that one is clearly in the background to both that one and that one.

Umm, it's a bit more difficult but again this one is a big, perhaps you put it into perspective, those are clearly behind. Umm, I guess that one is in front of the other two, as is this one.

These are a bit flatter, but there's clearly overlap again so that one is in front of those two. Umm, and they, again that one overlaps again (sorry I ran out of time).

SDV1:
So highlight my area or highlight each individual balloon, whatever, whatever I feel (whatever helps). So again, well this, this is the area. Umm, the things that highlight the balloons are the, the detail, the sharpness of the lines, umm, no merging, bit, bit of 3D, you got the depth and then you get the nearer images as well.

Umm, the area again is here. Umm, the areas that I said were easy to distinguish, the ends of the balloons, the, the depth of the images aren't so pronounced now.

Umm, this is the area. Umm, actually the distinguishing features that you look at, maybe the ends of the balloons are quite actually difficult to, to pick out in this one compared to the previous one.

SDV2:
Umm, The different directions of the lines on the balloons are helping to distinguish which balloons.

The blurring over here makes it more difficult to distinguish between the two different balloons.

And again the pixilation that you can see here doesn't help you distinguish with the different locations are.

SDV3:
OK, so theses, theses balloons, that balloon is in front of that balloon. This balloon is in front of the other two balloons behind; this balloon is in front of that balloon. (Random arr, err, and) That balloon and this balloon are in, are comparably located.

Umm, and then you got another level of detail, you got blurriness here again. So as in this before, this is completely not blurred, and so is this. Suggesting that this, and this are at the same, are on the same plane. Whereas this is blurred, and this is blurred, suggesting there on the same plane, right.

Umm, alright this is the blurring exaggerated, ummmm, so actually that's equally as blurred as, as, as that isn't it. So, even though it's secluded by that, it suggesting its behind. So that's really close to you and that's really far away.

VSD1:

Yes, so straight away again, I am sort of drawn to this area. Umm, this, the way this sort of, the focus sort of decreases here, draws my eye a little bit, to sort of take that in quickly, and I can see this, this is a bit fuzzy, in front of my vision. Like if something was positioned close to my eyes, you know how it goes a bit out of focus.

Again, around here more for this one. I find it a bit confusing, I kind of want to go from here to here and then take in these bits of the side, and umm, yes, it's a bit more difficult to figure it all out, cos my eyes are trying to take it all in at once bit it's a bit too much.

OK, yes, straight away around here again. Err, this soft focus again I think somehow draws my focus to this part of the image. This feels quite well defined so I feel that this is all close to me, this, this, and this. But the effect, this part here, this feels like the bit I'm being drawn too.

VSD2:
OK, so, this one stands out more (am I highlighting, yes you are highlighting). This one stands out more; it’s crisper than the others. This one falls into the background, because of the pixellated.

The only thing that offers depth is like the overlays here. Actually this is, this one stands out because it seems to be in front of most of the balloons. Although these are bigger, so they would appear actually to be closer and these further away.

The crispness on these pulls you to these, these balloons here. And this is just in the peripheral, just outside. Yes, this is further, (change of mind) this is closer.

VSD3:
OK, so umm, these balloons up here are obviously, they are higher than the ones down here, but in relation to, I suppose the ground, umm, I assume that there quite far away from the wall behind I think like blurriness.

Umm, with these balloons it doesn't look umm, as high off the ground, they might be at the level of the wall, because there is no real distinction between the wall and the back. Obviously you can tell that these ones are still raised higher than those ones. Umm, but yes, but they seem very far from the wall.

And then with these balloons they seem. I think they seem further away from the wall in fact, because the wall starts to get a bit blurry at the back so it looks like they're coming, like out this way, if that makes sense. Out and up this way. So, umm, yes I think they are further away and higher

SVD1:
I guess it's similar to my early description, there's no, nothing that differentiates, oooo. This is larger balloons up there. Up here it would appear to be the front and smaller at the back, but there's nothing in terms of the picture quality that helps you get a sense of depth.

Umm, whereas with this one you got a fuzzy image round the side and clearer, much clearer here, umm, and here to relate.

Umm, so yes again, clear, clearer lines help give you a, umm sense of depth.

SVD2:
(OK, Do you want me to highlight stuff as well. Yes, if you can if there is anything to highlight). Well they are all very clearly delineated I think, because they got clear lines (does that help you to know where they are? I think so). These are bigger and these are smaller. Is that good? Ha ha. These Ooooo.

These are blurry on the out; these ones here are blurrier than they were before. And these are clearer. So perhaps that means there further away, I don't know. Is that the kind of thing you want me to say?

Tell me ha ha. Umm, these, this side on the right hand side is clearer than the left hand side, these are blurrier than these. I'm not sure it makes, I suppose these look closer than these do.

SVD3:
This, the central ones because there in the centre of the picture, and then it's working, they are in reference to the wall, in the back and to each other, so you are using the knotty bits at the bottom. And with the nice sharp edges you can see where one balloon starts and ends.

In this one everything's gone a bit more blurry, so the edges are crossing to, not as immediately clear at this side of the picture, as in this side, this side is still quite sharp where the edges are. So this is the blurring in relation to each other and the wall.

Again this is similar, because they are all crossing into each other now. So it's not as immediately easy to (does this not help you to determine where the balloons are) I think it makes it less easy to see individual balloons as (more) a lump. You can see that balloon lump but not an individual balloon.

DSV1:
I'm looking at the central balloon, and I notice the two balloons directly behind it. This one here on the right and this one, this one on the left and this one on the right, umm slightly obscured.

The clarity of these balloons, the one that I fixated on and also the surrounding ones, it's very clear. There's no blurring of the boundaries so it makes it a lot easier to, to determine the position of the balloons, balloons in relation to the central one.

The lines of these balloons, the central one, but particularly the ones on the outside are more blurred; this makes it a bit more difficult to tell. Umm, it's the depth isn't it; to determine where they are in relation to the central balloon that I have been looking at.

DSV2:
Umm, I said I kind of looked here and here before didn't I. I think, umm, I don't know. I can see that those are behind, because that ones in the middle it's quite central so I can see that those are behind, and then see that these are kind of coming towards the front. Those are a bit blurry but you can see there in front. (Is that the right kind of idea? Yes, yes, you are doing really well. OK).

Umm, yer, here it's just clearer so you can see that one again, kind of, just because it's the central point, but for some reason I kind of looked here, I don't know, maybe it's because it's the middle of the image. I can see those are behind and yer, it just makes it a bit clearer. Those are clearest so I can see that there one in front of the other.

Umm, I sort of looked here, and kind of here because it's clearer. That's more blurry so it's not as clear to see where they are, but you can still kind of see, (arrr, yer, is that alright?)

DSV3:

OK, so first impressions, the dot looking like the eye, umm, gives a good idea of the ones you can actually see. Umm moving into the one on the left it was more the, umm, sections, the little flap on the bottom that is giving an indication, because the eye is not there.

Umm, the actual lines themselves, margining over makes it quite clear to see a break and the colour, crisp black against the white clearly allows that to happen.

In this one the balloons on the right hand side, they seem to be clear. Umm, definition between where they sitting (location on screen). Again the balloons up, in the centre, umm, they look crisp enough because, of three big black dots there, moving over to the left hand side, all blend into each other because of the blurred boundaries.

VDS1:

Umm, Ok, I think mostly the size, the balloons, because they all look the same. Umm, I think because these ones are bigger you kind of assume that there closer, whereas, because these ones are smaller (wow, wow, too quick) you assume there further away.

Umm, and the same again really, although, because these over here are blurred, it's a bit uncertain as to where they are in relation to each other. Umm, these ones it's clearer that there further away, but you can see the overlaps on those quite clearly.

Umm, this one it just again seems quite clear, these are all larger so. You can see that there in front of these ones, because there smaller basically. You can see the overlaps clearly on those ones, whereas on the others you couldn't.

VDS2:

Umm, Yes, this side is not as clear as the. (Please highlight - O, yes, ha ah, I don't think I have the gist of this highlighting, ha ha). O, Yes, it's not as clear as that bit.

Umm, Yes, this is drawing my attention.

Umm, I think more of it this time (breathing), because the balloons are clearer and the wall is clearer, ha ha (you are doing really well, really well.)

VDS3:
Obviously got the contrast here where you can make out where each different balloon is. The shapes help as well in terms of defining where the balloons lie in relation to each other.

These ones seem closer than the ones on this side, because the, because of the lack of clarity around the lines, so it seems like it is closer to you.

OK, with this one, again it's the contrast here so you can determine that obviously this balloon is in front of the other one. Umm, it's much clearer to recognise in this one because of the, because the way that the lines are clearer, more in focus.

6.3 Question 9 Transcribed participant descriptions

Q9: Look directly at your preferred fixation for each image; then describe any observations that make the image feel naturalistic.

DVS1:
Umm, the, so, as I mentioned, they kind of, the blur in this region kind of helps to give umm, a kind of a layer of depth, and some perspective, because it puts everything here in focus (and here) ha aha ah.

Umm, I think again theirs a bit of a blur here, but it's, it kind of assists but it's less comfortable, what kind of draws your eye is the clarity in this region, this overlap here.

Umm, the thing with this picture. The only thing I think that helps is the kind of clarity of these balloons, not; as I said the rest of this image I find quite jarring with the conflicting stripes. Then I have only kind of seen this string, that's quite natural, ha aha ah.

DVS2:
Umm, Only just noticed there's a string on this particular balloon. That makes it, that gives it a detail, it's a minor detail, but it helps to add to the realism of the screen.

This one doesn't feel as, as real. Umm, it could be my eyes playing tricks on me but it looks less focused, less, less crisp and sharp around these points, especially down this side.

Yes, as this one is a lot crisper, a lot sharper. Umm, the only thing that's not as I would expect is, I've got a strong sense of focus on these balloons here, but the wall is also crisp, so the depth of field of (the) perception isn't what I would perceive my eyes to actually be like in a natural environment.

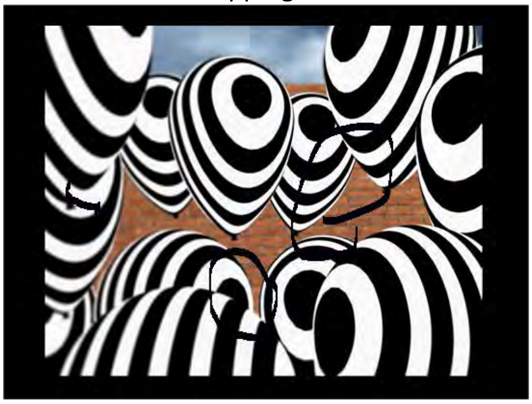
DVS3:
My eyes are always drawn to here, which naturally puts these into, out of focus which makes it a bit more natural. But then this part here is skewing me a bit, it's a bit to blurred.

Umm, It's to blurry here, here, doesn't feel naturalistic at all. Balloons wouldn't be blurry. Even when I look here, I can tell it's too burry over there.

I guess there just too flat, there's no depth, if that makes sense (yes). You can tell ones on top of the other there, but there's no depth, no depth to it.

SDV1:
So it's quite, very realistic because it's very, umm, sharp. You get the depthness of the image. Umm, so areas sort of like here, here, and the sharpness of the lines integrate with the background, make it very realistic. And I suppose, I'm sorry.

Not as, umm, natural, umm, because you got the blurring here, you can't, blurring round here you can't tell the depthness of the images. Umm, whereas images like here, you can tell, you can tell when one is overlapping to the other as well down here.



Again, not very natural because you got the blurriness round here, and here. You've got a bit of, bit of sharpness around here, which allows the prominent balloon to come out towards you, umm and again round here as well.

SDV2:
Umm, the attention to detail with the strings, and the ties of the balloons. Umm, and also the circular patterns giving it a 3D idea.

Umm, I don’t know, ha ha. I’m sorry. I can’t think of anything else to put than that.

That doesn’t look real at all, because of the pixilation. Sorry

SDV3:
OK, so the thing is, the is, the occlusion of balloons isn't it. So that's, that's, that's, that occludes that, that occludes that, that occludes that, and that, that and it doesn't work so well on this, in this, in this area, and everything is occluded by the, the wall is occluded.

To get on with this image the thing that makes it more naturalistic is the, is the blurriness isn't it. Blurriness here is comparable to the blurriness here, and here, because the occlusion. That's just, that's further away. Umm, and that's just, that's further away as well. Err, because it's behind that balloon but it's equally, equally blurred.

And this image is not naturalistic at all; the blurriness is, is too blurred, it's too blurred here, and here, and here. Err, but it's not blurred here at all. So it doesn't seem right. So it's the, it's, it's the interplay between occlusion and blurriness isn't it. So that's, that, that, that's, nerrrrooooo.

VSD1:
Umm, umm, I don't think the, the, the courses of this, these sort of you know, these sort of areas you know round here and here and here makes it seem particularly realistic.

This is my sort of focus. It does appear kind of natural but confusing so, umm, I think more natural because of the high degree of contrast, but at the same time confusing because of the high degree of contrast.

This one's probably an idealisation in some way of how, umm, the first, most naturalistic, this is my point of focus, in this setup in all the images but, err, umm. The, again this, this soft smoothing of the image here, the soft focus doesn't feel initially natural in some ways.

VSD2:
Umm, how these sink to the background and then these are in the foreground. I guess slight shading, so you get an impression that. I stare at this point, there, there but they're not.

Doesn't feel, this one doesn't feel at all natural, because all of these are fighting to be at the front. But Interesting, if I stare really hard at these, these do become, these do move to the front and these slip into the background.

Interestingly, focus is really easy round here. If I stare, these fall into the background, but they also, this one hurts my eyes slightly. Err, it's so, so blurry that it's not really natural. Umm

VSD3:
I don't think much of it does because it's just so blurry, and I don't really have, like, I don't see everything, I've got good vision so I don't see things like this. Umm, I suppose the string, (O sorry, the string there, that, it's gone now).

Umm, these images are more crisp, but still like, I'm not sure but there, there not, umm, very kind of clean circles on them, although the shape of them is kind of how you, how a balloon would kind of look like, umm, but still there a little bit to crisp I suppose.

And then where as these ones. Like if you were looking at a balloon set like this, then these ones would kind of be out in your peripheral vision or they wouldn't be so much of a clear focus cos you would be focusing around here. So umm, this looks more naturalistic because, although the lines are, I don't know, crisper. There's still like, where you wouldn't normally focus, more blurry.

SVD1:
Umm, Well I suppose the, the different rings allow you to sense the shape of the object, and the fact that there not, well they are 2 dimensional, but.

Yes, the blurring here I suppose, umm makes your, gives you a feeling that there much closer towards you. Whereas the crisper lines make them, helps you focus.

And likewise with this one, the, the blurry image, umm, makes you feel like it's too close, but there, it's much, umm, clearer than some of the other balloons that kind of draw you into them.

SVD2:
OK, umm I don't know what to say about that. I suppose there quite flat, because they've got clear lines round them (do they feel naturalistic) I don't know really, that's a rubbish answer.

They feel more natural than that to me. That doesn't feel naturalistic at all. It feels blurry. Blurry here, blurry here, and clearer here.

I suppose that was the most naturalistic, because these are blurrier, and I am being drawn to the middle of the picture. So it feels like these are further away than these.

SVD3:
Umm, this one here feels like you could be holding these balloons, and they are very close to you. You can clearly see exactly where they are in relation to each other, and the background environment. There nice and sharp, like they should be, as long as you have your lenses in, ha aha.

This, this smudging around the edges, I don't like it, it doesn't look naturalistic. It wouldn't look like that. Whereas these do and if. It's not naturalistic at all. It wouldn't have these edges if this was a real experience.

This one's not too bad. This one could be half; one lens in and one lens out maybe. You could, you could be holding these balloons and one of your contact lenses has fallen out, or you need to go and get your eyes checked out. This one isn't as uncomfortable and slightly naturalistic, but not as much as the first one.

DSV1:
The central balloon is quite sharp in focus. What makes this feel more naturalistic is the fact that the balloons on the outside are more blurred, particularly on the left, giving depth.

In this particular, umm, scene all of the balloons are very sharp, which makes it feel a bit less, less natural, because it doesn't give as much depth to the picture. Particular on the outside.

This picture, umm, on the right hand side, umm, it, it appears that the balloons are closer, because they are sharper. The balloons on the left are, umm, there lines are more blurred, which makes it feel that the balloons are a bit further away.

DSV2:

OK, actually I think this one, because I said kind of here and here. Because when you look at it, really if you look at something, that would be blurry because you would be looking directly at that point, that bit should be blurry, so I think this one probably seem most real, but I not sure if that goes against the answers I did at the beginning. That's why it was the most comfortable to look at.

This one, now I look at it now, actually seems quite flat to the screen, because it's all, because it's clear, and I think I just looked there because it was the middle. But actually if I was looking there, that bit shouldn't be as clear. It's what I'm now thinking. It just looks like it is more painted on.

And then this one, it's kind of got the blurry bit there which would be if you're looking kind of here or this bit's clearer. That would be blurry, but it's not in the same way as the first one, it's a different kind of blur. The first one's more like I'm actually looking at it. This one's more like, just looks like the pictures been painted all fuzzy. So the first one is the clearest one.

DSV3:
I feel that this balloon stands out most, it’s nice and clear. I can see that the two are obviously in the background, umm, although still quite clear.

This one is much, much clearer to me. Umm, it’s easy to see how many balloons, very crisp, and clear. Really covering all of them, again this one would jump out too me, however these two, down here seem even closer, these two sitting behind, umm.

This one here, the two bottom ones stand out as being closest. However, the, all the blurred lines all around here, umm, makes it disappointing to look at. Umm, losses the tension quite quickly.

VDS1:
Umm, I think this is slightly naturalistic. Umm, just cos I think when things are really up close to you, like these ones seem like they would be. There not always that clear, well for me anyway. So I think because they are a little bit like that, it makes it seem sort off more real.

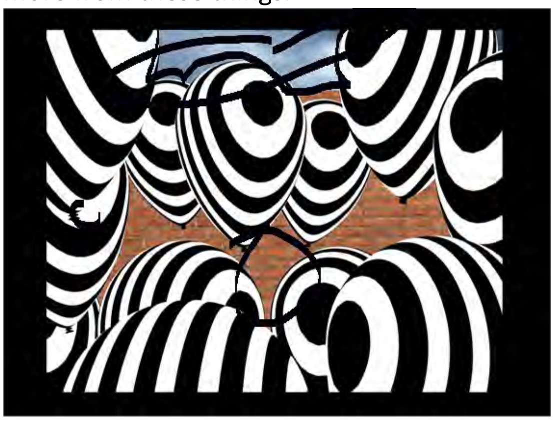
Umm, this I suppose doesn't, unless you have bad vision, because there so blurred. It just doesn't seem natural to me, these ones over here. These, this side of the picture more so, because these are clearer, don't know, just a different kind of blurred, as if you look, you have glasses on and you shouldn't or something.

Umm, these seem quite real. Umm, I'm not sure about these over here, just; you can't kind of work out that there balloons. They just almost look like loads of black lines all next to each other, so it doesn't seem that natural.

VDS2:
Umm, not a lot.

Umm, this one's a bit more naturalistic than the other, because of, I think these things, ha ha. And here isn't as fuzzy.

Arr, this one's naturalistic. These all look real, bricks look real, and kind of the sky sticks out a bit more from these things.



VDS3:
There's not a lot in this image that feels naturalistic, umm, obviously these are unclear, (highlight them) these unclear lines wouldn't occur in real life. Umm, this side of the image feels much more realistic, with the clarity of the lines, umm, but this side doesn't feel realistic at all.

This feels more realistic than the last one. Umm, again you kind of got this, this lack of clarity here which wouldn't occur in real life, and this side feels more, more realistic, more naturalistic. Umm, the centre of the image feels quite natural, in terms of you've got the depth between the balloons.

OK, this image I think is the most naturalistic of all three. You've got these clear lines here, umm, and again you've kind of got clear depth of perception in terms of the balloons. Umm, yes, this feels more, more naturalistic.

Appendices 7

7.1 Second application for ethical approval to carry out experiments

CARDIFF METROPOLITAN UNIVERSITY
APPLICATION FOR ETHICS APPROVAL

When undertaking a research or enterprise project, Cardiff Met staff and students are obliged to complete this form in order that the ethics implications of that project may be considered.

If the project requires ethics approval from an external agency such as the NHS or MoD, you will not need to seek additional ethics approval from Cardiff Met. You should however complete Part One of this form and attach a copy of your NHS application in order that your School is aware of the project.

The document ***Guidelines for obtaining ethics approval*** will help you complete this form. It is available from the Cardiff Met website.

Once you have completed the form, sign the declaration and forward to your School Research Ethics Committee.

PLEASE NOTE:

Participant recruitment or data collection must not commence until ethics approval has been obtained.

PART ONE

Name of applicant:	Joseph Baldwin
Supervisor (if student project):	Rob Pepperell, Steve Gill, Darren Walker
School:	Cardiff School of Art & Design
Student number (if applicable):	st10007499 / sm70479
Programme enrolled on (if applicable):	KESS funded PhD
Project Title:	Exploring methods of modelling real world spatial awareness in images.
Expected Start Date:	17/04/2013
Approximate Duration:	17/10/2014
Funding Body (if applicable):	Fovography is conceptualised by Robert Pepperell, with Cardiff Metropolitan University supporting its intellectual creation.
Other researcher(s) working on the project:	none
Will the study involve NHS patients or staff?	No
Will the study involve taking samples of human origin from participants?	No

In no more than 150 words, give a non technical summary of the project
To investigate the extent to which Fovography image properties, can create a greater sense of spatial awareness (depth), in comparison to conventional photographs. There is limited understanding of how our perception of the world is presented within the mind and how it can be represented in images. Historically, artists have tended to conform to rules based on linear perspective, using these pictorial laws to reproduce approximate scenes. Scientists have also tended to identify with human vision based on the basic role of optics through photography, but there are real vision limitations in these methods. The comparative study is a good starting point to analyze popular experiential feelings between original photographs, and Fovography counterparts. We will ask participants to navigate through an interactive slide show, recounting their experience of viewed images, through verbal, and ranked responses.

Does your project fall entirely within one of the following categories:	
Paper based, involving only documents in the public domain	No
Laboratory based, not involving human participants or human tissue samples	No
Practice based not involving human participants (eg curatorial, practice audit)	No
Compulsory projects in professional practice (eg Initial Teacher Education)	No
If you have answered YES to any of these questions, no further information regarding your project is required. If you have answered NO to all of these questions, you must complete Part 2 of this form	
DECLARATION: **I confirm that this project conforms with the Cardiff Met Research Governance Framework**	
Signature of the applicant: *Joseph Baldwin*	Date: 12/03/2013
FOR STUDENT PROJECTS ONLY	
Name of supervisor: Dr Darren Walker	Date: 12/03/2013
Signature of supervisor: *Dr Darren Walker*	

Research Ethics Committee use only	
Decision reached:	Project approved ☐ Project approved in principle ☐ Decision deferred ☐ Project not approved ☐ Project rejected ☐
Project reference number: Click here to enter text.	
Name: Click here to enter text.	Date: Click here to enter a date.

Signature:
Details of any conditions upon which approval is dependant: Click here to enter text.

PART TWO

A RESEARCH DESIGN	
A1 Will you be using an approved protocol in your project?	No
A2 If yes, please state the name and code of the approved protocol to be used[3]	
Click here to enter text.	
A3 Describe the research design to be used in your project	
Each session will involve participant's eye movement being recorded, whilst they look at images presented using conventional 2D display technology (computer monitor, projector, TV, etc). Display equipment with coupled eye tracking, allows participants gaze path of stimulus to be recorded without fitting them with special glasses, used in previous studies. The study should take about 30 minutes, using verbal and Likert scale responses, within an interactive slideshow. T- Tests and correlations are used to analyse ranked data, whilst video, and audio recordings of the research will be coded, studied and transcribed. We will then look for reoccurring themes, values and views. Approximately 30 participants, Male and female, ranging 18 – 50 years will be used. An internal staff/student canvas email will be sent, which will allow concealed sign up via, http://www.supersaas.co.uk/schedule/joebaldwin/Fovography_study. It will be necessary to pay the participants, as without it we cannot guarantee a full sample at this time. In previous studies course credits have been offered to Psychology students, but these are no longer available as a way to sign up participants. A gift card (Amazon) would be given for signing up, journey time, and time spent participating in the study.	
A4 Will the project involve deceptive or covert research?	No
A5 If yes, give a rationale for the use of deceptive or covert research	
Click here to enter text.	

B PREVIOUS EXPERIENCE
B1 What previous experience of research involving human participants relevant to this project do you have?
I have successfully run two previous human research studies, involving image comparison stimuli, and eye tracking equipment with supervisor guidance. I have previously been a classroom teacher for 10 years.
B2 **Student project only** What previous experience of research involving human participants relevant to this project does your supervisor have?
Dr Darren Walker has extensive experience in running experimental studies involving both young and old participants.

C POTENTIAL RISKS
C1 What potential risks do you foresee?

[3] An Approved Protocol is one which has been approved by Cardiff Met to be used under supervision of designated members of staff; a list of approved protocols can be found on the Cardiff Met website here

We have tried the equipment with colleagues, and undertaken research into the risk of discomfort. Our investigations suggest that participants are not at risk in the study.
C2 How will you deal with the potential risks?
However, should any participant experience discomfort whilst viewing, and responding to images, they will be able to stop immediately.

When submitting your application you **MUST** attach a copy of the following:

- All information sheets
- Consent/assent form(s)

Refer to the document ***Guidelines for obtaining ethics approval*** for further details on what format these documents should take.

Application for ethics approval v1 August 2012

Cardiff Metropolitan University
Prifysgol Fetropolitan Caerdydd
UWIC

Date: 24 April 2013

Joseph Baldwin
Cardiff School of Art & Design
Cardiff Metropolitan University
Howard Gardens
Cardiff
CF24 0SP

Dear Joseph

Application for Ethics Approval: J. Baldwin
Title of Project: Exploring methods of modelling real world spatial awareness in images.
CSAD EC reference number: 04-1213-A

Thank you for resubmitting your application for ethics approval. This was considered by the Chair of the Cardiff School of Art and Design Research Ethics Committee.

I can confirm that CSAD REC has approved your application.

Ethics approval for the project has been granted for an initial period of twelve months. Should your project extend beyond this time an application for an extension to the approval will be required by CSAD REC.

Please note, your project has been granted ethics approval based on the information provided in your application. However, should this change at any point during your study or should you wish to engage participants to undertake further research then you are required to reapply to CSAD REC for ethics approval.

Best Wishes

Wendy Keay-Bright

Dr. Wendy Keay-Bright
Chair: Cardiff School of Art and Design Research Ethics Committee
Reader in Inclusive Design
Cardiff Metropolitan University

Cardiff School of Art & Design
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7.2 Canvas email

Looking for participants - PhD study - £10 Amazon voucher - 20 minutes.

Dear University associate,

Please can you spare some time to participate in a PhD study; looking at the visual properties of a photographed environment.

Your involvement:
You will view various images, whilst responding to questions relating to your viewable experience. Each session will involve participant's eye movement being recorded, whilst images are presented using a monitor.

- You will complete a participant consent form prior to taking part, which will give further explanation of the study.
- The study should then take no more 20 minutes.
- A £10 gift card (Amazon) will be issued at the end of each session for signing up, journey time, and participating in the study.

Please use the link below to sign up for one session
The study will take place in the Llandaff Psychology department, N block, 3rd floor (The PARC rooms).

- Timetable slots are assigned on a first come, first served basis.
- Select your preferred day and time.
- Your name, and email address will only be visible to myself.

http://www.supersaas.co.uk/schedule/joebaldwin/Fovography_study

Please feel free to email me any questions jobaldwin@cardiffmet.ac.uk

Best Regards
Joe Baldwin
Academic Associate/Cyswllt Academaidd
Cardiff Metropolitan University/Prifysgol Fetropolitan Caerdydd,

7.3 Participant information sheet

Cardiff Metropolitan University RESEARCH ETHICS COMMITTEE

Cardiff Metropolitan University

Cardiff School of Art & Design, Western Avenue, CARDIFF CF5 2YB
www.cardiffmet.ac.uk

Participant Information Sheet

Title of project**: Exploring methods of modelling real world spatial awareness in images.**

Your participation in the research project:
The purpose of this document is to let you know what this study will involve, in order that you may make an informed decision on whether or not you want to take part.

Why you have been asked?
You have been asked to participate in a user study; looking at the spatial awareness (depth) properties of a photographed environment. This will be carried out using conventional 2D display technology (computer monitor, projector, TV, etc).

The study will be run by Joe Baldwin, within the psychology department, at Cardiff Metropolitan University. The results of the study will be used to inform the development of a new spatial awareness (depth) process, and may also be published in academic papers.

By agreeing to take part in this study, you confirm that you are:

- 18 years of age
- Familiar with, and make use of various forms of 2D display technology (TV, cinema projector, phones).

There is absolutely no obligation of any kind to join the study, and the university will not discriminate in any way against anyone who does not want to take part.

Gift card!
A gift card (Amazon) will be issued at the end of the session for signing up, journey time, and time spent participating in the study.

What would happen if you join the study?
Each session will involve participant's eye movement being recorded, whilst they look at images presented using conventional display technology (computer monitor, projector, TV, etc). Display equipment with coupled eye tracking, allows participants gaze path of stimulus to be recorded without time spent fitting special glasses, used in precious studies. The study should take about 30 minutes, including verbal and ranking responses within an interactive slideshow.

What happens if you want to change your mind?
If you decide to join the study you can change your mind and stop at any time. We will completely respect your decision.

Are there any risks?
We have tried the equipment with colleagues, and undertaken research into the risk of discomfort. Our investigations suggest that participants are not at risk in the study. However, should any participant experience discomfort whilst viewing, and responding to images, they will be able to stop immediately.

Your rights
Joining the study does not mean you have to give up any legal rights. In the very unlikely event of something going wrong, the Cardiff Metropolitan University fully indemnifies its staff, and participants are covered by its insurance.

What happens to the questionnaire, interview and video results?
Video and audio recordings of the research will be coded, studied and transcribed. We will then look for reoccurring themes, values and views.

Are there any benefits from taking part?
There are no direct benefits to you for taking part; however this study may help improve the types of products available to you in the future.

How we protect your privacy
You will be identified exclusively by an ID code throughout documentation. Data access will be limited to the researcher in question, me (Joseph Baldwin), PhD supervisory team, and the external examiner. Should associated lecturers require access at a future date (for example data analysis); this will be permissible only with one of the above named parties in attendance. All data captured will be deleted after analysis unless specific elements are necessary to keep helping justify the rationale for PhD hypothesis. This retained data will be stored in a locked cupboard, in accordance with data protection guidelines. Other research data, such as interview transcriptions, will also be coded and stored in a locked cupboard. Data will be used for agreed purposes only and anticipate this to be for 5 years. All participants will be debriefed at the end of their participation.

Please Note: *YOU WILL BE GIVEN A COPY OF THIS SHEET TO KEEP, TOGETHER WITH A COPY OF YOUR CONSENT FORM*

Contact Details
If you want to find out more about the project, or if you need more information to help you make a decision about joining in, please contact:

Mr Joseph Baldwin
Academic associate,
Cardiff School of Art & Design,
Cardiff Metropolitan University
jobaldwin@cardiffmet.ac.uk

7.4 Participant consent form

Cardiff Metropolitan University RESEARCH ETHICS COMMITTEE

Cardiff Metropolitan University

Ethics Protocol Number: N/A   Participant study ID number:

PARTICIPANT CONSENT FORM

Title of Project: Exploring methods of modelling real world spatial awareness in images.

Name of Researcher: Joseph Baldwin

Participant to complete this section: **Please initial each box.**

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my relationship with the University, or my legal rights, being affected. ☐

3. I understand that relevant sections of any of research notes and data collected during the study may be looked at by responsible individuals from the University for monitoring purposes, where it is relevant to my taking part in this research. ☐

4. I give permission for study to be video recorded ☐

5. I agree to the use of anonymous data and quotes in publications ☐

6. I agree to take part in the above study. ☐

7. I agree to be contacted in the future by University researchers who would like to invite me to participate in follow up studies to this project ☐

____

Name of Participant

____

Signature of Participant Date

_____Joseph Baldwin____

Name of person taking consent

____

Signature of person taking consent Date

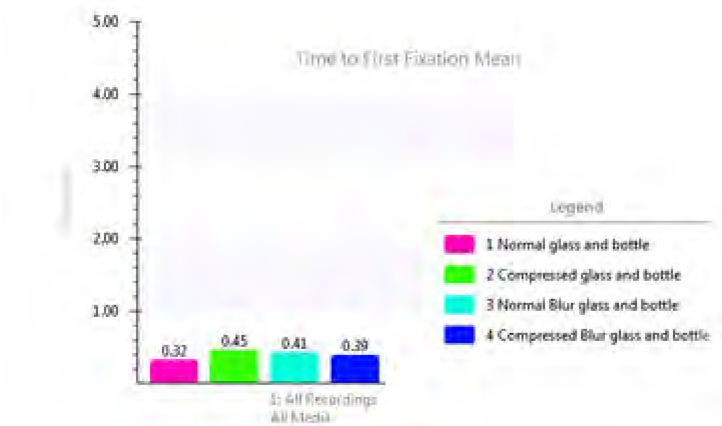
When completed, 1 copy for participant and 1 copy for researcher site

Appendices 8

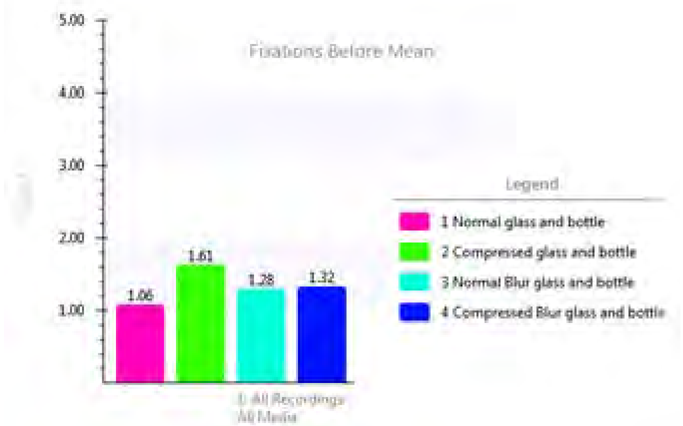
8.1 Repeated measures screening combinations of stimuli

Group 1	Group 4	Group 5	Group 6
Glass	Sapphire3	Sapphire4	Flower
Sapphire1	Sapphire2	Flower	Sapphire3
Sapphire2	Flower	Sapphire3	Sapphire1
Sapphire3	Glass	Sapphire2	Sapphire4
Sapphire4	Sapphire1	Glass	Sapphire2
Flower	Sapphire4	Sapphire1	Glass
Table - Showing the repeated measures order that each group viewed the different combinations of stimuli.			

8.2 Tobii studio intended focus area (AOI) mean bar charts for each condition: Time to First Fixation, Fixations Before, Visit Durations, Visit Counts, and Fixation Counts

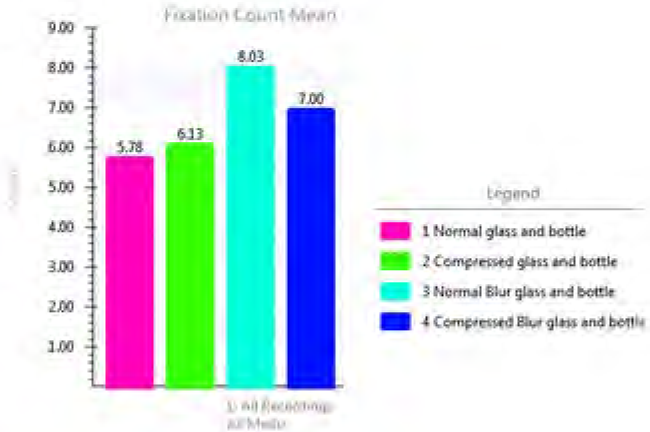


Time to First Fixation: The time from the start of the stimulus display until the test participant fixates on the AOI or AOI Group for the first time (seconds).



Fixations Before: Number of times the participant fixates on the media before fixating on an AOI or AOI Group for the first time (count).

Total Visit Duration: (former Observation Length) Duration of all visits within an AOI or an AOI Group (seconds).



Fixation count: Number of times the participant fixates on an AOI or an AOI Group (count).

Visit Count: Number of visits within an AOI or an AOI Group (count).

8.3 Percentage Fixation, showing which participants had not fixated on the intended focus area (AOI) in each condition

Percentage Fixated Percentage of participants that fixated at least once within an AOI or AOI Group (%).

Percentage Fixated												
All Media												
	1 Normal glass and bottle			2 Compressed glass and b...			3 Normal Blur glass and b...			4 Compressed Blur glass a...		
Participants	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)
g1a	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g1b	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g1c	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g1d	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g1e	1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%
g1f	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g1g	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%
g1h	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4a	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4b	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4c	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4d	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4e	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4f	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4g	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4h	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5a	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5b	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5c	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5d	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5e	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5f	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5g	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5h	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6a	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6b	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6c	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6d	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6e	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6f	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6g	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6h	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
All Recordings	32	100%	3200%	32	97%	3100%	32	100%	3200%	32	97%	3100%

8.4 Time to First Fixation for the intended focus area (AOI) in each condition (different number (N count) of participants respectively)

Time to First Fixation The time from the start of the stimulus display until the test participant fixates on the AOI or AOI Group for the first time (seconds).

	Time to First Fixation											
	All Media											
	1 Normal glass and bottle			2 Compressed glass and b...			3 Normal Blur glass and b...			4 Compressed Blur glass a...		
Participants	N (Count)	Mean (Secon	Sum (Secon	N (Count)	Mean (Secon	Sum (Secon	N (Count)	Mean (Secon	Sum (Secon	N (Count)	Mean (Secon	Sum (Secon
g1a	1	0.11	0.11	1	2.66	2.66	1	0.52	0.52	1	0.00	0.00
g1b	1	0.29	0.29	1	0.07	0.07	1	0.23	0.23	1	0.25	0.25
g1c	1	2.66	2.66	1	1.29	1.29	1	0.82	0.82	1	1.31	1.31
g1d	1	0.37	0.37	1	0.00	0.00	1	0.63	0.63	1	0.73	0.73
g1e	1	0.41	0.41		-	-	1	0.17	0.17	1	0.63	0.63
g1f	1	0.17	0.17	1	0.00	0.00	1	0.00	0.00	1	0.00	0.00
g1g	1	0.00	0.00	1	4.22	4.22	1	0.00	0.00		-	-
g1h	1	0.37	0.37	1	0.00	0.00	1	0.36	0.36	1	1.03	1.03
g4a	1	0.00	0.00	1	0.00	0.00	1	0.00	0.00	1	0.00	0.00
g4b	1	0.39	0.39	1	0.24	0.24	1	0.00	0.00	1	0.22	0.22
g4c	1	0.55	0.55	1	0.46	0.46	1	0.50	0.50	1	0.36	0.36
g4d	1	0.32	0.32	1	0.00	0.00	1	0.00	0.00	1	0.00	0.00
g4e	1	0.00	0.00	1	0.00	0.00	1	0.10	0.10	1	0.05	0.05
g4f	1	0.21	0.21	1	0.00	0.00	1	0.19	0.19	1	0.00	0.00
g4g	1	0.00	0.00	1	1.13	1.13	1	1.58	1.58	1	0.92	0.92
g4h	1	0.32	0.32	1	0.26	0.26	1	0.33	0.33	1	0.31	0.31
g5a	1	0.53	0.53	1	0.26	0.26	1	0.28	0.28	1	0.05	0.05
g5b	1	0.26	0.26	1	0.04	0.04	1	0.14	0.14	1	0.33	0.33
g5c	1	0.44	0.44	1	0.00	0.00	1	0.41	0.41	1	0.32	0.32
g5d	1	0.64	0.64	1	0.22	0.22	1	3.33	3.33	1	0.16	0.16
g5e	1	0.00	0.00	1	0.00	0.00	1	0.00	0.00	1	0.27	0.27
g5f	1	0.00	0.00	1	0.00	0.00	1	0.00	0.00	1	0.21	0.21
g5g	1	0.51	0.51	1	0.57	0.57	1	1.76	1.76	1	1.53	1.53
g5h	1	0.46	0.46	1	0.69	0.69	1	0.24	0.24	1	0.53	0.53
g6a	1	0.24	0.24	1	0.34	0.34	1	0.03	0.03	1	0.42	0.42
g6b	1	0.25	0.25	1	0.15	0.15	1	0.27	0.27	1	0.67	0.67
g6c	1	0.00	0.00	1	0.93	0.93	1	0.29	0.29	1	0.40	0.40
g6d	1	0.23	0.23	1	0.00	0.00	1	0.02	0.02	1	0.00	0.00
g6e	1	0.25	0.25	1	0.24	0.24	1	0.00	0.00	1	0.24	0.24
g6f	1	0.00	0.00	1	0.00	0.00	1	0.37	0.37	1	0.00	0.00
g6g	1	0.00	0.00	1	0.00	0.00	1	0.31	0.31	1	0.39	0.39
g6h	1	0.26	0.26	1	0.26	0.26	1	0.24	0.24	1	0.77	0.77
All Recordings	32	0.32	10.27	31	0.45	14.03	32	0.41	13.16	31	0.39	12.10

8.5 Time to First Fixation: One-way within subjects ANOVA, and Bonferroni post-hoc tests - Intended focus area

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

TimeToFirstFixation	Dependent Variable
1	NormalGlassBottle
2	CompressedGlassBottle
3	NormalDOFGlassBottle
4	CompressedDOFGlassBottle

Descriptive Statistics

	Mean	Std. Deviation	N
NormalGlassBottle	.3277	.48007	30
CompressedGlassBottle	.3270	.56316	30
NormalDOFGlassBottle	.4350	.68918	30
CompressedDOFGlassBottle	.3823	.40155	30

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
TimeToFirstFixation	Pillai's Trace	.031	.292[b]	3.000	27.000	.831	.031
	Wilks' Lambda	.969	.292[b]	3.000	27.000	.831	.031
	Hotelling's Trace	.032	.292[b]	3.000	27.000	.831	.031
	Roy's Largest Root	.032	.292[b]	3.000	27.000	.831	.031

a. Design: Intercept
Within Subjects Design: TimeToFirstFixation

b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
TimeToFirstFixation	.714	9.350	5	.096	.846	.934	.333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: TimeToFirstFixation

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
TimeToFirstFixation	Sphericity Assumed	.240	3	.080	.376	.771	.013
	Greenhouse-Geisser	.240	2.538	.095	.376	.737	.013
	Huynh-Feldt	.240	2.801	.086	.376	.757	.013
	Lower-bound	.240	1.000	.240	.376	.545	.013
Error(TimeToFirstFixation)	Sphericity Assumed	18.531	87	.213			
	Greenhouse-Geisser	18.531	73.594	.252			
	Huynh-Feldt	18.531	81.241	.228			
	Lower-bound	18.531	29.000	.639			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TimeToFirstFixation	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
TimeToFirstFixation	Linear	.111	1	.111	.837	.368	.028
	Quadratic	.020	1	.020	.086	.772	.003
	Cubic	.109	1	.109	.403	.531	.014

Error(TimeToFirstFixation)	Linear	3.845	29	.133				
	Quadratic	6.853	29	.236				
	Cubic	7.833	29	.270				

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	16.251	1	16.251	29.828	.000	.507
Error	15.800	29	.545			

Estimated Marginal Means

TimeToFirstFixation

Estimates

Measure: MEASURE_1

TimeToFirstFixation	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	.328	.088	.148	.507
2	.327	.103	.117	.537
3	.435	.126	.178	.692
4	.382	.073	.232	.532

Pairwise Comparisons

Measure: MEASURE_1

(I) TimeToFirstFixation	(J) TimeToFirstFixation	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	.001	.116	1.000	-.327	.329
	3	-.107	.134	1.000	-.486	.271
	4	-.055	.082	1.000	-.287	.178
2	1	-.001	.116	1.000	-.329	.327
	3	-.108	.142	1.000	-.509	.293
	4	-.055	.112	1.000	-.373	.262
3	1	.107	.134	1.000	-.271	.486
	2	.108	.142	1.000	-.293	.509
	4	.053	.120	1.000	-.288	.394

	1	.055	.082	1.000	-.178	.287
4	2	.055	.112	1.000	-.262	.373
	3	-.053	.120	1.000	-.394	.288

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.031	.292[a]	3.000	27.000	.831	.031
Wilks' lambda	.969	.292[a]	3.000	27.000	.831	.031
Hotelling's trace	.032	.292[a]	3.000	27.000	.831	.031
Roy's largest root	.032	.292[a]	3.000	27.000	.831	.031

Each F tests the multivariate effect of TimeToFirstFixation. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

8.6 Fixations Before: One-way within subjects ANOVA, and Bonferroni post-hoc tests - Intended focus area

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

FixationsBefore	Dependent Variable
1	NormalGlassBottle
2	CompressedGlassBottle
3	NormalDOFGlassBottle
4	CompressedDOFGlassBottle

Descriptive Statistics

	Mean	Std. Deviation	N
NormalGlassBottle	1.1333	1.13664	30
CompressedGlassBottle	1.1333	1.97804	30
NormalDOFGlassBottle	1.3667	2.23581	30
CompressedDOFGlassBottle	1.3667	1.40156	30

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
FixationsBefore	Pillai's Trace	.045	.419[b]	3.000	27.000	.741	.045
	Wilks' Lambda	.955	.419[b]	3.000	27.000	.741	.045

	Hotelling's Trace	.047	.419[b]	3.000	27.000	.741	.045
	Roy's Largest Root	.047	.419[b]	3.000	27.000	.741	.045

a. Design: Intercept
Within Subjects Design: FixationsBefore. b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
FixationsBefore	.494	19.547	5	.002	.762	.830	.333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: FixationsBefore

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
FixationsBefore	Sphericity Assumed	1.633	3	.544	.245	.865	.008
	Greenhouse-Geisser	1.633	2.285	.715	.245	.812	.008
	Huynh-Feldt	1.633	2.491	.656	.245	.829	.008
	Lower-bound	1.633	1.000	1.633	.245	.624	.008
Error(FixationsBefore)	Sphericity Assumed	193.367	87	2.223			
	Greenhouse-Geisser	193.367	66.263	2.918			
	Huynh-Feldt	193.367	72.240	2.677			
	Lower-bound	193.367	29.000	6.668			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	FixationsBefore	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
FixationsBefore	Linear	1.307	1	1.307	1.196	.283	.040
	Quadratic	.000	1	.000	.000	1.000	.000
	Cubic	.327	1	.327	.106	.747	.004
Error(FixationsBefore)	Linear	31.693	29	1.093			
	Quadratic	72.000	29	2.483			
	Cubic	89.673	29	3.092			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	187.500	1	187.500	34.091	.000	.540
Error	159.500	29	5.500			

Estimated Marginal Means
FixationsBefore

Estimates

Measure: MEASURE_1

FixationsBefore	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	1.133	.208	.709	1.558
2	1.133	.361	.395	1.872
3	1.367	.408	.532	2.202
4	1.367	.256	.843	1.890

Pairwise Comparisons

Measure: MEASURE_1

(I) FixationsBefore	(J) FixationsBefore	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	.000	.359	1.000	-1.016	1.016
	3	-.233	.420	1.000	-1.422	.956
	4	-.233	.207	1.000	-.820	.353
2	1	.000	.359	1.000	-1.016	1.016
	3	-.233	.486	1.000	-1.609	1.142
	4	-.233	.383	1.000	-1.317	.850
3	1	.233	.420	1.000	-.956	1.422
	2	.233	.486	1.000	-1.142	1.609

	4	.000	.398	1.000	-1.128	1.128
4	1	.233	.207	1.000	-.353	.820
	2	.233	.383	1.000	-.850	1.317
	3	.000	.398	1.000	-1.128	1.128

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.045	.419[a]	3.000	27.000	.741	.045
Wilks' lambda	.955	.419[a]	3.000	27.000	.741	.045
Hotelling's trace	.047	.419[a]	3.000	27.000	.741	.045
Roy's largest root	.047	.419[a]	3.000	27.000	.741	.045

Each F tests the multivariate effect of FixationsBefore. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

8.7 Total Visit Duration: One-way within subjects ANOVA, and Bonferroni post-hoc tests - Intended focus area

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

TotalVisitDuration	Dependent Variable
1	NormalGlassBottle
2	CompressedGlassBottle
3	NormalDOFGlassBottle
4	CompressedDOFGlassBottle

Descriptive Statistics

	Mean	Std. Deviation	N
NormalGlassBottle	1.6040	.64374	30
CompressedGlassBottle	1.5427	.89392	30
NormalDOFGlassBottle	2.1420	.92818	30
CompressedDOFGlassBottle	1.8703	.95246	30

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
TotalVisitDuration	Pillai's Trace	.301	3.871[b]	3.000	27.000	.020	.301
	Wilks' Lambda	.699	3.871[b]	3.000	27.000	.020	.301
	Hotelling's Trace	.430	3.871[b]	3.000	27.000	.020	.301
	Roy's Largest Root	.430	3.871[b]	3.000	27.000	.020	.301

a. Design: Intercept
 Within Subjects Design: TotalVisitDuration
b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
TotalVisitDuration	.643	12.243	5	.032	.788	.863	.333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.
a. Design: Intercept
 Within Subjects Design: TotalVisitDuration
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
TotalVisitDuration	Sphericity Assumed	6.784	3	2.261	3.712	.015	.113
	Greenhouse-Geisser	6.784	2.365	2.869	3.712	.023	.113

	Huynh-Feldt	6.784	2.588	2.621	3.712	.020	.113
	Lower-bound	6.784	1.000	6.784	3.712	.064	.113
Error(TotalVisitDuration)	Sphericity Assumed	52.996	87	.609			
	Greenhouse-Geisser	52.996	68.579	.773			
	Huynh-Feldt	52.996	75.065	.706			
	Lower-bound	52.996	29.000	1.827			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TotalVisitDuration	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
TotalVisitDuration	Linear	2.933	1	2.933	4.138	.051	.125
	Quadratic	.332	1	.332	.434	.515	.015
	Cubic	3.519	1	3.519	9.960	.004	.256
Error(TotalVisitDuration)	Linear	20.554	29	.709			
	Quadratic	22.196	29	.765			
	Cubic	10.246	29	.353			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	384.385	1	384.385	332.866	.000	.920
Error	33.488	29	1.155			

Estimated Marginal Means
TotalVisitDuration

Estimates

Measure: MEASURE_1

TotalVisitDuration	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	1.604	.118	1.364	1.844
2	1.543	.163	1.209	1.876
3	2.142	.169	1.795	2.489
4	1.870	.174	1.515	2.226

Pairwise Comparisons

Measure: MEASURE_1

(I) TotalVisitDuration	(J) TotalVisitDuration	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	.061	.171	1.000	-.424	.546
	3	-.538*	.188	.047	-1.072	-.004
	4	-.266	.194	1.000	-.815	.282
2	1	-.061	.171	1.000	-.546	.424
	3	-.599*	.183	.016	-1.116	-.083
	4	-.328	.261	1.000	-1.065	.410
3	1	.538*	.188	.047	.004	1.072
	2	.599*	.183	.016	.083	1.116
	4	.272	.200	1.000	-.296	.839
4	1	.266	.194	1.000	-.282	.815
	2	.328	.261	1.000	-.410	1.065
	3	-.272	.200	1.000	-.839	.296

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.301	3.871[a]	3.000	27.000	.020	.301
Wilks' lambda	.699	3.871[a]	3.000	27.000	.020	.301
Hotelling's trace	.430	3.871[a]	3.000	27.000	.020	.301
Roy's largest root	.430	3.871[a]	3.000	27.000	.020	.301

Each F tests the multivariate effect of TotalVisitDuration. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

8.8 Visit Count: One-way within subjects ANOVA, and Bonferroni post-hoc tests - Intended fixation area

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

VisitCount	Dependent Variable
1	NormalGlassBottle
2	CompressedGlassBottle

3	NormalDOFGlassBottle
4	CompressedDOFGlassBottle

Descriptive Statistics

	Mean	Std. Deviation	N
NormalGlassBottle	3.0000	1.11417	30
CompressedGlassBottle	2.8000	1.15669	30
NormalDOFGlassBottle	3.0000	.94686	30
CompressedDOFGlassBottle	2.9667	1.09807	30

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
VisitCount	Pillai's Trace	.039	.367[b]	3.000	27.000	.777	.039
	Wilks' Lambda	.961	.367[b]	3.000	27.000	.777	.039
	Hotelling's Trace	.041	.367[b]	3.000	27.000	.777	.039
	Roy's Largest Root	.041	.367[b]	3.000	27.000	.777	.039

a. Design: Intercept

Within Subjects Design: VisitCount

b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
VisitCount	.906	2.730	5	.742	.936	1.000	.333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: VisitCount

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
VisitCount	Sphericity Assumed	.825	3	.275	.326	.807	.011

	Greenhouse-Geisser	.825	2.808	.294	.326	.794	.011
	Huynh-Feldt	.825	3.000	.275	.326	.807	.011
	Lower-bound	.825	1.000	.825	.326	.573	.011
Error(VisitCount)	Sphericity Assumed	73.425	87	.844			
	Greenhouse-Geisser	73.425	81.432	.902			
	Huynh-Feldt	73.425	87.000	.844			
	Lower-bound	73.425	29.000	2.532			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	VisitCount	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
VisitCount	Linear	.015	1	.015	.015	.905	.001
	Quadratic	.208	1	.208	.257	.616	.009
	Cubic	.602	1	.602	.866	.360	.029
Error(VisitCount)	Linear	29.735	29	1.025			
	Quadratic	23.542	29	.812			
	Cubic	20.148	29	.695			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	1038.408	1	1038.408	483.045	.000	.943
Error	62.342	29	2.150			

Estimated Marginal Means
VisitCount

Estimates

Measure: MEASURE_1

VisitCount	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	3.000	.203	2.584	3.416
2	2.800	.211	2.368	3.232
3	3.000	.173	2.646	3.354
4	2.967	.200	2.557	3.377

Pairwise Comparisons

Measure: MEASURE_1

(I) VisitCount	(J) VisitCount	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	.200	.206	1.000	-.382	.782
	3	.000	.225	1.000	-.637	.637
	4	.033	.251	1.000	-.678	.745
2	1	-.200	.206	1.000	-.782	.382
	3	-.200	.227	1.000	-.843	.443
	4	-.167	.267	1.000	-.924	.590
3	1	.000	.225	1.000	-.637	.637
	2	.200	.227	1.000	-.443	.843
	4	.033	.242	1.000	-.652	.719
4	1	-.033	.251	1.000	-.745	.678
	2	.167	.267	1.000	-.590	.924
	3	-.033	.242	1.000	-.719	.652

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.039	.367[a]	3.000	27.000	.777	.039
Wilks' lambda	.961	.367[a]	3.000	27.000	.777	.039
Hotelling's trace	.041	.367[a]	3.000	27.000	.777	.039
Roy's largest root	.041	.367[a]	3.000	27.000	.777	.039

Each F tests the multivariate effect of VisitCount. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

8.9 Fixation Count: One-way within subjects ANOVA, and Bonferroni post-hoc tests - Intended fixation area

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

FixationCount	Dependent Variable
1	NormalGlassBottle
2	CompressedGlassBottle

3	NormalDOFGlassBottle
4	CompressedDOFGlassBottle

Descriptive Statistics

	Mean	Std. Deviation	N
NormalGlassBottle	5.8000	2.21904	30
CompressedGlassBottle	6.2667	3.31073	30
NormalDOFGlassBottle	8.2333	3.30812	30
CompressedDOFGlassBottle	7.1000	3.46758	30

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
FixationCount	Pillai's Trace	.400	6.011[b]	3.000	27.000	.003	.400
	Wilks' Lambda	.600	6.011[b]	3.000	27.000	.003	.400
	Hotelling's Trace	.668	6.011[b]	3.000	27.000	.003	.400
	Roy's Largest Root	.668	6.011[b]	3.000	27.000	.003	.400

a. Design: Intercept

Within Subjects Design: FixationCount

b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
FixationCount	.752	7.920	5	.161	.829	.913	.333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: FixationCount

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
FixationCount	Sphericity Assumed	102.567	3	34.189	4.707	.004	.140

	Greenhouse-Geisser	102.567	2.487	41.240	4.707	.007	.140
	Huynh-Feldt	102.567	2.739	37.451	4.707	.006	.140
	Lower-bound	102.567	1.000	102.567	4.707	.038	.140
Error(FixationCount)	Sphericity Assumed	631.933	87	7.264			
	Greenhouse-Geisser	631.933	72.124	8.762			
	Huynh-Feldt	631.933	79.422	7.957			
	Lower-bound	631.933	29.000	21.791			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	FixationCount	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
FixationCount	Linear	51.627	1	51.627	5.507	.026	.160
	Quadratic	19.200	1	19.200	2.450	.128	.078
	Cubic	31.740	1	31.740	6.933	.013	.193
Error(FixationCount)	Linear	271.873	29	9.375			
	Quadratic	227.300	29	7.838			
	Cubic	132.760	29	4.578			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	5630.700	1	5630.700	330.013	.000	.919
Error	494.800	29	17.062			

Estimated Marginal Means
FixationCount

Estimates

Measure: MEASURE_1

FixationCount	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	5.800	.405	4.971	6.629
2	6.267	.604	5.030	7.503
3	8.233	.604	6.998	9.469

4	7.100	.633	5.805	8.395

Pairwise Comparisons

Measure: MEASURE_1

(I) FixationCount	(J) FixationCount	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.467	.619	1.000	-2.220	1.286
	3	-2.433*	.594	.002	-4.116	-.750
	4	-1.300	.754	.571	-3.434	.834
2	1	.467	.619	1.000	-1.286	2.220
	3	-1.967*	.602	.017	-3.670	-.263
	4	-.833	.874	1.000	-3.307	1.641
3	1	2.433*	.594	.002	.750	4.116
	2	1.967*	.602	.017	.263	3.670
	4	1.133	.689	.666	-.819	3.085
4	1	1.300	.754	.571	-.834	3.434
	2	.833	.874	1.000	-1.641	3.307
	3	-1.133	.689	.666	-3.085	.819

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.400	6.011[a]	3.000	27.000	.003	.400
Wilks' lambda	.600	6.011[a]	3.000	27.000	.003	.400
Hotelling's trace	.668	6.011[a]	3.000	27.000	.003	.400
Roy's largest root	.668	6.011[a]	3.000	27.000	.003	.400

Each F tests the multivariate effect of FixationCount. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

8.10 Heat map visualisations for participant groups 4, 5 & 6

Normal Condition Group4

Compressed Condition Group4

Normal DOF Condition Group4

Compressed DOF Condition Group4

Normal Condition Group5

Compressed Condition Group5

Normal DOF Condition Group5

Compressed DOF Condition Group5

Normal image

Compressed image

Normal DOF Condition Group6

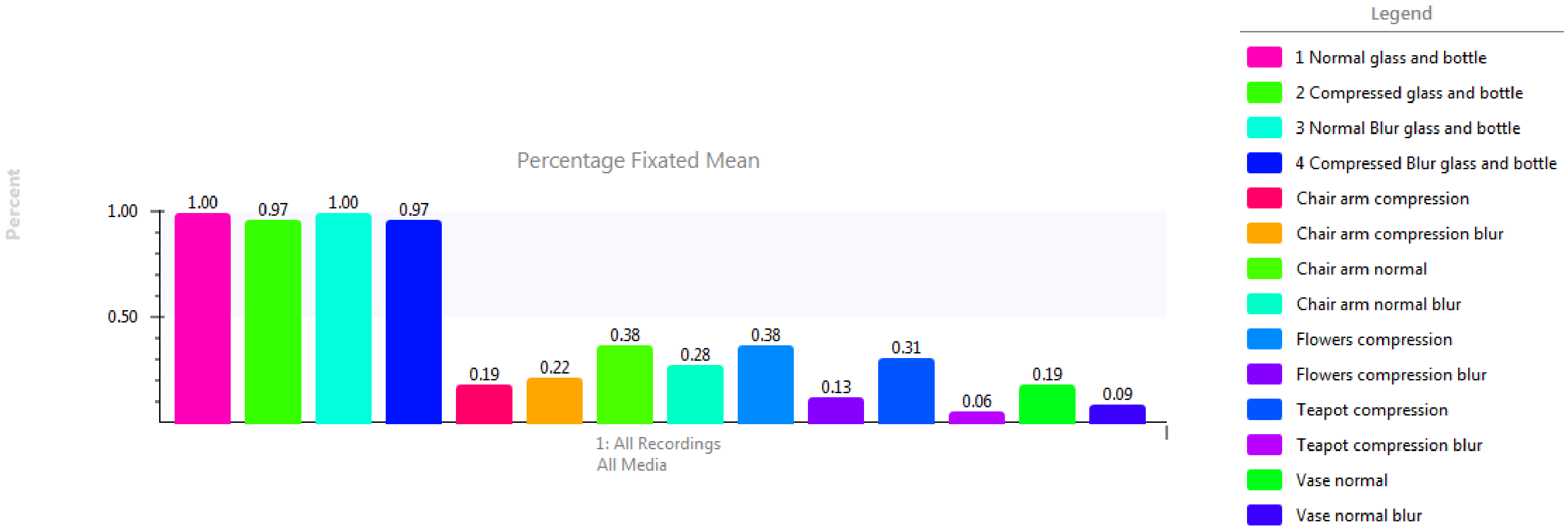
Compressed DOF Condition Group6

8.11 Percentage Fixation mean, showing which participants had not fixated on background objects (AOI) in each condition

Percentage Fixated Percentage of participants that fixated at least once within an AOI or AOI Group (%). **MEAN**

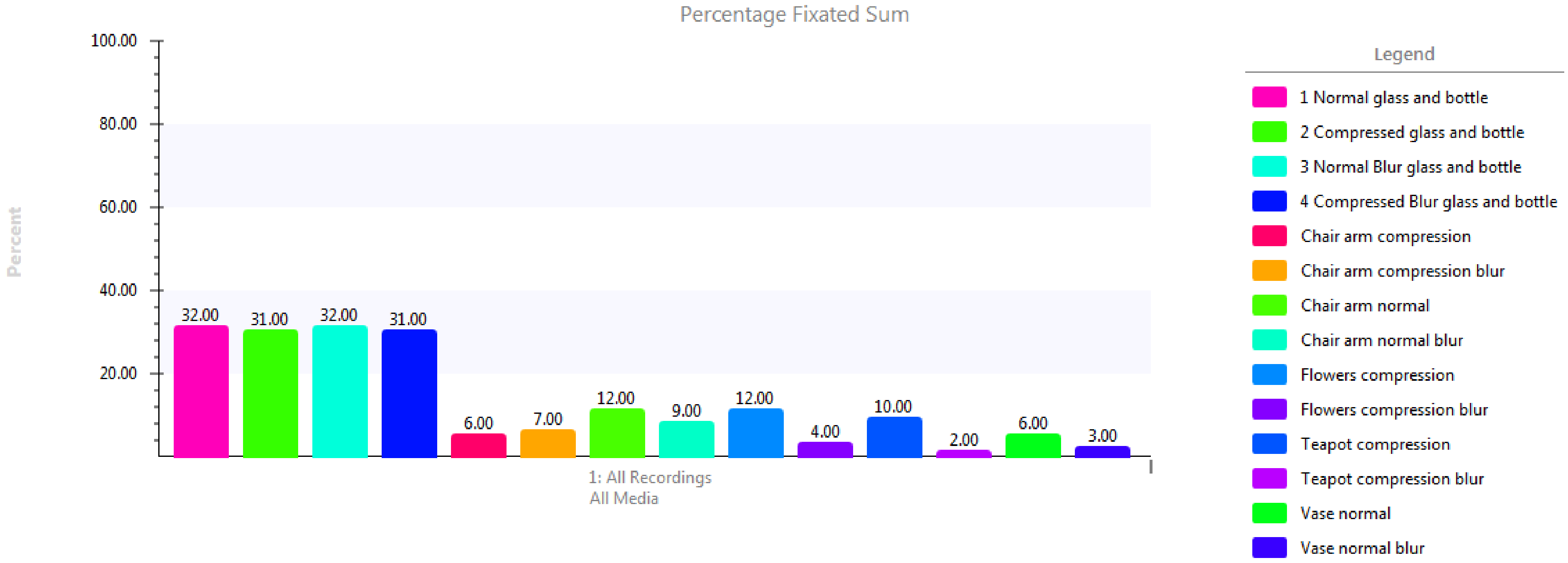
Chair arm compression			Chair arm compression blur			Chair arm normal			Chair arm normal blur			Flowers compression			Flowers compression blur			Teapot compression			Teapot compression blur			Vase normal			Vase normal blur		
N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)
1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%
1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%
1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%
1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%
1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%
1	0%	0%	1	100%	100%	1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%
1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%
1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%
1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
32	19%	600%	32	22%	700%	32	38%	1200%	32	28%	900%	32	38%	1200%	32	12%	400%	32	31%	1000%	32	6%	200%	32	19%	600%	32	9%	300%

Percentage Fixated Percentage of participants that fixated at least once within an AOI or AOI Group (%). **MEAN**



8.12 Percentage Fixation sum, showing the number (N count) of participants that fixated on background objects (AOI) in each condition

Percentage Fixated Percentage of participants that fixated at least once within an AOI or AOI Group (%). **SUM**



8.13 Percentage Fixated: One-way within subjects ANOVA, and Bonferroni post-hoc tests - Background objects

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

AOI	Dependent Variable
1	ChairArmCompression
2	ChairArmCompressionDOF
3	ChairArmNormal
4	ChairArmNormalDOF
5	FlowersCompression
6	FlowersCompressionBlur
7	TeapotCompression
8	TeapotCompressionBlur
9	VaseNormal
10	VaseNormalDOF

Descriptive Statistics

	Mean	Std. Deviation	N
ChairArmCompression	.19	.397	32
ChairArmCompressionDOF	.22	.420	32
ChairArmNormal	.38	.492	32
ChairArmNormalDOF	.28	.457	32
FlowersCompression	.38	.492	32
FlowersCompressionBlur	.13	.336	32
TeapotCompression	.31	.471	32
TeapotCompressionBlur	.06	.246	32
VaseNormal	.19	.397	32
VaseNormalDOF	.09	.296	32

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
AOI	Pillai's Trace	.537	2.961[b]	9.000	23.000	.017	.537
	Wilks' Lambda	.463	2.961[b]	9.000	23.000	.017	.537
	Hotelling's Trace	1.159	2.961[b]	9.000	23.000	.017	.537
	Roy's Largest Root	1.159	2.961[b]	9.000	23.000	.017	.537

a. Design: Intercept

Within Subjects Design: AOI

b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
AOI	.038	90.943	44	.000	.668	.846	.111

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: AOI

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
AOI	Sphericity Assumed	3.591	9	.399	2.846	.003	.084
	Greenhouse-Geisser	3.591	6.011	.597	2.846	.011	.084
	Huynh-Feldt	3.591	7.617	.471	2.846	.006	.084
	Lower-bound	3.591	1.000	3.591	2.846	.102	.084
Error(AOI)	Sphericity Assumed	39.109	279	.140			
	Greenhouse-Geisser	39.109	186.333	.210			
	Huynh-Feldt	39.109	236.128	.166			
	Lower-bound	39.109	31.000	1.262			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	AOI	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
AOI	Linear	.750	1	.750	6.313	.017	.169
	Quadratic	.716	1	.716	6.202	.018	.167
	Cubic	.334	1	.334	2.028	.164	.061
	Order 4	.003	1	.003	.023	.882	.001
	Order 5	.104	1	.104	.789	.381	.025

	Order 6	.005	1	.005	.083	.776	.003
	Order 7	.202	1	.202	1.238	.274	.038
	Order 8	.132	1	.132	.882	.355	.028
	Order 9	1.344	1	1.344	6.106	.019	.165
	Linear	3.683	31	.119			
	Quadratic	3.579	31	.115			
	Cubic	5.112	31	.165			
	Order 4	4.342	31	.140			
Error(AOI)	Order 5	4.095	31	.132			
	Order 6	1.777	31	.057			
	Order 7	5.053	31	.163			
	Order 8	4.645	31	.150			
	Order 9	6.824	31	.220			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	15.753	1	15.753	38.922	.000	.557
Error	12.547	31	.405			

Estimated Marginal Means
AOI

Estimates

Measure: MEASURE_1

AOI	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	.188	.070	.045	.330
2	.219	.074	.067	.370
3	.375	.087	.198	.552
4	.281	.081	.117	.446
5	.375	.087	.198	.552
6	.125	.059	.004	.246
7	.313	.083	.143	.482
8	.063	.043	-.026	.151
9	.188	.070	.045	.330
10	.094	.052	-.013	.201

Pairwise Comparisons

Measure: MEASURE_1

(I) AOI	(J) AOI	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.031	.095	1.000	-.373	.311
	3	-.188	.105	1.000	-.564	.189
	4	-.094	.104	1.000	-.467	.280
	5	-.188	.105	1.000	-.564	.189
	6	.063	.077	1.000	-.214	.339
	7	-.125	.098	1.000	-.477	.227
	8	.125	.087	1.000	-.188	.438
	9	.000	.090	1.000	-.323	.323
	10	.094	.069	1.000	-.154	.342
2	1	.031	.095	1.000	-.311	.373
	3	-.156	.101	1.000	-.521	.209
	4	-.063	.089	1.000	-.383	.258
	5	-.156	.091	1.000	-.483	.171
	6	.094	.082	1.000	-.202	.390
	7	-.094	.113	1.000	-.501	.313
	8	.156	.079	1.000	-.128	.441
	9	.031	.114	1.000	-.380	.442
	10	.125	.074	1.000	-.143	.393
3	1	.188	.105	1.000	-.189	.564
	2	.156	.101	1.000	-.209	.521
	4	.094	.104	1.000	-.280	.467
	5	.000	.110	1.000	-.395	.395
	6	.250	.100	.826	-.111	.611
	7	.063	.109	1.000	-.331	.456
	8	.313*	.083	.032	.013	.612
	9	.188	.070	.533	-.064	.439
	10	.281	.092	.213	-.051	.613
4	1	.094	.104	1.000	-.280	.467
	2	.063	.089	1.000	-.258	.383
	3	-.094	.104	1.000	-.467	.280
	5	-.094	.104	1.000	-.467	.280
	6	.156	.101	1.000	-.209	.521
	7	-.031	.105	1.000	-.409	.347
	8	.219	.098	1.000	-.132	.570
	9	.094	.104	1.000	-.280	.467
	10	.188	.083	1.000	-.112	.487
5	1	.188	.105	1.000	-.189	.564
	2	.156	.091	1.000	-.171	.483

	3	.000	.110	1.000	-.395	.395
	4	.094	.104	1.000	-.280	.467
	6	.250	.119	1.000	-.177	.677
	7	.063	.100	1.000	-.296	.421
	8	.313	.105	.247	-.064	.689
	9	.188	.114	1.000	-.222	.597
	10	.281	.092	.213	-.051	.613
	1	-.063	.077	1.000	-.339	.214
	2	-.094	.082	1.000	-.390	.202
	3	-.250	.100	.826	-.611	.111
	4	-.156	.101	1.000	-.521	.209
6	5	-.250	.119	1.000	-.677	.177
	7	-.188	.095	1.000	-.527	.152
	8	.063	.043	1.000	-.094	.219
	9	-.063	.089	1.000	-.383	.258
	10	.031	.071	1.000	-.223	.286
	1	.125	.098	1.000	-.227	.477
	2	.094	.113	1.000	-.313	.501
	3	-.063	.109	1.000	-.456	.331
	4	.031	.105	1.000	-.347	.409
7	5	-.063	.100	1.000	-.421	.296
	6	.188	.095	1.000	-.152	.527
	8	.250	.090	.408	-.073	.573
	9	.125	.087	1.000	-.188	.438
	10	.219	.087	.768	-.093	.531
	1	-.125	.087	1.000	-.438	.188
	2	-.156	.079	1.000	-.441	.128
	3	-.313*	.083	.032	-.612	-.013
	4	-.219	.098	1.000	-.570	.132
8	5	-.313	.105	.247	-.689	.064
	6	-.063	.043	1.000	-.219	.094
	7	-.250	.090	.408	-.573	.073
	9	-.125	.074	1.000	-.393	.143
	10	-.031	.071	1.000	-.286	.223
	1	.000	.090	1.000	-.323	.323
	2	-.031	.114	1.000	-.442	.380
	3	-.188	.070	.533	-.439	.064
	4	-.094	.104	1.000	-.467	.280
9	5	-.188	.114	1.000	-.597	.222
	6	.063	.089	1.000	-.258	.383
	7	-.125	.087	1.000	-.438	.188
	8	.125	.074	1.000	-.143	.393
	10	.094	.082	1.000	-.202	.390

	1	-.094	.069	1.000	-.342	.154
	2	-.125	.074	1.000	-.393	.143
	3	-.281	.092	.213	-.613	.051
	4	-.188	.083	1.000	-.487	.112
10	5	-.281	.092	.213	-.613	.051
	6	-.031	.071	1.000	-.286	.223
	7	-.219	.087	.768	-.531	.093
	8	.031	.071	1.000	-.223	.286
	9	-.094	.082	1.000	-.390	.202

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.537	2.961[a]	9.000	23.000	.017	.537
Wilks' lambda	.463	2.961[a]	9.000	23.000	.017	.537
Hotelling's trace	1.159	2.961[a]	9.000	23.000	.017	.537
Roy's largest root	1.159	2.961[a]	9.000	23.000	.017	.537

Each F tests the multivariate effect of AOI. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

8.14 Differences between conditions in AOI found on foreground and background objects

Bombay Sapphire image 1, participant group 1
AOI group 1 - 1000 normal image AOI group

Bombay Sapphire image 2, participant group 1
AOI group 2 - 1000 compressed

Bombay Sapphire image 3, participant group 1
AOI group 3 - 1000 normal blur

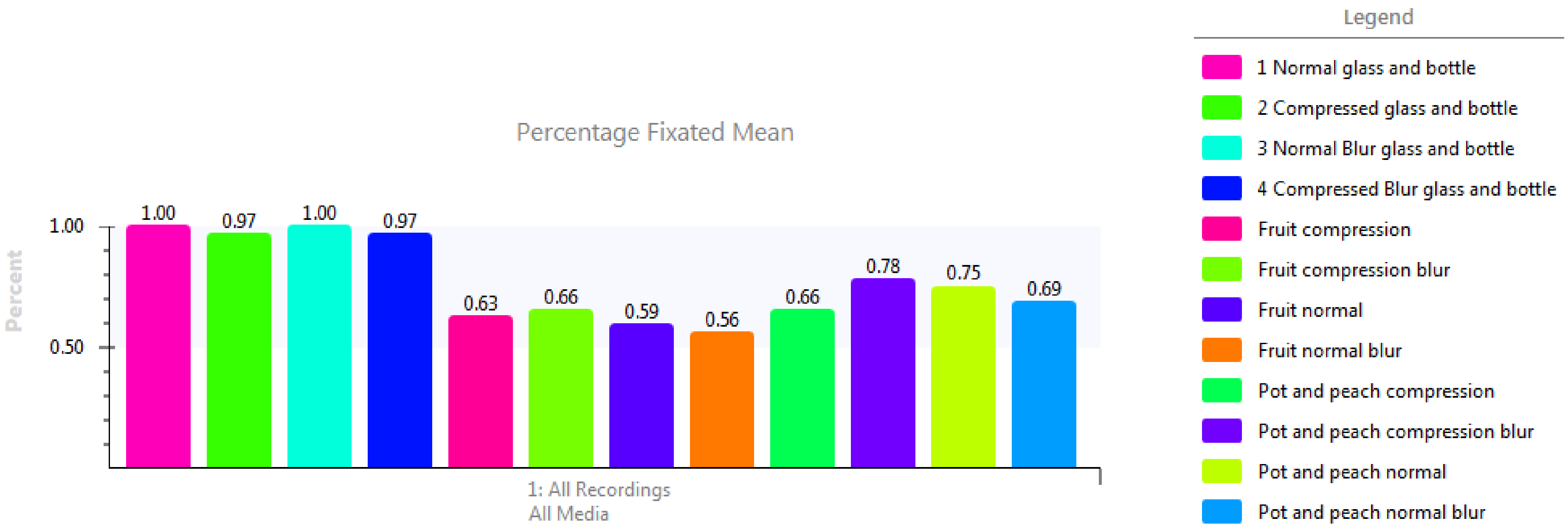
Bombay Sapphire image 4, participant group 1
AOI group 4 - 1000 compressed blur

8.15 Percentage Fixation mean, showing which participants had not fixated on secondary foreground objects (AOI) in each condition

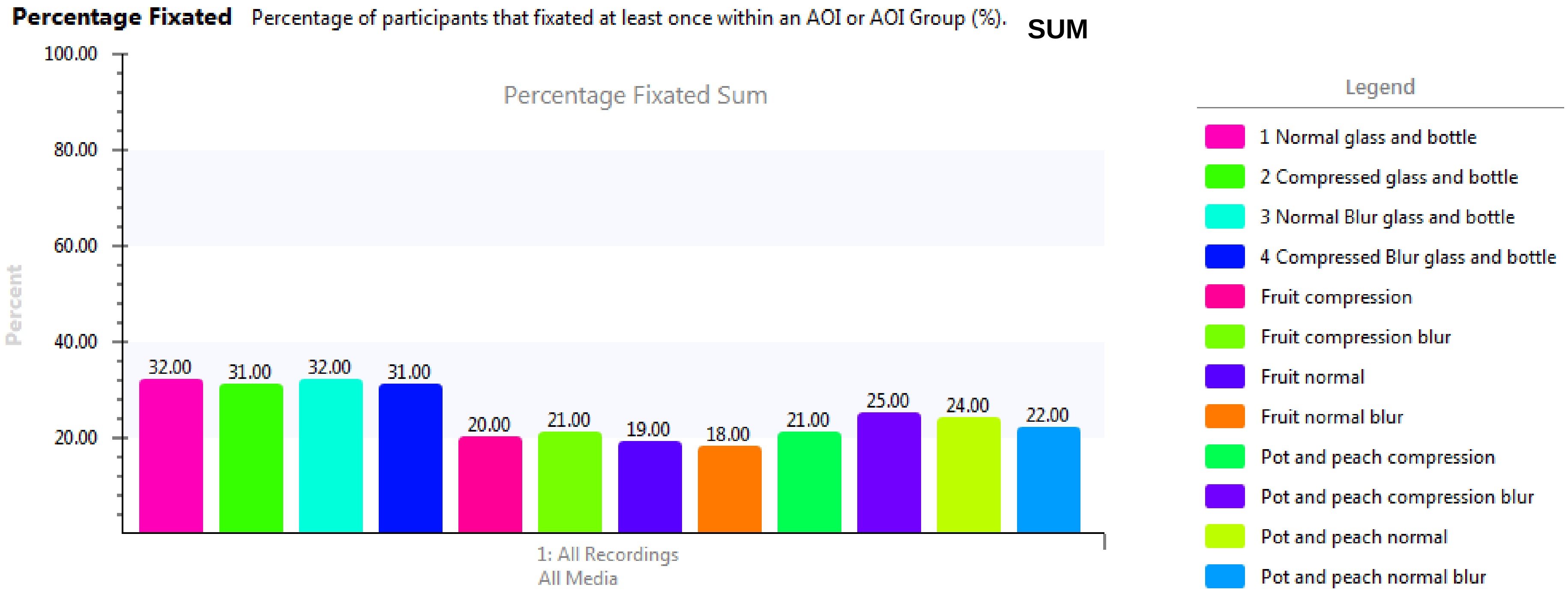
Percentage Fixated Percentage of participants that fixated at least once within an AOI or AOI Group (%). **MEAN**

Fruit compression			Fruit compression blur			Fruit normal			Fruit normal blur			Pot and peach compression			Pot and peach compressio...			Pot and peach normal			Pot and peach normal blur		
N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)
1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%
1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%
1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%
1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%
1	0%	0%	1	100%	100%	1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%
1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%
1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%	1	0%	0%
1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%
1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
1	100%	100%	1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%
1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%
1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%	1	0%	0%
1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%	1	0%	0%
1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%
1	0%	0%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%	1	0%	0%
1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%
1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%
1	0%	0%	1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%
1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%
1	0%	0%	1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%
32	62%	2000%	32	66%	2100%	32	59%	1900%	32	56%	1800%	32	66%	2100%	32	78%	2500%	32	75%	2400%	32	69%	2200%

Percentage Fixated Percentage of participants that fixated at least once within an AOI or AOI Group (%). **MEAN**



8.16 Percentage Fixation sum, showing the number (N count) of participants that fixated on secondary foreground objects (AOI) in each condition



8.17 Percentage Fixated: One-way within subjects ANOVA, and Bonferroni post-hoc tests - Secondary foreground objects

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

Foregrounds	Dependent Variable
1	FruitCompression
2	FruitCompressionDOF
3	FruitNormal
4	FruitNormalDOF
5	PotPeachCompression
6	PotPeachCompressionDOF
7	PotPeachNormal
8	PotPeachNormalDOF

Descriptive Statistics

	Mean	Std. Deviation	N
FruitCompression	.63	.492	32
FruitCompressionDOF	.66	.483	32
FruitNormal	.59	.499	32
FruitNormalDOF	.56	.504	32
PotPeachCompression	.66	.483	32
PotPeachCompressionDOF	.78	.420	32
PotPeachNormal	.75	.440	32
PotPeachNormalDOF	.69	.471	32

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Foregrounds	Pillai's Trace	.191	.842[b]	7.000	25.000	.564	.191
	Wilks' Lambda	.809	.842[b]	7.000	25.000	.564	.191
	Hotelling's Trace	.236	.842[b]	7.000	25.000	.564	.191
	Roy's Largest Root	.236	.842[b]	7.000	25.000	.564	.191

a. a. Design: Intercept Within Subjects Design: Foregrounds. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Foregrounds	.420	24.663	27	.598	.817	1.000	.143

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
 Within Subjects Design: Foregrounds

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Foregrounds	Sphericity Assumed	1.234	7	.176	.869	.532	.027
	Greenhouse-Geisser	1.234	5.719	.216	.869	.514	.027
	Huynh-Feldt	1.234	7.000	.176	.869	.532	.027
	Lower-bound	1.234	1.000	1.234	.869	.358	.027
Error(Foregrounds)	Sphericity Assumed	44.016	217	.203			
	Greenhouse-Geisser	44.016	177.278	.248			
	Huynh-Feldt	44.016	217.000	.203			
	Lower-bound	44.016	31.000	1.420			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	Foregrounds	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Foregrounds	Linear	.465	1	.465	1.715	.200	.052
	Quadratic	.027	1	.027	.129	.721	.004
	Cubic	.320	1	.320	1.636	.210	.050
	Order 4	.263	1	.263	1.744	.196	.053
	Order 5	.121	1	.121	.434	.515	.014

	Order 6	.038	1	.038	.204	.655	.007
	Order 7	3.642E-005	1	3.642E-005	.000	.987	.000
	Linear	8.404	31	.271			
	Quadratic	6.414	31	.207			
	Cubic	6.066	31	.196			
Error(Foregrounds)	Order 4	4.675	31	.151			
	Order 5	8.651	31	.279			
	Order 6	5.833	31	.188			
	Order 7	3.973	31	.128			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	112.891	1	112.891	295.092	.000	.905
Error	11.859	31	.383			

Estimated Marginal Means

Foregrounds

Estimates

Measure: MEASURE_1

Foregrounds	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	.625	.087	.448	.802
2	.656	.085	.482	.830
3	.594	.088	.414	.774
4	.563	.089	.381	.744
5	.656	.085	.482	.830
6	.781	.074	.630	.933
7	.750	.078	.591	.909
8	.688	.083	.518	.857

Pairwise Comparisons

Measure: MEASURE_1

(I) Foregrounds	(J) Foregrounds	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	-.031	.131	1.000	-.478	.416

	3	.031	.105	1.000	-.328	.391
	4	.063	.118	1.000	-.342	.467
	5	-.031	.114	1.000	-.422	.360
	6	-.156	.111	1.000	-.536	.223
	7	-.125	.108	1.000	-.493	.243
	8	-.063	.109	1.000	-.436	.311
	1	.031	.131	1.000	-.416	.478
	3	.063	.109	1.000	-.311	.436
	4	.094	.122	1.000	-.323	.510
2	5	.000	.110	1.000	-.376	.376
	6	-.125	.117	1.000	-.524	.274
	7	-.094	.130	1.000	-.537	.350
	8	-.031	.131	1.000	-.478	.416
	1	-.031	.105	1.000	-.391	.328
	2	-.063	.109	1.000	-.436	.311
	4	.031	.114	1.000	-.360	.422
3	5	-.063	.127	1.000	-.495	.370
	6	-.188	.114	1.000	-.577	.202
	7	-.156	.111	1.000	-.536	.223
	8	-.094	.113	1.000	-.481	.293
	1	-.063	.118	1.000	-.467	.342
	2	-.094	.122	1.000	-.510	.323
	3	-.031	.114	1.000	-.422	.360
4	5	-.094	.113	1.000	-.481	.293
	6	-.219	.117	1.000	-.617	.179
	7	-.188	.095	1.000	-.511	.136
	8	-.125	.133	1.000	-.579	.329
	1	.031	.114	1.000	-.360	.422
	2	.000	.110	1.000	-.376	.376
	3	.063	.127	1.000	-.370	.495
5	4	.094	.113	1.000	-.293	.481
	6	-.125	.087	1.000	-.422	.172
	7	-.094	.104	1.000	-.449	.262
	8	-.031	.105	1.000	-.391	.328
	1	.156	.111	1.000	-.223	.536
	2	.125	.117	1.000	-.274	.524
	3	.188	.114	1.000	-.202	.577
6	4	.219	.117	1.000	-.179	.617
	5	.125	.087	1.000	-.172	.422
	7	.031	.095	1.000	-.294	.356
	8	.094	.094	1.000	-.227	.414
7	1	.125	.108	1.000	-.243	.493

	2	.094	.130	1.000	-.350	.537
	3	.156	.111	1.000	-.223	.536
	4	.188	.095	1.000	-.136	.511
	5	.094	.104	1.000	-.262	.449
	6	-.031	.095	1.000	-.356	.294
	8	.063	.100	1.000	-.278	.403
	1	.063	.109	1.000	-.311	.436
	2	.031	.131	1.000	-.416	.478
	3	.094	.113	1.000	-.293	.481
8	4	.125	.133	1.000	-.329	.579
	5	.031	.105	1.000	-.328	.391
	6	-.094	.094	1.000	-.414	.227
	7	-.063	.100	1.000	-.403	.278

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.191	.842[a]	7.000	25.000	.564	.191
Wilks' lambda	.809	.842[a]	7.000	25.000	.564	.191
Hotelling's trace	.236	.842[a]	7.000	25.000	.564	.191
Roy's largest root	.236	.842[a]	7.000	25.000	.564	.191

Each F tests the multivariate effect of Foregrounds. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

8.18 Normal condition: One-way within subjects ANOVA, and Bonferroni post-hoc tests - Intended focus AOI, and both secondary foreground AOIs

Within-Subjects Factors

Measure: MEASURE_1

normalAOI	Dependent Variable
1	Normal
2	FruitNormal
3	PotPeachNormal

Descriptive Statistics

	Mean	Std. Deviation	N
Normal	1.00	.000	32

FruitNormal	.59	.499	32
PotPeachNormal	.75	.440	32

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
normalAOI	Pillai's Trace	.480	13.852[b]	2.000	30.000	.000	.480
	Wilks' Lambda	.520	13.852[b]	2.000	30.000	.000	.480
	Hotelling's Trace	.923	13.852[b]	2.000	30.000	.000	.480
	Roy's Largest Root	.923	13.852[b]	2.000	30.000	.000	.480

a. Design: Intercept
Within Subjects Design: normalAOI

b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
normalAOI	.816	6.098	2	.047	.845	.888	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: normalAOI

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
normalAOI	Sphericity Assumed	2.687	2	1.344	9.636	.000	.237

	Greenhouse-Geisser	2.687	1.689	1.591	9.636	.001	.237
	Huynh-Feldt	2.687	1.776	1.513	9.636	.000	.237
	Lower-bound	2.687	1.000	2.687	9.636	.004	.237
Error(normalAOI)	Sphericity Assumed	8.646	62	.139			
	Greenhouse-Geisser	8.646	52.367	.165			
	Huynh-Feldt	8.646	55.056	.157			
	Lower-bound	8.646	31.000	.279			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	normalAOI	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
normalAOI	Linear	1.000	1	1.000	10.333	.003	.250
	Quadratic	1.687	1	1.687	9.266	.005	.230
Error(normalAOI)	Linear	3.000	31	.097			
	Quadratic	5.646	31	.182			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	58.594	1	58.594	358.060	.000	.920
Error	5.073	31	.164			

Estimated Marginal Means
normalAOI

Estimates

Measure: MEASURE_1

normalAOI	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	1.000	.000	1.000	1.000
2	.594	.088	.414	.774
3	.750	.078	.591	.909

Pairwise Comparisons

Measure: MEASURE_1

(I) normalAOI	(J) normalAOI	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	.406*	.088	.000	.183	.630
	3	.250*	.078	.009	.053	.447
2	1	-.406*	.088	.000	-.630	-.183
	3	-.156	.111	.507	-.437	.125
3	1	-.250*	.078	.009	-.447	-.053
	2	.156	.111	.507	-.125	.437

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.480	13.852[a]	2.000	30.000	.000	.480
Wilks' lambda	.520	13.852[a]	2.000	30.000	.000	.480
Hotelling's trace	.923	13.852[a]	2.000	30.000	.000	.480
Roy's largest root	.923	13.852[a]	2.000	30.000	.000	.480

Each F tests the multivariate effect of normalAOI. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

8.19 Compression condition: One-way within subjects ANOVA, and Bonferroni post-hoc tests - Intended focus AOI, and both secondary foreground AOIs

Within-Subjects Factors

Measure: MEASURE_1

compressionaoi	Dependent Variable
1	Compression
2	FruitCompression
3	PotPeachCompression

Descriptive Statistics

	Mean	Std. Deviation	N
Compression	.97	.177	32

FruitCompression	.63	.492	32
PotPeachCompression	.66	.483	32

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
comressionaoi	Pillai's Trace	.420	10.846[b]	2.000	30.000	.000	.420
	Wilks' Lambda	.580	10.846[b]	2.000	30.000	.000	.420
	Hotelling's Trace	.723	10.846[b]	2.000	30.000	.000	.420
	Roy's Largest Root	.723	10.846[b]	2.000	30.000	.000	.420

a. Design: Intercept Within Subjects Design: comressionaoi

b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
comressionaoi	.866	4.324	2	.115	.882	.931	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept Within Subjects Design: comressionaoi

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
comressionaoi	Sphericity Assumed	2.313	2	1.156	7.400	.001	.193
	Greenhouse-Geisser	2.313	1.763	1.311	7.400	.002	.193
	Huynh-Feldt	2.313	1.862	1.242	7.400	.002	.193
	Lower-bound	2.313	1.000	2.313	7.400	.011	.193
Error(comressionaoi)	Sphericity Assumed	9.688	62	.156			

	Greenhouse-Geisser	9.688	54.662	.177			
	Huynh-Feldt	9.688	57.708	.168			
	Lower-bound	9.688	31.000	.313			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	comressionaoi	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
comressionaoi	Linear	1.562	1	1.562	14.091	.001	.312
	Quadratic	.750	1	.750	3.720	.063	.107
Error(comressionaoi)	Linear	3.437	31	.111			
	Quadratic	6.250	31	.202			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	54.000	1	54.000	279.000	.000	.900
Error	6.000	31	.194			

Estimated Marginal Means

comressionaoi

Estimates

Measure: MEASURE_1

comressionaoi	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	.969	.031	.905	1.032
2	.625	.087	.448	.802
3	.656	.085	.482	.830

Pairwise Comparisons

Measure: MEASURE_1

(I) comressionaoi	(J) comressionaoi	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	.344*	.096	.004	.100	.588
	3	.313*	.083	.002	.102	.523
2	1	-.344*	.096	.004	-.588	-.100

	3	-.031	.114	1.000	-.321	.258
3	1	-.313*	.083	.002	-.523	-.102
	2	.031	.114	1.000	-.258	.321

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.420	10.846[a]	2.000	30.000	.000	.420
Wilks' lambda	.580	10.846[a]	2.000	30.000	.000	.420
Hotelling's trace	.723	10.846[a]	2.000	30.000	.000	.420
Roy's largest root	.723	10.846[a]	2.000	30.000	.000	.420

Each F tests the multivariate effect of comressionaoi. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

8.20 Normal DOF condition AOI: One-way within subjects ANOVA, and Bonferroni post-hoc tests - Intended focus AOI, and both secondary foreground AOIs

Within-Subjects Factors

Measure: MEASURE_1

normaldofaoi	Dependent Variable
1	NormalDOF
2	FruitNormalDOF
3	PotPeachNormalDOF

Descriptive Statistics

	Mean	Std. Deviation	N
NormalDOF	1.00	.000	32
FruitNormalDOF	.56	.504	32
PotPeachNormalDOF	.69	.471	32

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
normaldofaoi	Pillai's Trace	.601	22.608[b]	2.000	30.000	.000	.601

	Wilks' Lambda	.399	22.608[b]	2.000	30.000	.000	.601
	Hotelling's Trace	1.507	22.608[b]	2.000	30.000	.000	.601
	Roy's Largest Root	1.507	22.608[b]	2.000	30.000	.000	.601

a. Design: Intercept
 Within Subjects Design: normaldofaoi
b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
normaldofaoi	.603	15.183	2	.001	.716	.741	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.
a. Design: Intercept
 Within Subjects Design: normaldofaoi
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
normaldofaoi	Sphericity Assumed	3.250	2	1.625	9.372	.000	.232
	Greenhouse-Geisser	3.250	1.431	2.270	9.372	.001	.232
	Huynh-Feldt	3.250	1.482	2.194	9.372	.001	.232
	Lower-bound	3.250	1.000	3.250	9.372	.005	.232
Error(normaldofaoi)	Sphericity Assumed	10.750	62	.173			

	Greenhouse-Geisser	10.750	44.376	.242			
	Huynh-Feldt	10.750	45.928	.234			
	Lower-bound	10.750	31.000	.347			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	normaldofaoi	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
normaldofaoi	Linear	1.562	1	1.562	14.091	.001	.312
	Quadratic	1.688	1	1.688	7.154	.012	.188
Error(normaldofaoi)	Linear	3.437	31	.111			
	Quadratic	7.313	31	.236			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	54.000	1	54.000	418.500	.000	.931
Error	4.000	31	.129			

Estimated Marginal Means
normaldofaoi

Estimates

Measure: MEASURE_1

normaldofaoi	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	1.000	.000	1.000	1.000
2	.563	.089	.381	.744
3	.688	.083	.518	.857

Pairwise Comparisons

Measure: MEASURE_1

(I) normaldofaoi	(J) normaldofaoi	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	.438*	.089	.000	.212	.663
	3	.313*	.083	.002	.102	.523
2	1	-.438*	.089	.000	-.663	-.212
	3	-.125	.133	1.000	-.461	.211
3	1	-.313*	.083	.002	-.523	-.102
	2	.125	.133	1.000	-.211	.461

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.601	22.608[a]	2.000	30.000	.000	.601
Wilks' lambda	.399	22.608[a]	2.000	30.000	.000	.601
Hotelling's trace	1.507	22.608[a]	2.000	30.000	.000	.601
Roy's largest root	1.507	22.608[a]	2.000	30.000	.000	.601

Each F tests the multivariate effect of normaldofaoi. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

8.21 Compression DOF condition: One-way within subjects ANOVA, and Bonferroni post-hoc tests - Intended focus AOI, and both secondary foreground AOIs

Within-Subjects Factors

Measure: MEASURE_1

Comressiondofaoi	Dependent Variable
1	CompressionDOF
2	FruitCompressionDOF
3	PotPeachCompressionDOF

Descriptive Statistics

	Mean	Std. Deviation	N
CompressionDOF	.97	.177	32
FruitCompressionDOF	.66	.483	32
PotPeachCompressionDOF	.78	.420	32

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Comressiondofaoi	Pillai's Trace	.313	6.841[b]	2.000	30.000	.004	.313
	Wilks' Lambda	.687	6.841[b]	2.000	30.000	.004	.313
	Hotelling's Trace	.456	6.841[b]	2.000	30.000	.004	.313
	Roy's Largest Root	.456	6.841[b]	2.000	30.000	.004	.313

a. Design: Intercept
 Within Subjects Design: Comressiondofaoi
b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Comressiondofaoi	.838	5.300	2	.071	.861	.906	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.
a. Design: Intercept
 Within Subjects Design: Comressiondofaoi
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Comressiondofaoi	Sphericity Assumed	1.583	2	.792	5.034	.009	.140
	Greenhouse-Geisser	1.583	1.721	.920	5.034	.013	.140
	Huynh-Feldt	1.583	1.813	.873	5.034	.012	.140

	Lower-bound	1.583	1.000	1.583	5.034	.032	.140
Error(Comressiondofaoi)	Sphericity Assumed	9.750	62	.157			
	Greenhouse-Geisser	9.750	53.358	.183			
	Huynh-Feldt	9.750	56.200	.173			
	Lower-bound	9.750	31.000	.315			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	Comressiondofaoi	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Comressiondofaoi	Linear	.562	1	.562	5.073	.032	.141
	Quadratic	1.021	1	1.021	5.013	.032	.139
Error(Comressiondofaoi)	Linear	3.437	31	.111			
	Quadratic	6.313	31	.204			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	61.760	1	61.760	490.131	.000	.941
Error	3.906	31	.126			

Estimated Marginal Means

Comressiondofaoi

Estimates

Measure: MEASURE_1

Comressiondofaoi	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	.969	.031	.905	1.032
2	.656	.085	.482	.830
3	.781	.074	.630	.933

Pairwise Comparisons

Measure: MEASURE_1

(I) Comresssiondofaoi	(J) Comresssiondofaoi	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	.313*	.095	.007	.073	.552
	3	.188	.083	.095	-.023	.398
2	1	-.313*	.095	.007	-.552	-.073
	3	-.125	.117	.877	-.420	.170
3	1	-.188	.083	.095	-.398	.023
	2	.125	.117	.877	-.170	.420

Based on estimated marginal means

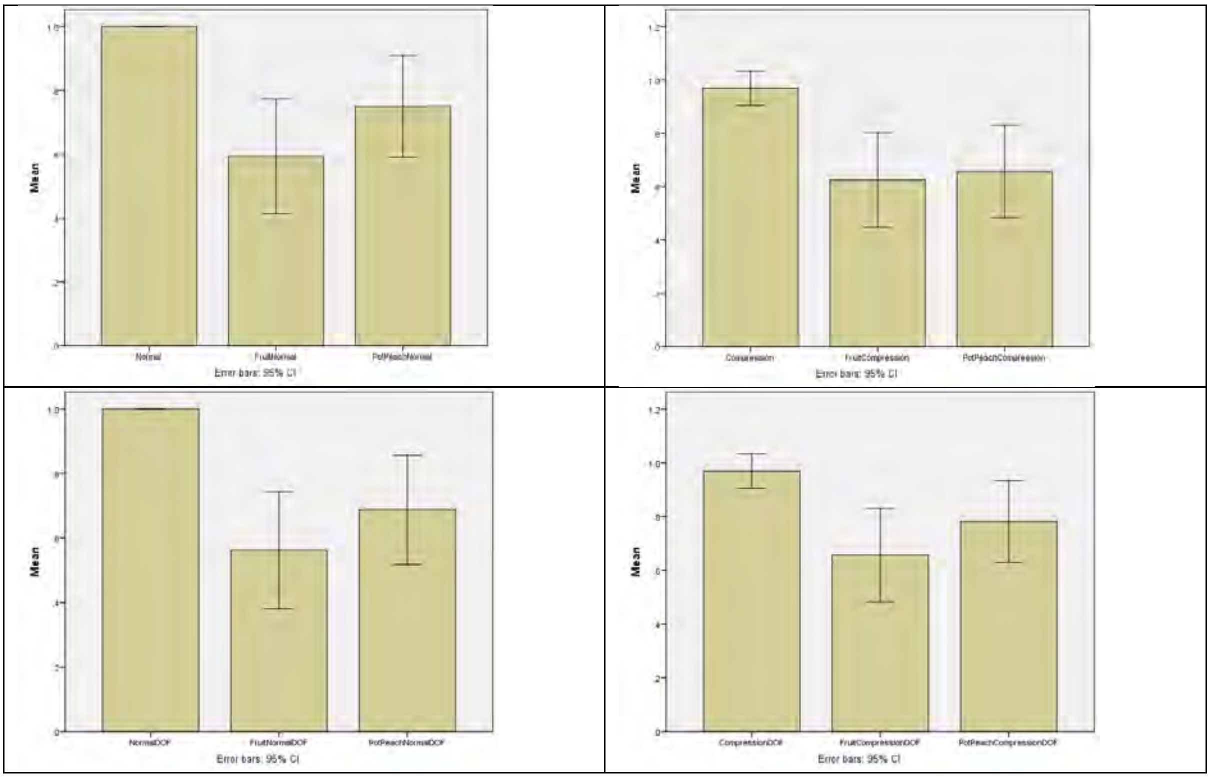
*. The mean difference is significant at the .05 level b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.313	6.841[a]	2.000	30.000	.004	.313
Wilks' lambda	.687	6.841[a]	2.000	30.000	.004	.313
Hotelling's trace	.456	6.841[a]	2.000	30.000	.004	.313
Roy's largest root	.456	6.841[a]	2.000	30.000	.004	.313

Each F tests the multivariate effect of Comresssiondofaoi. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic



Appendices 9

9.1 Repeated measures screening combinations of stimuli

Group 1	Group 4	Group 5	Group 6
N+c	Nb+c	C+cb	Nb+cb
N+nb	N+cb	Nb+cb	Nb+c
N+cb	Nb+cb	Nb+c	N+nb
Nb+c	N+c	N+cb	C+cb
C+cb	N+nb	N+c	N+cb
Nb+cb	C+cb	N+nb	N+c

Table - Showing the repeated measures order that each group viewed the different combinations of stimuli.

9.2 The condition in each pairing which participants thought conveyed the greatest sensation of background distance

Participant Code	C	CB		N	C	N	CB	N	NB	NB	C	NB	CB
g1a>Distance		1			1		1		1	1			1
g1b>Distance	1				1	1		1			1		1
g1c>Distance		1			1		1		1	1			1
g1d>Distance	1				1		1		1		1	1	
g1e>Distance	1				1		1	1			1		1
g1f>Distance	1				1		1		1	1		1	
g1g>Distance	1				1		1		1		1	1	
g1h>Distance		1			1		1		1	1			1
g4a>Distance		1			1		1		1	1			1
g4b>Distance		1			1		1		1		1		1
g4c>Distance		1			1		1		1	1			1
g4d>Distance		1			1		1	1			1		1
g4e>Distance		1			1		1		1		1		1
g4f>Distance		1			1		1		1	1			1
g4g>Distance		1			1		1		1		1		1
g4h>Distance	1				1		1	1		1			1
g5a>Distance	1				1		1		1		1	1	
g5b>Distance	1			1		1		1			1	1	
g5c>Distance		1		1			1		1	1			1
g5d>Distance		1			1		1		1	1			1
g5e>Distance		1			1	1			1	1		1	
g5f>Distance		1			1		1		1	1			1
g5g>Distance		1			1		1		1		1		1
g5h>Distance		1			1		1	1			1		1
g6a>Distance		1			1		1		1	1			1
g6b>Distance		1			1		1	1			1		1
g6c>Distance		1			1		1		1	1			1

g6d>Distance		1		1		1		1		1	1	
g6e>Distance		1		1		1		1		1		1
g6f>Distance	1		1		1		1		1		1	
g6g>Distance	1			1		1	1		1			1
g6h>Distance		1		1		1		1		1		1
	10	22	3	29	4	28	9	23	16	16	8	24

Stimuli code	c-cb	n-c	n-cb	n-nb	Nb-c	Nb-cb
Totals	10/22	3/29	4/28	9/23	16/16	8/24
Perceived greater distance - Stimuli codes and preference total used for statistical analysis SPSS.						

The analysis between two Conditions, of greater sensation of background distance: Chi-square test of association, tests for the existence of a relationship between two variables. This test can be used with nominal, ordinal, or scale variables, so it is a very versatile test, but it is sensitive to sample sizes too. It is important to have at least a few cases in each of the values of both of the variables involved in this test or the results will be skewed.

9.3 Chi-square test performed between paired stimuli c & n

	Observed N	Expected N	Residual
c	29	16.0	13.0
n	3	16.0	-13.0
Total	32		

Test Statistics

	n2c
Chi-Square	21.125[a]
df	1
Asymp. Sig.	.000

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 16.0.

9.4 Chi-square test performed between paired stimuli c & cb

	Observed N	Expected N	Residual
c	10	16.0	-6.0
cb	22	16.0	6.0
Total	32		

Test Statistics

	c1cb
Chi-Square	4.500[a]
f	1
Asymp. Sig.	.034

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cel frequency is 16.0.

9.5 Chi-square test performed between paired stimuli cb & n

	Observed N	Expected N	Residual
cb	28	16.0	12.0
n	4	16.0	-12.0
Total	32		

Test Statistics

	n3cb
Chi-Square	18.000[a]
df	1
Asymp. Sig.	.000

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cel frequency is 16.0.

9.6 Chi-square test performed between paired stimuli n & nb

	Observed N	Expected N	Residual
n	9	16.0	-7.0
nb	23	16.0	7.0
Total	32		

Test Statistics

	n4nb
Chi-Square	6.125[a]
df	1
Asymp. Sig.	.013

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cel frequency is 16.0.

9.7 Chi-square test performed between paired stimuli c & nb

	Observed N	Expected N	Residual
c	16	16.0	.0
nb	16	16.0	.0
Total	32		

Test Statistics

	nb5c
Chi-Square	.000[a]
df	1
Asymp. Sig.	1.000

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cel frequency is 16.0.

9.8 Chi-square test performed between paired stimuli cb & nb

	Observed N	Expected N	Residual
cb	24	16.0	8.0
nb	8	16.0	-8.0
Total	32		

Test Statistics

	nb6cb
Chi-Square	8.000[a]
df	1
Asymp. Sig.	.005

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cel frequency is 16.0.

Appendices 10

10.1 Repeated measures screening combinations for stimuli

Group 1	Group 4	Group 5	Group 6
Glass	Tea pot	Watch	Watch
Watch	Watch	Tea pot	Glass
Tea pot	Glass	Glass	Tea pot
Table.... Showing the order that each group viewed the stimuli.			

10.2 Participant results table showing which condition in each pairing produced the greatest sense of depth

g1a>Depth	Stimuli type	Scale response	F count	N count	g5a>Depth	Stimuli type	Scale responce	F count	N count
Glass	f	4			Watch	f	2		
Watch	f	4			Tea pot	f	2		
Tea pot	f	3	3	0	Glass	f	4	3	0
g1b>Depth	Stimuli type	Scale response			g5b>Depth	Stimuli type	Scale responce		
Glass	n	4			Watch	n	5		
Watch	f	4			Tea pot	n	5		
Tea pot	f	4	2	1	Glass	n	5	0	3
g1c>Depth	Stimuli type	Scale response			g5c>Depth	Stimuli type	Scale responce		
Glass	f	2			Watch	f	4		
Watch	f	2			Tea pot	f	4		
Tea pot	f	1	3	0	Glass	f	3	3	0
g1d>Depth	Stimuli type	Scale response			g5d>Depth	Stimuli type	Scale responce		
Glass	f	4			Watch	f	3		
Watch	f	4			Tea pot	f	2		
Tea pot	f	1	3	0	Glass	f	1	3	0
g1e>Depth	Stimuli type	Scale response			g5e>Depth	Stimuli type	Scale responce		
Glass	f	3			Watch	f	4		
Watch	f	4			Tea pot	f	4		
Tea pot	f	3	3	0	Glass	f	3	3	0
g1f>Depth	Stimuli type	Scale response			g5f>Depth	Stimuli type	Scale responce		
Glass	f	4			Watch	f	4		
Watch	f	4			Tea pot	f	4		
Tea pot	f	5	3	0	Glass	f	3	3	0

g1g>Depth	Stimuli type	Scale response			g5g>Depth	Stimuli type	Scale responce		
Glass	n	4			Watch	f	5		
Watch	n	4			Tea pot	f	5		
Tea pot	f	4	1	2	Glass	f	5	3	0
g1h>Depth	Stimuli type	Scale response			g5h>Depth	Stimuli type	Scale responce		
Glass	f	4			Watch	f	4		
Watch	f	2			Tea pot	f	4		
Tea pot	f	3	3	0	Glass	f	5	3	0
g4a>Depth	Stimuli type	Scale responce			g6a>Depth	Stimuli type	Scale responce		
Tea pot	f	3			Watch	f	4		
Watch	f	3			Glass	f	4		
Glass	f	4	3	0	Tea pot	f	4	3	0
g4b>Depth	Stimuli type	Scale responce			g6b>Depth	Stimuli type	Scale responce		
Tea pot	f	4			Watch	f	4		
Watch	f	4			Glass	f	3		
Glass	f	4	3	0	Tea pot	f	3	3	0
g4c>Depth	Stimuli type	Scale responce			g6c>Depth	Stimuli type	Scale responce		
Tea pot	f	5			Watch	f	4		
Watch	f	3			Glass	f	4		
Glass	f	3	3	0	Tea pot	f	3	3	0
g4d>Depth	Stimuli type	Scale responce			g6d>Depth	Stimuli type	Scale responce		
Tea pot	f	4			Watch	f	4		
Watch	f	2			Glass	f	4		
Glass	f	3	3	0	Tea pot	f	4	3	0
g4e>Depth	Stimuli type	Scale responce			g6e>Depth	Stimuli type	Scale responce		
Tea pot	f	4			Watch	n	3		
Watch	f	4			Glass	f	2		
Glass	f	3	3	0	Tea pot	n	2	1	2
g4f>Depth	Stimuli type	Scale responce			g6f>Depth	Stimuli type	Scale responce		
Tea pot	f	4			Watch	f	4		
Watch	f	3			Glass	f	4		
Glass	f	3	3	0	Tea pot	f	3	3	0

g4g>Depth	Stimuli type	Scale responce			g6g>Depth	Stimuli type	Scale responce		
Tea pot	f	5			Watch	f	4		
Watch	f	5			Glass	f	4		
Glass	f	5	3	0	Tea pot	f	4	3	0
g4h>Depth	Stimuli type	Scale responce			g6h>Depth	Stimuli type	Scale responce		
Tea pot	f	4			Watch	n	4		
Watch	f	4			Glass	f	4		
Glass	n	2	2	1	Tea pot	f	4	2	1

Participant	Teapot	Watch	Glass	TeapotFOV	TeapotNORM	WatchFOV	WatchNORM	GlassFOV	GlassNORM	Frequency2	GlassOnly	Frequency3	WatchOnly	Frequency4	TeapotOnly
1	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	30.00	Fovography	29.00	Fovography	31.00	Fovography
2	Fovography	Fovography	Normal	Yes	No	Yes	No	No	Yes	2.00	Normal	3.00	Normal	1.00	Normal
3	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
4	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
5	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
6	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
7	Fovography	Fovography	Fovography	Yes	No	No	Yes	No	Yes	.	.	.	.	.	.
8	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
9	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
10	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
11	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
12	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
13	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
14	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
15	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
16	Fovography	Fovography	Normal	Yes	No	Yes	No	No	Yes	.	.	.	.	.	.
17	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
18	Normal	Normal	Fovography	No	Yes	No	Yes	No	Yes	.	.	.	.	.	.
19	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
20	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
21	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
22	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
23	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
24	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
25	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
26	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
27	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
28	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
29	Fovography	Normal	Fovography	No	Yes	No	Yes	Yes	No	.	.	.	.	.	.
30	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
31	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	.	.	.	.	.	.
32	Fovography	Normal	Fovography	Yes	No	No	Yes	Yes	No	.	.	.	.	.	.

10.3 Transcribed explanation for each chosen condition

Group 1 – Glass, Watch, Teapot

G1a
left.
The hands look pretty much the same size, but the table and the objects in the background, they seem smaller, more drastically smaller, and also you can see further on the ones on the left, the ones on the right seem a bit close.
right
Again you can see a lot more in the background; you can see a further distance. Also your focus is drawn to the watch, because of the clarity. So looking at it there you can see that there is something in the distance.
right

A lot more going on in the picture and your attention is brought to the one on the right, and the objects on the left, the cupboard they seem a little curved, that gives it a greater sense of depth I think. The left image seems a little bit flat.

G1b
right
Because I could see more I think. It was less blurry.
right
Because I can see more of the room.
The right
For the same reasons; I can see more of the room. The teapot is drawing my focus inwards, because it is less blurry than the background.

G1c
Left
You feel the depth is a lot more.... It's like a Triangle. It's drawing your attention further into the room. Whereas that is more boxed and everything is more contained so you like to say there is a greater sense of depth in this picture.
Right
Again there is more of an elongated field of vision, so you are looking further into the picture.
Right
Same again really; elongated field of vision. Everything is placed in a, a more, everything's in stages rather than everything being in, contained in the same light....E.g. Someone's legs, and then it stretches out to the object, rather than it just being placed in the middle.

G1d
Left
Because the cabinet seems further away. It seems to be more in the image.
Right
Again same reason really; in the fact that the cabinet is further away, there is more in the picture.
Right
It seems, because it's a greater area, it's given more of a perspective. That's all

G1e
Left
Because I can see more of the cabinet, and I can see the wall, I can't see the wall in that one
Right
Because I can see more things in it. Because the watch, because everything else is more blurry compared to the watch in the middle
Right
Because it's looking at a bigger space, and I am taking note of the sides because of those colourful things, and the teapot stands out much more than the teapot on the left.

G1f
Left
You can see more
Right
Because you can see more, see more of the room
Right
Because you can see more of the room, it gives you more information, the person and how big the legs are.

G1g
Right (Normal)
Because to me it's clearer; clarity, and...... It's the sofa drawing your line, your eye towards the table more, rather than blocking it on the left. (Understanding of depth?) I would be looking for a horizon, which does not exist in here as such, but it means that the line of the sofa is drawing me to the centre.
<u>Which image gives you a greater sense of distance....... The left one........</u>
Left (Normal)
It is clearer
<u>Which image gives you a greater sense of distance....... The right one........</u>
Right (Fov)
Because there are legs in it, which implies to me that there is more room.
Which image gives you a greater sense of distance....... The same right; because you can see what looks like the floor.

G1h
Left
Because there is more going on in the image, it's a bigger crop of the image. This one on the right seems to be a smaller crop of the one on the left, so you can't see as much of the cabinet and the instrument behind.
Right
More life like, you got a, you have a; the watch is in focus, whereas the rest of the image is blurred. It is more like you are looking at a focus point and the image around is blurred; and again it is of a bigger scene, there is more happening in the scene, so you can tell it's a bigger, the camera is looking further.
Right
The teapot is in focus again, with the surroundings and environment it's in. It is a bigger environment again. His legs, his legs, her legs; you can see there, they are very close to the camera. It's like a perspective shot I guess of the room. It is like a wide angle as well compared to the one on the left, which is a kind of a flat image with everything in focus, which seems quite flat, there is no kind of perspective on it for me.

Group 4 – Teapot, Watch, Glass

G4a
Right
Because the white block appears to be further, further away, and we can see more.
Right
You can see further into the room, see more of the room, you can see back to the side board, and the other one only goes as far as the sofa. You can see more, you can see wider and deeper
Left
It has, one can see a lot more of that rug on the left. That rug, the strip, that strip of orange is much longer on the left than it is on the right.

G4b
Right
There is more to see, so it's, there is a wider focus or depth. Does that make sense?
Right
Again there is more of the image, you can see a lot more, which again shows the depth
Left
Because the table looks much further away, and there is a lot more to the left hand side of the image, and the right actually. Again there is more in the view. Not very technical terms I know.

G4c
Right
Because there is more going on in the picture and you get more of a sense of depth, because there are other things in the picture (list items), and the things in the right hand corner. Depth is relative to the objects around it, so that's why the right image appears deeper, and I have a greater sense of depth with that one because it is relative to other objects, whereas the other one is relatively straight forward.
Right
I think there is more going on in the picture. The blurred background gives me a sense that it is a much deeper image. Whereas because the watch, and wrist is more in focus, it almost feels like the rest of the picture is further away. Right image seems to have more depth than the left image. There is a lot more going on in the right picture as well.
Left
Because there is a lot more colour and a lot more going on, so it's relative to what I am focusing on straight away is the glass, but I am looking at the glass but there is so much going on around it. The way the glass is tilted gives it an impression that it is a deeper picture, but it is just different to the right hand picture. The leg is blurred in the left hand picture, which almost seems like the glass if further away than the leg so I think that's more depth. I am more going on there is a lot more, there are a lot more objects in that picture, richer colours and stuff like that

G4d
Right
It looks like there's more, it looks further back, there's is more depth, more, and there is more room. It looks like the room is bigger, so there is a greater depth compared to this image, where it looks quite flat, and it doesn't look like there is much depth
Right
Again it just looks like there is more, there is a greater image to the. It just seems like although it is slightly blurred, it just seems like there is a greater depth to the image, there is more image there, more kind of surround to the image.
Left
It looks longer. The actual image itself looks a lot longer. It looks like, again similar to the other ones, that there is in the left image more depth to it, so the image looks longer, whereas the right one to me looks more flat at the front, so there is less depth to it

G4e
Right
Certain aspects of the image are out of focus implying that they are further away. I can see my knees, well a set of knees rather, which giving a sense that I am sitting away from the object. There is more in the field of vision, more goldfish shape, goldfish lens so it kind of implies I am sitting further back, more in the image than the one on the left hand side. More in it, the focus, and the fact that the edges are coming around which is giving me a sense of being further back
Right
Again there are, aspects which are closer to the point of vision, that I can see in the right hand one which I can't see in the left hand one. Eg the chest and the shoulders of the person looking out which I can't see in the left hand image. So that is telling me that I am looking from a slightly further back point of view. Same point from the previous image in that it looks like i am looking out from a fish eye lens. More objects, a broader field of vision in the right hand image, which makes me feel like I am looking from a slightly further back point of view. In hindsight there is actually very little in it, I can see how you could see both sets of images from exactly the same point given the lens you a looking through as opposed to the position you are looking from.
Left
For exactly the same reasons. I think that they are taken from the same point in space, but because. The differences are the width, breadth of field of vision, primarily. It shows you more, therefore it is trying to tell me that it is taken further back, but on second glance I can that it is just a wider angled lens on the camera. I guess the point that the original picture was taken from is actually the same position I think, but there is slightly more being shown in the field of vision on the left hand side one than the right, so the impression I am given that the greater depth is on the left hand side.

G4f
Right
Because there is more, it looks like it is going back more, because there is more in the photo.
Right

Because there is more background; it looks like it is going back further I guess because there is more in the photo again.
Left
Because you could see more in it, and it looked more like tunnel vision.

G4g
Right
Well there is more to it as a whole. The left image looks like it is straight up in your face compared to the right image. It takes you, helps you focus into it more.
Right
Because they have used the blur, that focusing in on the watch, they have left the rest blurred out. It looks like the watch is standing out against the background. Whereas the left image it's all sort of all on the same plane. You can tell that his watch is in front of his face. They did not use that blur to give you a sense of depth, but as a person you can see that there is depth, but not as much as the right.
Left
Again they have used blur for both, but because I think they have used more for the picture on the left, more artefacts, more objects you know, and obviously the wall and you can see the guitar. Whereas the image on the right is just looks close, whereas the picture on the left, it takes you into the whole room, and also her leg. The shine on either two side, leads your eye onto further objects

G4h
Right
Because it seems that it is taken from further away, so there is more distance in the, there is more depth in the image. So the main thing is the size of the grid, so the teapots are the same size, but the grid here (left image) is closer, and in this one it is further away (right image) slightly smaller.
Right
There is, similar to the last one in a way. So there is, I get a greater sense of things being further away, partly because there are more things there, and they are smaller.
Right (Normal)
It's difficult. Everything seems a little flat in the one on the left. So, whilst there are more things and they are smaller, in a further away and distance kind of thing. They also could just be on a screen that is flat. There is more distance represented in the left image, but it seems more flat.

Group 5 –Watch, Teapot, Glass

G5a
Right
I think it is clearer than the left one, more dissimilar to the left one
Right
Because it is not clear/similar to the left one. I mean the distance also between the lens of the camera, and the wall also.
Left
Because of the, it's clearer. The movement/ position of the hand, it looking depth more than the right one, and also the photo of the fruit is different than the left one, it is clear in the (looking at the normal image)

G5b
Left (Normal)
Because left shows all things, and you can see everything in this picture, not like the right one. As well it is clearer.
Left
Depth is .... show the all
Right..........
It shows everything better..... Which image shows more objects? Right one.......because I look to the wine, and hand, not all things in these pictures.
If you see the picture frame in the right one compared to the left one.......
If you were to answerer the question again which one would you choose?
Left one, because left one shows everything in the room... So would you change your mind maybe on the other ones? I can change.

G5c
Right
Because the background is a bit more blurry, so it feels like it is closer, there is more scenery, more background scenery.
Right
Because the camera is a bit higher up, so you can see deeper into the photo. For example on the table, you can see more of the table than you can see on the left. The camera appears to be further back so you can see more.
Left
Once again, because I can see more. I can see deeper into the photo on the left hand side than I can on the right hand side, just because I am at a lower angle compared to the one on the right.

G5d
Right
Because I can see more of the room, the watch is up close, and I can see more behind it. Whereas on the other one it’s all up close, and you can’t see anything behind
Right
There is more stuff in it. So that makes me feel that I can. There is more depth; I am seeing more going back, my visual field is. There is more in my visual field so that’s why I feel that it’s, I can see further back whereas the left hand one is up close, so it doesn’t feel like my visual field as much, because I don’t feel I can see back as far., and it just seems closer (the image on the left).
Left
Same reason again I suppose. Because I can see further down the room, so it seems deeper.

G5e
Right
It just seems like there is more there. There’s just more distance. More included in the image on the sides and background.
Right
It feels like I am further away, looking at the image. The legs do this. It just seems everything is just more focused into one thing. It seems like it is more open.

Left
Same again really; the table looks like it is further away from the wine, the drink in the hand. The carpet, it seems like there is more carpet even though I think it is the same amount.

G5f
Right
You can just see more into the room
Right
Same again. I think because you can see more of the space, the corners of the wall I suppose.
Left
Sae reason again, because you can see more of the space. I guess being able to see objects that are further away, like the things on the dresser on the back wall.

G5g
Right
I think it looks like it is much more further away than the left one. I guess it's a bigger picture as well, I think that the sofa and the fur.
Right
Because it looks like it is a bigger picture, there is more information in the picture. There is way more than the left one, the left one feels like it is many time closer than the right one
Left
More information for eyes. You can see almost the whole room, and on the right one you can't. You can only see (looking down at the table), you can't even see the wall, which you can see on the left one, so there is more information for my eyes to tell me there is more depth.

G5h
Right
The field of view is much larger. You can see more of the room, so it's more depth.
Right
The camera is further from the object, it's focused further from the object, and you see more of the room, of the back, of the 3D. So yes I would say right, defiantly.
Left
And I would say left for the same reasons as I said before. You can see much more of the room, and it seems to be that the camera has a wider angle or aperture.

Group 6 – Watch, Glass, Teapot

G6a
Right
Because the right image is less focused, it feels like it is further away, the objects in the background
Left
The objects in the background look smaller and therefore further away. There is more in the image, in the left, more images in the left.
Right

Lot more objects in the image. The teapot is, the black teapot is out of focus a little bit, it seems further away. The dots on the wallpaper seem a bit smaller, the grid as well is a lot smaller, looks further away than the grid on the left hand side.

G6b
Right
The main feature that I am basically looking at is the focus of the fruit bowl and lamp plus the sofa. Far more visible on the left, far more insightful their (right image). Even thought there is a visual rick there, you would think left there because they are all in focus, the actual depth of it I know is to the right because it's smaller and you can see more of the room than the left. The automatic part of my brain would say left because it is all in focus, but the blurriness tricks your brain a bit. If that makes sense
Left
You can see a lot more of the room. The one on the right seems closer in. Again I'm just using a visual object, the sideboard is far nearer on the right than it is on the left. It is farther away on the left hand side, against the wall. You can't see the mural on the wall either, you are too close in. You can see the mural fully on the yellow wall in the left, it is more falls back. The one on the right is far, in your face I suppose, far more cluttered.
Right
The key focal points that give it away is the cupboard has been taken off, and the plaster removed from the tiles. You see the box very much closer on the left, the one on the right is further back, depth.
You can see the outline of it in smaller detail.
The teapot looks like it has been "wibble wobbled" to look similar in size, the backdrop itself being blurry aids for the visual impact that it is further away, as does the general size of the tiles. On the left they are far larger on the right they are smaller.
The head on the bottom left is larger on the left, where the head on the bottom right is smaller. Other than that, the final give away is the light stand; on the left image you can see the handle adjuster in larger detail than on the right.

G6c
Right
Just because the background objects are, appear to be further away. It is a bit confusing at first to make sense the image is a bit fuzzy in a sense, but if you compare the oriental teacup that's much closer in that image, than it is on the image on the left than it is on the right. More information range
Left
It s to do with the view you have on the surrounding environment. I am tilting my head back a little in the left one, not that I usually wear leggings obviously. Both I think are believable, certainly more believable than the first one, the right (previous images) I struggle to find it so believable; but the left image gives you a more realistic sense of depth in this round of images, but it feels like everything is a bit further away. Yes the image on the left
Right
Just because there are more clues in the image about the depth, the visual depth if you know what I mean. There are more things to make a reference; more objects in the background, so you have the bust for example in the bottom right, and then you have the other things in the background like right in the corner there, you have some

sort of cupboard. I find it difficult to make my decision, because something about the composition on the image on the left sort of conveys a certain sense of perspective, a feeling of depth, but because there is less information in it to sort of refer to, and because you sort of have this wide angle field of view in the right image. I went with the one on the right.

G6d
Right
Because I think it is kind of blurry, so you kind of focus on the persons arm so everything else looks like it is further away
Left
Because you can see more in the background, but actually it's at a different angle as well. So the person seems to be further back, so they get to see more of the room.
Right
Maybe again because there is more in the background so it seems like it is further away. You can see the person's legs so it is as if they are looking at it rather than the picture on the left. The person, I guess I am looking at it, whereas the one on the left is more just like a picture, on the right it's more like there is something going on. That is not a very good description is it?
Seems more blurry on the right hand side, so it seems like its further away. You don't focus so much directly on the actual teapot. Kind of around the teapot or unless it's just my eyesight of course.

G6e
Left (Normal)
Because I can see more objects clearer, so I can, I guess I have clarity on the room. To me I can see that this sofa thing (Left image), I can see the depth on the sofa because it is in focus to me. Does this make sense?
Depth as in field of vision depth.
Left
Because I could see more of the room around it.
Left (Normal)
Because this, because the one on the left is in focus I can see the depth of the spotty paper, whereas the blurring on the right means that I can't really get an idea of how far back it goes; the teapot to the wall. Does that make sense?
Depth discussion.... Further reason for depth... The one on the right, the picture goes further back, but it's the depth of the image that I can see here (looking at the left image), I can see on the left, more depth of that table than I can (looking at the right image) because of the focus of it.

G6f
Right
Because you have got more in the image, on the right hand side. You have the top of the chase lounge; you have the background of the wall, so it feels like you are zoomed out a bit more
Left
Again, because you appear to have more of the background, you have included the wall. The right image, as if you have a 45 degree angle pointing down onto the floor, whereas the left image is more chest height, horizontal, landscape I would say
Right

Because it covers the floor, you got the corners of the walls, it feels like you are sat back in the image, even though the left hand side of that image is quite blurry, and maybe looks like it is a bit out of proportion. With the left hand image you feel like you are pretty much sat there, much nearer it. Whereas the right image you are sat back. Also it helps that the guy has his got his legs and you feel like you are not in front of that person, you are that person.

G6g
Right
Because I have the wall as a point of reference, well I can't see the wall in the left picture.
Left
I can't see the wall in the right image.
Right
Because I can see more of the room. I can see a person's legs; there are more objects that are kind of giving me more information to base a scale on.

G6h
Left (Normal)
I don't know, I suppose that everything is clearer to me in the left image, that is why I think that the right is showing me more information, but I am drawn to looking more at the left
Left
Because what catching my eye, the arm shows a lot more of that (eye tracker shows looking at the arm and glass) compared to the right one. The first thing that catches my eye is the arm, and the drink, and I see, for some reason I see more detail on the left side of that than I feel I do on the right.
Right
Just because there is more detail around it, even though I don't see the teapot as prominently as the other one (left image), I am more drawn to everything else around it. I like to see more that side (right image) so I am more focus on what's going on around the teapot in the canter than I am on that one (left image). I am just more drawn to looking at the other one (right image), it is more interesting.

10.4 Chi-square test performed between the paired teapot stimuli

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Teapot4	32	.9688	.17678	.00	1.00

Chi-Square Test Frequencies

Teapot

	Observed N	Expected N	Residual
Normal	1	16.0	-15.0
Fovography	31	16.0	15.0
Total	32		

Test Statistics

	Teapot4
Chi-Square	28.125[a]
df	1
Asymp. Sig.	.000

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 16.0.

10.5 Chi-square test performed between the paired watch stimuli

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Watch3	32	.9063	.29614	.00	1.00

Chi-Square Test Frequencies

Watch

	Observed N	Expected N	Residual
Normal	3	16.0	-13.0
Fovography	29	16.0	13.0
Total	32		

Test Statistics

	Watch3
Chi-Square	21.125[a]
df	1
Asymp. Sig.	.000

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 16.0.

10.6 Chi-square test performed between the paired glass stimuli

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Glass2	32	.9375	.24593	.00	1.00

Chi-Square Test Frequencies

Glass

	Observed N	Expected N	Residual
Normal	2	16.0	-14.0
Fovography	30	16.0	14.0
Total	32		

Test Statistics

	Glass2
Chi-Square	24.500[a]
df	1
Asymp. Sig.	.000

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 16.0.

10.7 Conditions totals table calculated by way of favouritism

Image type	Normal picture	Fovography picture
Participant choice	1.00	31.00
The modal value of stimulus picked by the 32 participants is used to weight image preference.		

Participant	Teapot	Watch	Glass	TeapotFOV	TeapotNORM	WatchFOV	WatchNORM	GlassFOV	GlassNORM	OverallFOV	OverallNorm	Preference	Frequency1	BothTypes
1	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	31.00	Fovography
2	Fovography	Fovography	Normal	Yes	No	Yes	No	No	Yes	2.00	1.00	Fovography	1.00	Normal
3	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
4	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
5	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
6	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
7	Fovography	Fovography	Fovography	Yes	No	No	Yes	No	Yes	3.00	.00	Fovography	.	.
8	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
9	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
10	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
11	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
12	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
13	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
14	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
15	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
16	Fovography	Fovography	Normal	Yes	No	Yes	No	No	Yes	2.00	1.00	Fovography	.	.
17	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
18	Normal	Normal	Fovography	No	Yes	No	Yes	No	Yes	1.00	2.00	Normal	.	.
19	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
20	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
21	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
22	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
23	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
24	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
25	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
26	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
27	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
28	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
29	Fovography	Normal	Fovography	No	Yes	No	Yes	Yes	No	2.00	1.00	Fovography	.	.
30	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
31	Fovography	Fovography	Fovography	Yes	No	Yes	No	Yes	No	3.00	.00	Fovography	.	.
32	Fovography	Normal	Fovography	Yes	No	No	Yes	Yes	No	2.00	1.00	Fovography	.	.

10.8 Chi-square test performed between Fovography and Normal results

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Both1	32	.9688	.17678	.00	1.00

Chi-Square Test Frequencies

Both

	Observed N	Expected N	Residual

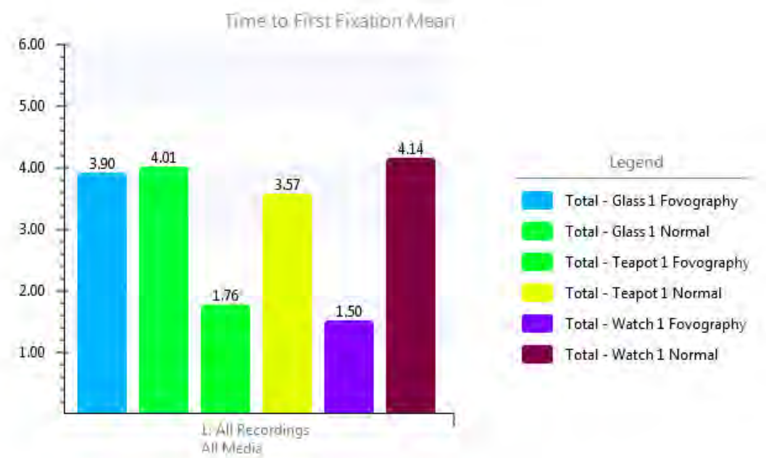
Normal	1	16.0	-15.0
Fovography	31	16.0	15.0
Total	32		

Test Statistics

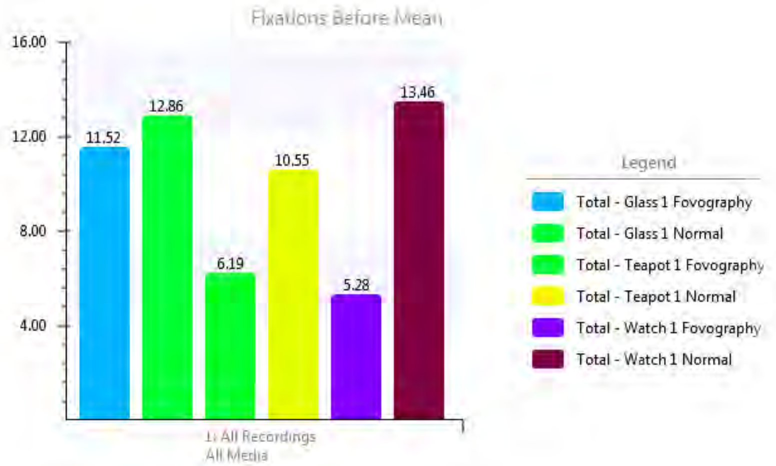
	Both1
Chi-Square	28.125[a]
df	1
Asymp. Sig.	.000

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 16.0.

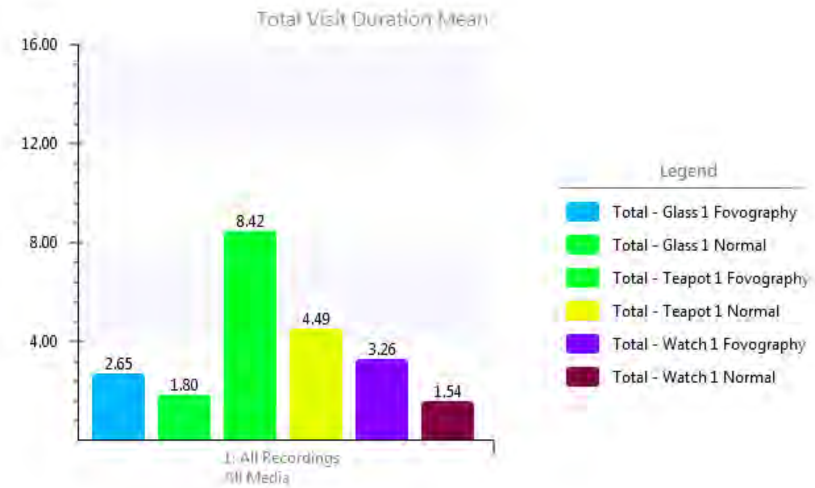
10.9 Intended focus area (AOI) mean bar charts for each condition: Time to First Fixation, Fixations Before, Visit Duration, Visit Count, and Fixation Counts



Time to first fixation: The time from the start of the stimulus display until the test participant fixates on the AOI or AOI Group for the first time (seconds).

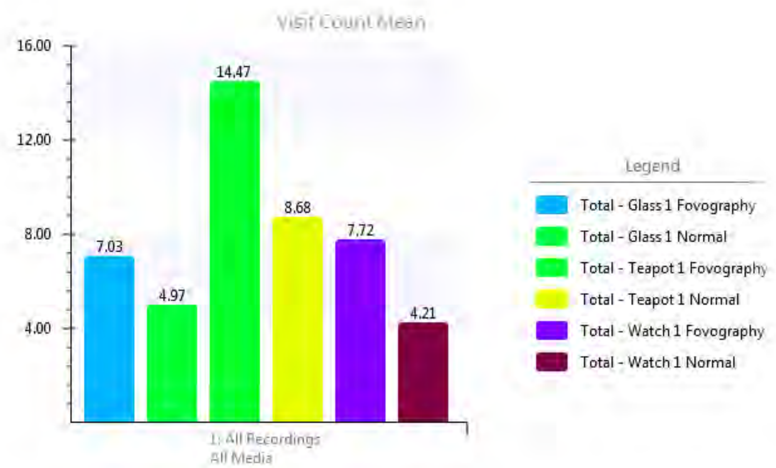


Fixations Before: Number of times the participant fixates on the media before fixating on an AOI or AOI Group for the first time (count).



Total Visit Duration: (former Observation Length) Duration of all visits within an AOI or an AOI Group (seconds).

Fixation count: Number of times the participant fixates on an AOI or an AOI Group (count).



Visit Count: Number of visits within an AOI or an AOI Group count).

10.10 Percentage Fixation, showing which participants had not fixated on the intended focus area (AOI) in each condition

Percentage Fixated Percentage of participants that fixated at least once within an AOI or AOI Group (%).

	Percentage Fixated																	
	All Media																	
	Total - Glass 1 Fovography			Total - Glass 1 Normal			Total - Teapot 1 Fovography			Total - Teapot 1 Normal			Total - Watch 1 Fovography			Total - Watch 1 Normal		
Participants	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)	N (Count)	Mean (Percent)	Sum (Percent)
g1a	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g1b	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g1c	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%	1	100%	100%	1	0%	0%
g1d	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g1e	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g1f	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g1g	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g1h	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4a	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4b	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4c	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4d	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4e	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4f	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4g	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g4h	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5a	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5b	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5c	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5d	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5e	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5f	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g5g	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%
g5h	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6a	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%
g6b	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	0%	0%
g6c	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6d	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6e	1	0%	0%	1	0%	0%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6f	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6g	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
g6h	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%	1	100%	100%
All Recordings	32	91%	2900%	32	91%	2900%	32	100%	3200%	32	97%	3100%	32	100%	3200%	32	88%	2800%

10.11 Time to First Fixation for the intended focus area (AOI) in each condition (different number (N count) of participants respectively)

Time to First Fixation The time from the start of the stimulus display until the test participant fixates on the AOI or AOI Group for the first time (seconds).

	Time to First Fixation																	
	All Media																	
	Total - Glass 1 Fovography			Total - Glass 1 Normal			Total - Teapot 1 Fovography			Total - Teapot 1 Normal			Total - Watch 1 Fovography			Total - Watch 1 Normal		
Participants	N (Count)	Mean (Seconds)	Sum (Seconds)	N (Count)	Mean (Seconds)	Sum (Seconds)	N (Count)	Mean (Seconds)	Sum (Seconds)	N (Count)	Mean (Seconds)	Sum (Seconds)	N (Count)	Mean (Seconds)	Sum (Seconds)	N (Count)	Mean (Seconds)	Sum (Seconds)
g1a	1	2.94	2.94	1	0.85	0.85	1	1.11	1.11	1	0.68	0.68	1	0.51	0.51	1	4.92	4.92
g1b	1	2.62	2.62	1	2.43	2.43	1	0.95	0.95	1	8.80	8.80	1	0.53	0.53	1	7.41	7.41
g1c	1	28.63	28.63	1	4.36	4.36	1	12.88	12.88	-	-	-	1	2.96	2.96	-	-	-
g1d	1	0.74	0.74	1	0.49	0.49	1	0.66	0.66	1	1.63	1.63	1	0.65	0.65	1	0.35	0.35
g1e	1	16.93	16.93	1	17.54	17.54	1	0.66	0.66	1	1.70	1.70	1	1.60	1.60	1	0.39	0.39
g1f	1	2.00	2.00	1	9.56	9.56	1	3.66	3.66	1	2.03	2.03	1	2.93	2.93	1	1.40	1.40
g1g	1	0.50	0.50	1	1.24	1.24	1	1.00	1.00	1	1.48	1.48	1	0.48	0.48	1	0.77	0.77
g1h	1	0.60	0.60	1	1.86	1.86	1	2.87	2.87	1	0.44	0.44	1	0.74	0.74	1	0.26	0.26
g4a	1	0.35	0.35	1	7.42	7.42	1	1.63	1.63	1	0.67	0.67	1	0.69	0.69	1	0.52	0.52
g4b	1	0.46	0.46	1	1.32	1.32	1	1.58	1.58	1	0.99	0.99	1	0.83	0.83	1	2.36	2.36
g4c	1	1.68	1.68	1	2.93	2.93	1	0.61	0.61	1	1.07	1.07	1	0.45	0.45	1	1.33	1.33
g4d	1	0.32	0.32	1	9.90	9.90	1	0.69	0.69	1	22.82	22.82	1	0.62	0.62	1	19.10	19.10
g4e	1	7.97	7.97	1	0.30	0.30	1	1.37	1.37	1	2.06	2.06	1	0.53	0.53	1	9.19	9.19
g4f	-	-	-	-	-	-	1	1.53	1.53	1	4.56	4.56	1	2.73	2.73	1	6.18	6.18
g4g	1	0.30	0.30	1	1.12	1.12	1	1.67	1.67	1	0.81	0.81	1	0.95	0.95	1	3.02	3.02
g4h	1	0.70	0.70	1	0.51	0.51	1	0.62	0.62	1	2.84	2.84	1	1.05	1.05	1	0.48	0.48
g5a	1	0.32	0.32	1	1.08	1.08	1	3.02	3.02	1	0.55	0.55	1	0.53	0.53	1	1.45	1.45
g5b	1	0.50	0.50	1	1.07	1.07	1	2.94	2.94	1	0.96	0.96	1	0.38	0.38	1	1.39	1.39
g5c	1	0.39	0.39	1	1.35	1.35	1	3.30	3.30	1	0.45	0.45	1	0.91	0.91	1	0.27	0.27
g5d	1	1.19	1.19	1	3.97	3.97	1	0.68	0.68	1	1.90	1.90	1	2.15	2.15	1	6.94	6.94
g5e	1	0.76	0.76	1	0.47	0.47	1	1.06	1.06	1	0.79	0.79	1	0.41	0.41	1	1.23	1.23
g5f	1	0.40	0.40	1	0.84	0.84	1	0.59	0.59	1	0.81	0.81	1	1.04	1.04	1	0.45	0.45
g5g	1	2.73	2.73	1	1.62	1.62	1	0.65	0.65	1	6.50	6.50	1	1.13	1.13	-	-	-
g5h	1	0.82	0.82	1	0.37	0.37	1	1.65	1.65	1	0.59	0.59	1	0.88	0.88	1	2.47	2.47
g6a	1	10.70	10.70	1	1.44	1.44	1	1.88	1.88	1	0.92	0.92	1	2.91	2.91	-	-	-
g6b	-	-	-	-	-	-	1	0.91	0.91	1	40.32	40.32	1	2.67	2.67	-	-	-
g6c	1	0.73	0.73	1	0.44	0.44	1	0.72	0.72	1	1.54	1.54	1	6.67	6.67	1	3.42	3.42
g6d	1	0.29	0.29	1	6.45	6.45	1	0.94	0.94	1	0.27	0.27	1	0.73	0.73	1	11.29	11.29
g6e	-	-	-	-	-	-	1	1.17	1.17	1	0.57	0.57	1	1.00	1.00	1	0.58	0.58
g6f	1	20.32	20.32	1	16.64	16.64	1	0.94	0.94	1	1.48	1.48	1	2.17	2.17	1	18.57	18.57
g6g	1	5.49	5.49	1	14.73	14.73	1	1.30	1.30	1	0.00	0.00	1	4.35	4.35	1	8.16	8.16
g6h	1	1.69	1.69	1	3.88	3.88	1	0.91	0.91	1	0.46	0.46	1	1.68	1.68	1	2.15	2.15
All Recordings	29	3.90	113.10	29	4.01	116.19	32	1.76	56.17	31	3.57	110.67	32	1.50	47.87	28	4.14	116.05

10.12 Paired t-tests for Time to First Fixation means

T-Test - Time to First Fixation

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	GlassFovograph	3.8990	29	6.87973	1.27753
	GlassNormal	4.0062	29	5.02083	.93235
Pair 2	TeapotFovograph	1.3958	31	.87374	.15693
	TeapotNormal	3.5706	31	8.02587	1.44149
Pair 3	WatchFovograph	1.3639	28	1.39661	.26394
	WatchNormal	4.1446	28	5.16785	.97663

Paired Samples Correlations

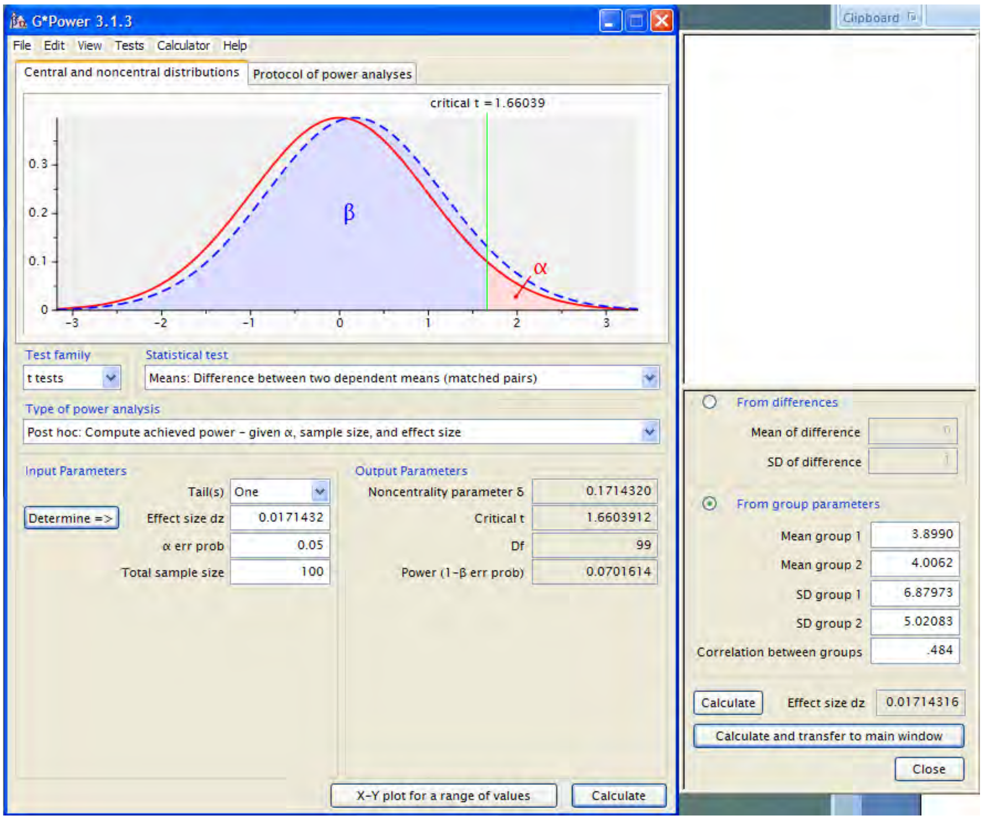
		N	Correlation	Sig.
Pair 1	GlassFovograph & GlassNormal	29	.484	.008
Pair 2	TeapotFovograph & TeapotNormal	31	-.214	.248
Pair 3	WatchFovograph & WatchNormal	28	.124	.529

Paired Samples Test

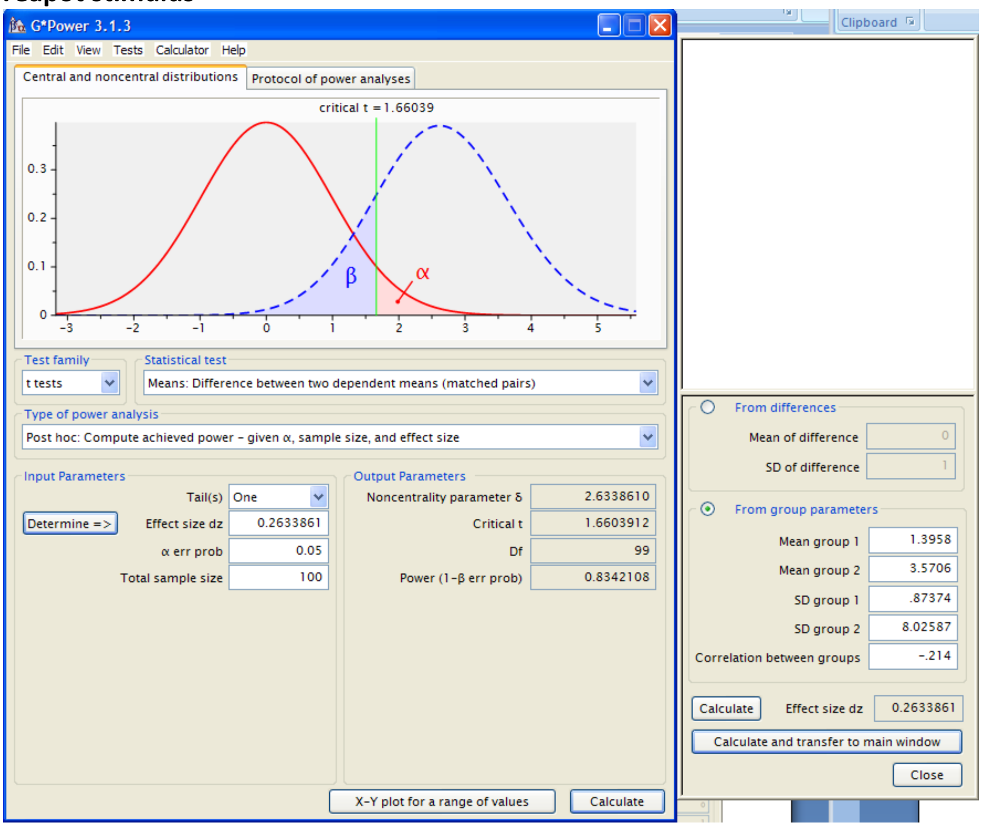
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	GlassFovograph - GlassNormal	-.10724	6.25410	1.16136	-2.48617	2.27169	-.092	28	.927
Pair 2	TeapotFovograph - TeapotNormal	-2.17484	8.25706	1.48301	-5.20355	.85388	-1.467	30	.153
Pair 3	WatchFovograph - WatchNormal	-2.78071	5.18319	.97953	-4.79054	-.77088	-2.839	27	.008

10.13 Effective size calculations for Paired t-tests (G*Power 3.1)

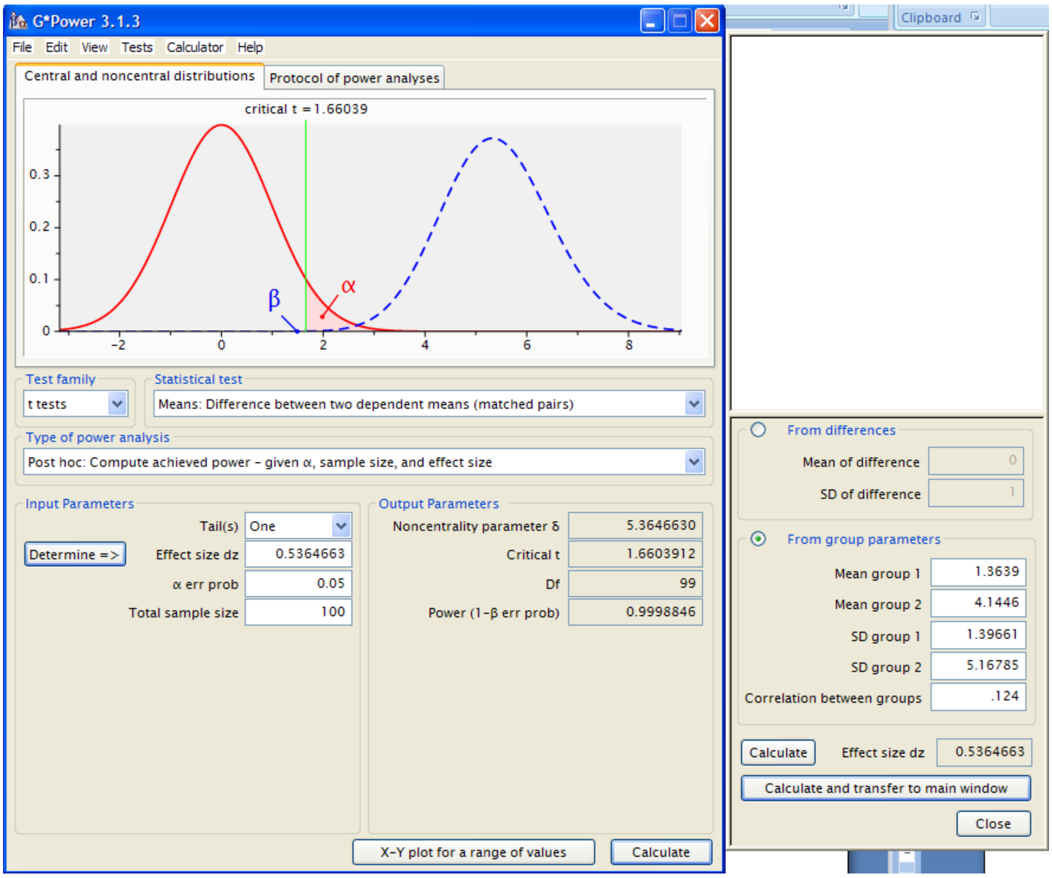
Glass stimulus



Teapot stimulus



Watch stimulus



10.14 Paired t-tests for Fixations Before means

T-Test - Fixations Before

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	GlassFovograph	11.5172	29	18.21620	3.38266
	GlassNormal	12.8621	29	14.35699	2.66603
Pair 2	TeapotFovograph	5.1667	30	3.20649	.58542
	TeapotNormal	10.9000	30	20.77523	3.79302
Pair 3	WatchFovograph	4.9643	28	4.37571	.82693
	WatchNormal	13.4643	28	15.72797	2.97231

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	GlassFovograph & GlassNormal	29	.437	.018
Pair 2	TeapotFovograph & TeapotNormal	30	-.233	.216

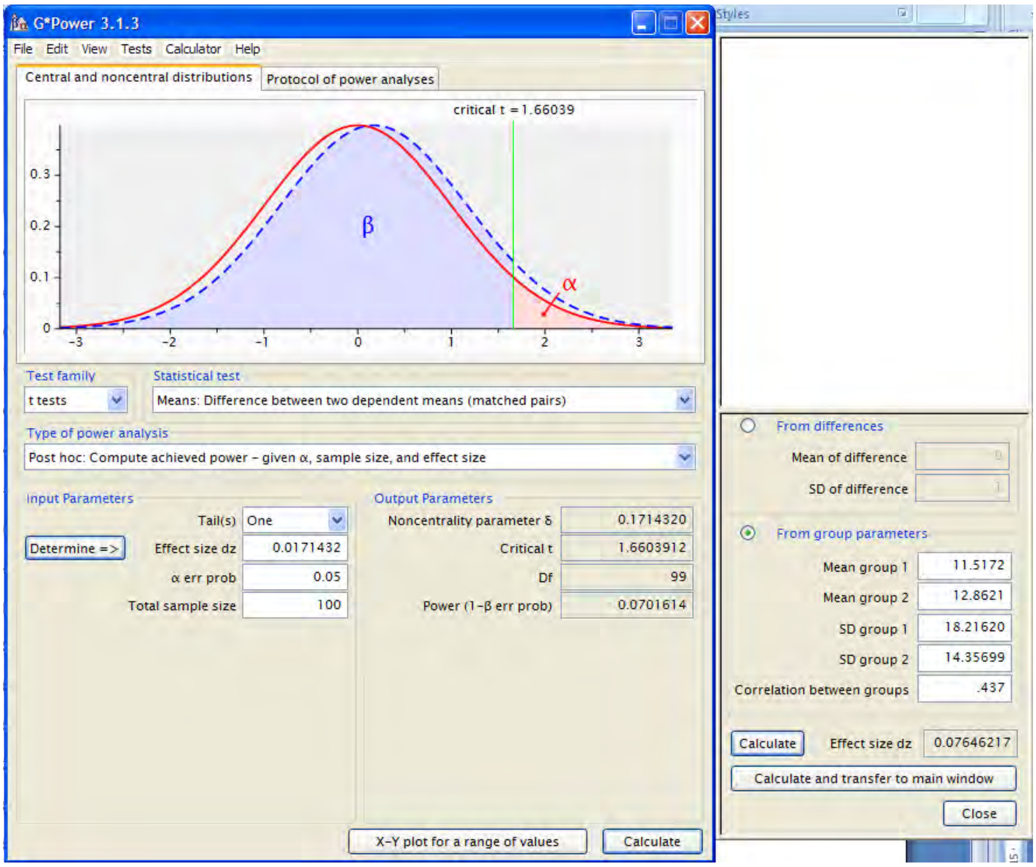
Pair 3 WatchFovograph & WatchNormal	28	.113	.568

Paired Samples Test

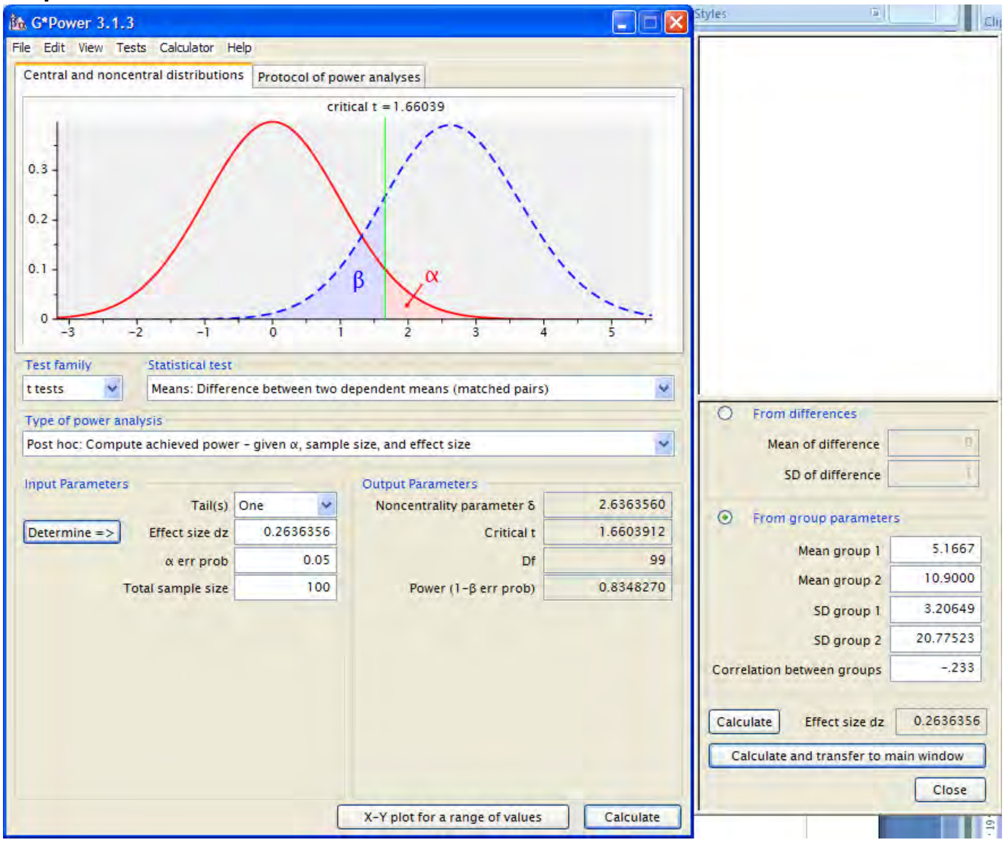
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 GlassFovograph - GlassNormal	-1.34483	17.58302	3.26508	-8.03305	5.34340	-.412	28	.684
Pair 2 TeapotFovograph - TeapotNormal	-5.73333	21.74608	3.97027	-13.85345	2.38679	-1.444	29	.159
Pair 3 WatchFovograph - WatchNormal	-8.50000	15.84298	2.99404	-14.64327	-2.35673	-2.839	27	.008

10.15 Effective size calculations for Paired t-tests (G*Power 3.1)

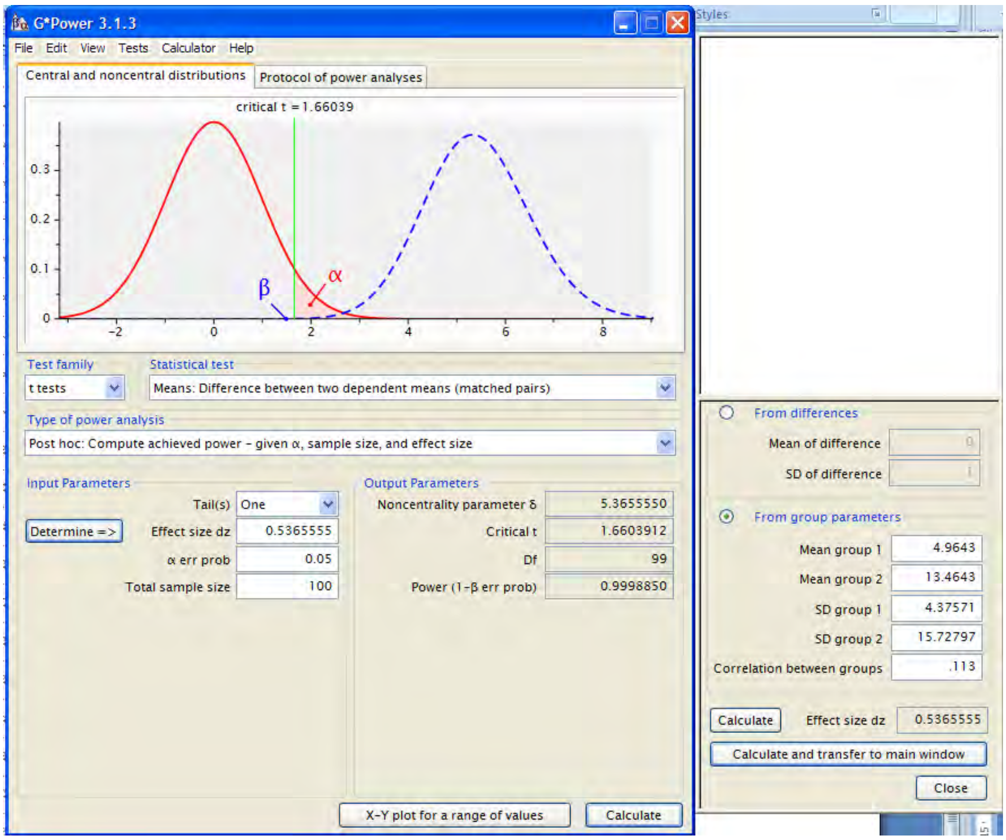
Glass stimulus



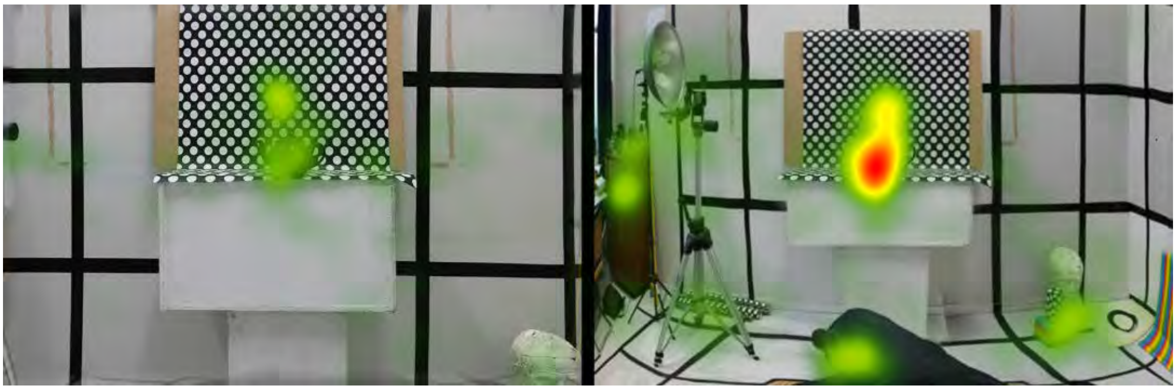
Teapot stimulus



Watch stimulus

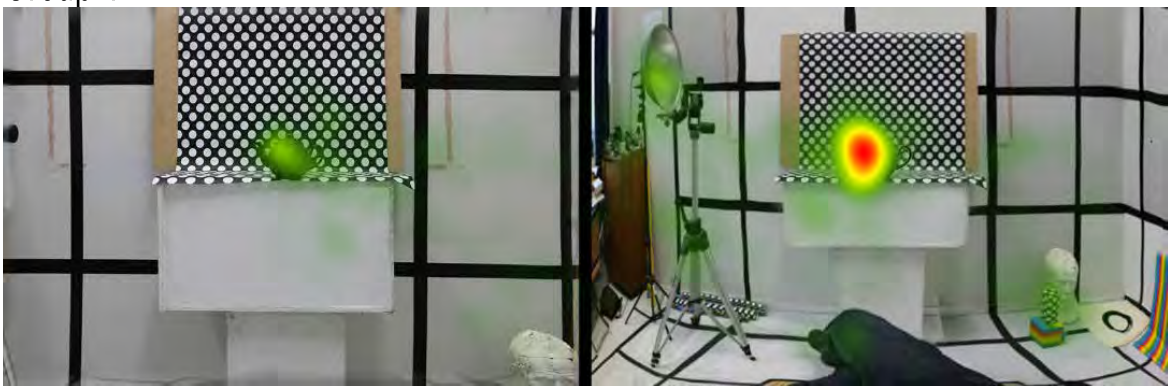


10.16 Heat map images for the teapot, glass of wine, and watch conditions



Group 1

Group 4

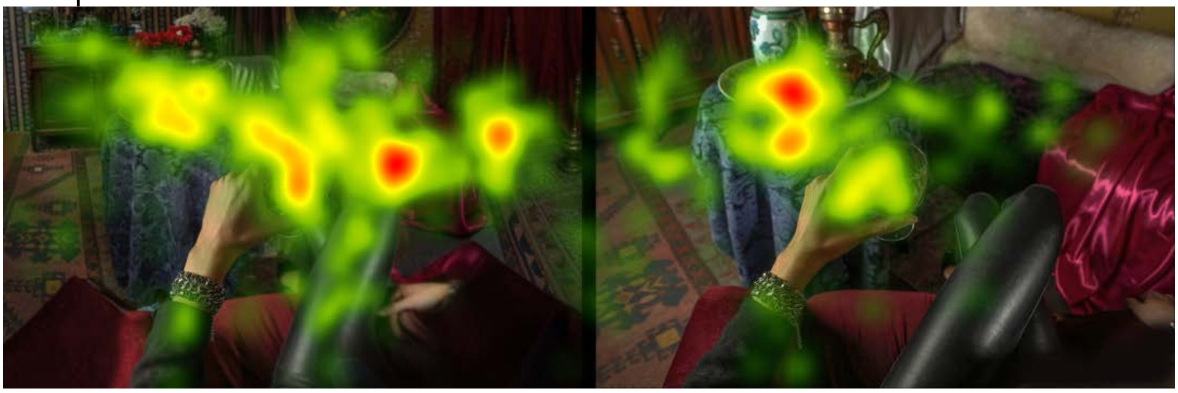


Group 5

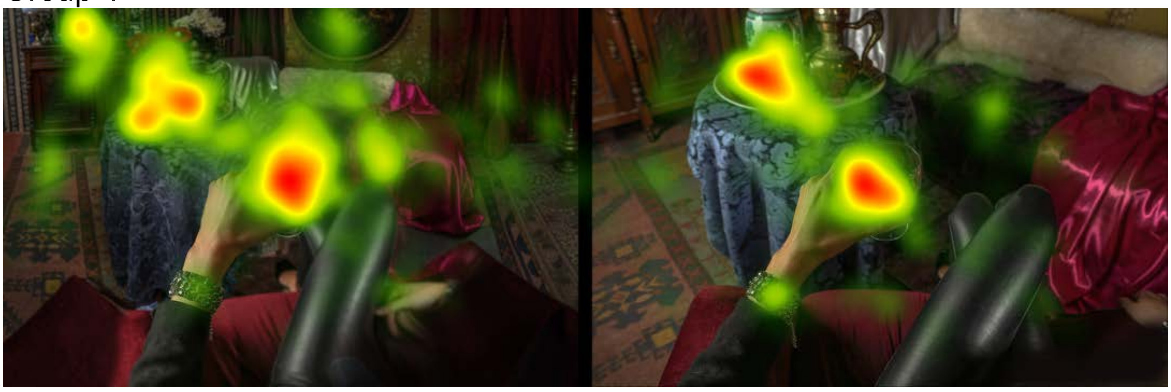
Group 6

Teapot scene: Heat maps visualisations outputted from eye tracking (data of the four groups) of participants viewing the Normal Condition on the left, and the Fovography Condition on the right.

Group 1



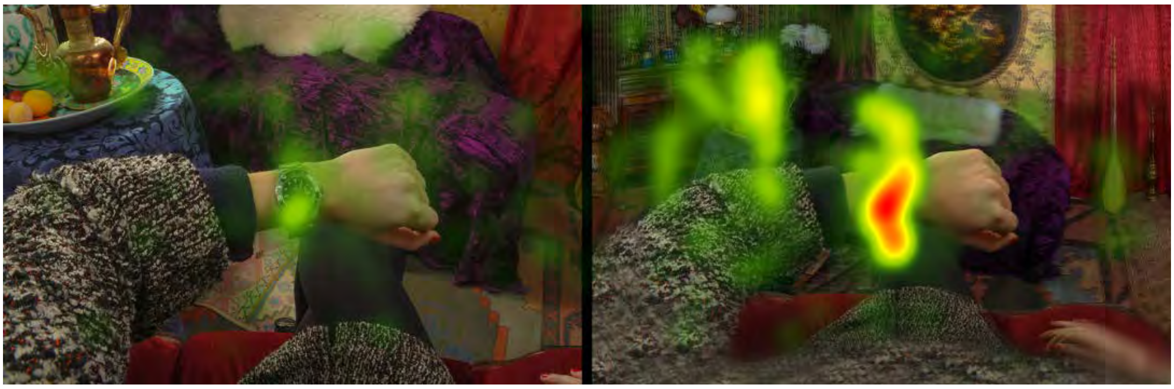
Group 4



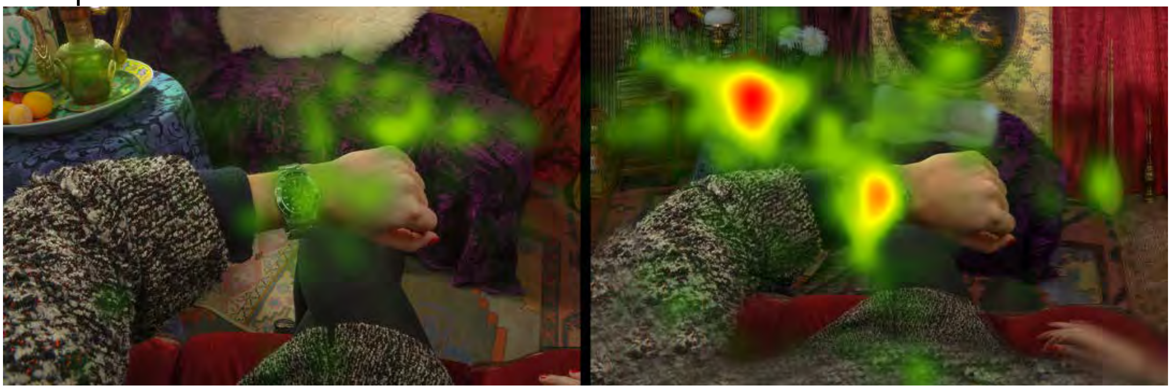
Group 5

Group 6

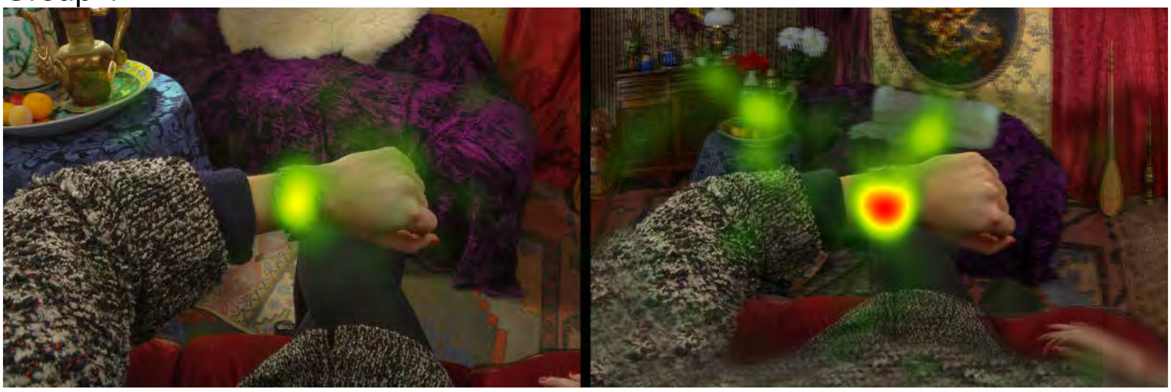
Glass of wine scene: Heat maps visualisations outputted from eye tracking (data of the four groups) of participants viewing the Normal Condition on the right, and the Fovography Condition on the left.



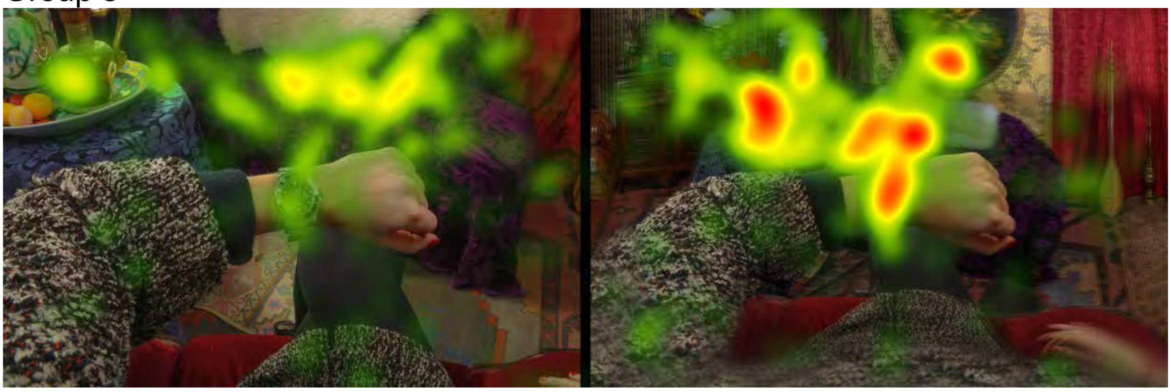
Group 1



Group 4



Group 5



Group 6

Watch scene: Heat maps visualisations outputted from eye tracking (data of the four groups) of participants viewing the Normal Condition on the left, and the Fovography Condition on the right.

Appendices 11

This part of the appendices contains unedited data and analysis produced as part of two initial Fovography experiments, and is included here for reference purposes. In both of these experiments, the comparative visual tasks provided inconclusive data.

11.1 Two initial Fovography experiments with inconclusive results

Overview

The stimuli produced for the first two Fovography experiments comprised of five objects arranged on a table, which was flush with a white background wall. Because the wall was white, and without a pattern, it was decided that it would be best to attach additional objects to it. This was done in an effort to better represent the visual changes being made to the visual field of the Fovography picture, when image effects such as compression and indistinctness caused by blur are introduced. However, it would be explained to participants that the various wall objects were not selectable during tasks, and that only one of the five table objects was intended as the main object of attention from each stimulus (Figure 1).

Figure 1. The table objects comprised of a black teapot, plastic brain, oriental teapot, vase with flowers, and a cardboard tube with a dome on top.

The five attention objects on the table were rearranged four times, and on every occasion a different object was positioned in the middle of the table, as the intended focus. Each new focus object was placed at a pre-arranged distance from the back wall (TABLE 1), which was marked on a line across the middle of the table.

Focus object	Distance from the wall
Oriental teapot	20cm
Black teapot	30cm
Plastic brain	40cm
Cardboard tube with dome	50cm

TABLE 1. The central position of four table objects intended as focuses; each set at a different distance from the wall to make four distance scenes.

Every time a different object was positioned along the centre line of the table, a new drawing of the scene was made using this object as a focus, and the origin of the compression layout. After the completion of each new focus object drawing, a line of sight table photograph was taken, which corresponded to the same distance as the person's eyes, drawing the table scene (Figure 2).

Figure 2. The seated location of the person drawing the table scene, and the line of sight camera position which corresponded to the same distance as the person's eyes.

The drawing method of using a sustained focus onto a single area of interest (object) was proposed through Prof. R. Pepperell's own visual investigations, as being the only way to factually record our experiential qualities of peripheral vision. This drawing is then used as a template for compression and disparity in contrast to central attention (Figure 3).

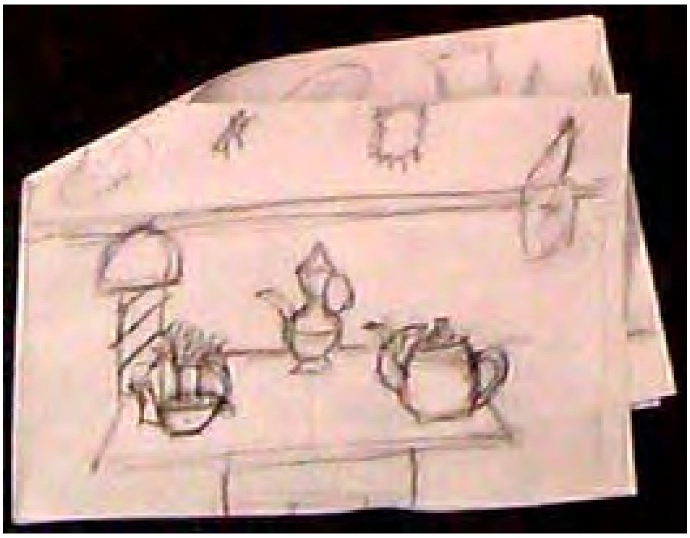


Figure 3. A drawing of a scene whist maintaining a single object focus, which is suggested to give a truer spatial account of our visual field.

When the sketch is compared against a photograph taken from the same line of sight origin (Figure 4), the drawn visual field is proportionally dissimilar to the photographic record. The drawing shows an upsizing of the object focused on within the fixation area, and a greater amount of peripheral content. This content becomes increasingly compressed and indistinct towards peripheral limits of the image; however, it is not possible to depict the amount of indistinctness caused through blur.

Figure 4. A photograph taken using a wide angle lens (50mm), from the same line of sight origin which it was drawn from.

To better represent the full scope of our visual field within a single image, multiple photographs are taken across the scene (Figure 5). These then would be joined together, to produce an image with increased horizontal and vertical visual angle.

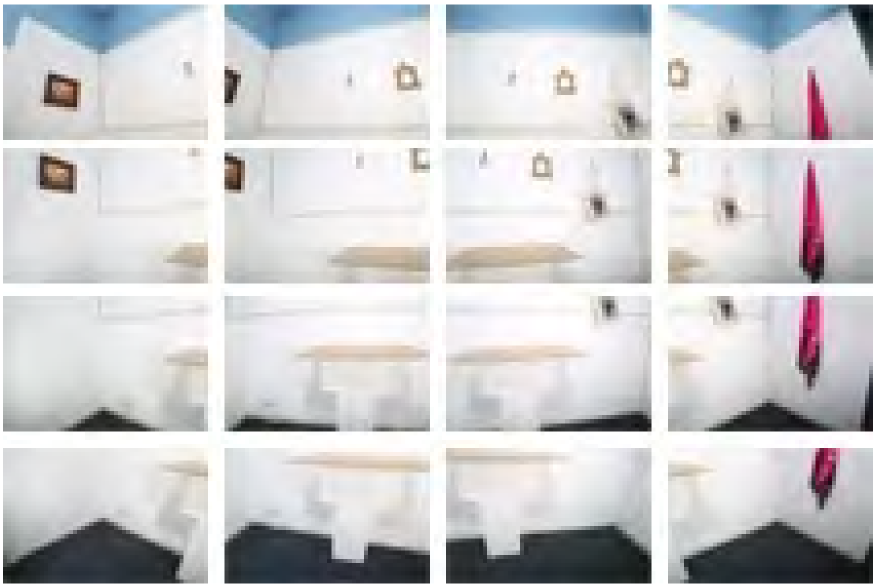


Figure 5. The scene was photographed multiple times, and these images where batch imported to create an image with a full visual field.

These multiple photographs were taken without the five table objects, so that the background orientation remained constant across the four different focus object arrangements, which would be overlaid into position later. The multiple photographs were batch imported into image editing software (Photoshop), where they were layered over each other, and joined seamlessly together with some additional operator manipulation. This allowed a single background image to be composed, with a similar scope of visual information recorded in the drawing. This background image now had a larger visual angle than a single line of sight photograph, taken using a standard 50mm lens, could produce from the origin of the viewer's observation (Figure 6).

Figure 6. The multiple photographs of the scene were batch imported to create an image, which contained the same scope of visual angle produced by the human visual field.

The visual field of the scene then needed to be transformed further, so that it created the expected geometry of an optical image, and the cropped rectangular border that we are familiar with when viewing normal 2D media (Figure 7).

Figure 7. Finalised background image, containing the scope of visual information found in the drawing, but without the additional experiential qualities depicted.

The next step was to overlay onto the background image, in turn, the four line of sight photographs containing a changed focus object, surrounded by the table objects (Figure 8).

Figure 8. Line of sight photograph of the oriental teapot at a distance of 20cm from the wall.

Each line of sight photograph was first cropped around the table, to include the five objects positioned on it. This image was then pasted onto the empty table in the background image, where it was scaled down to match the size of the table it was covering (Figure 9).

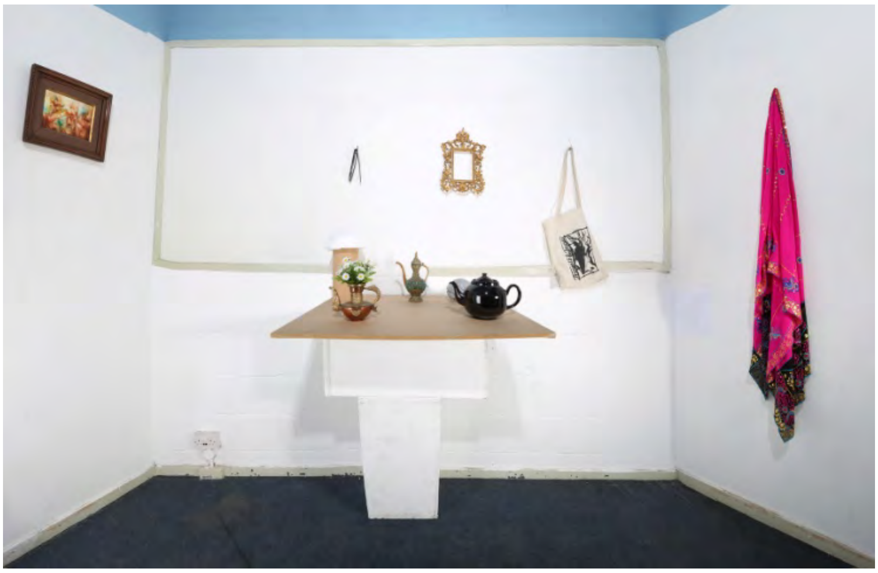


Figure 9. The oriental teapot focus object image, set at a distance of 20cm from the wall, with a large visual field.

The crop, overlay, and scaling technique were repeated for the remaining three line of sight photographs, producing a total of four large visual field images. Each of these images had a changed arrangement of table objects, and new a focus object at a different distance from the back wall.

These geometrical (optical) equivalent formats, were then used as foundation images for the introduction of compression and peripheral blur Fovography image effects, and DOF familiar to normal 2D media (Figure 10).

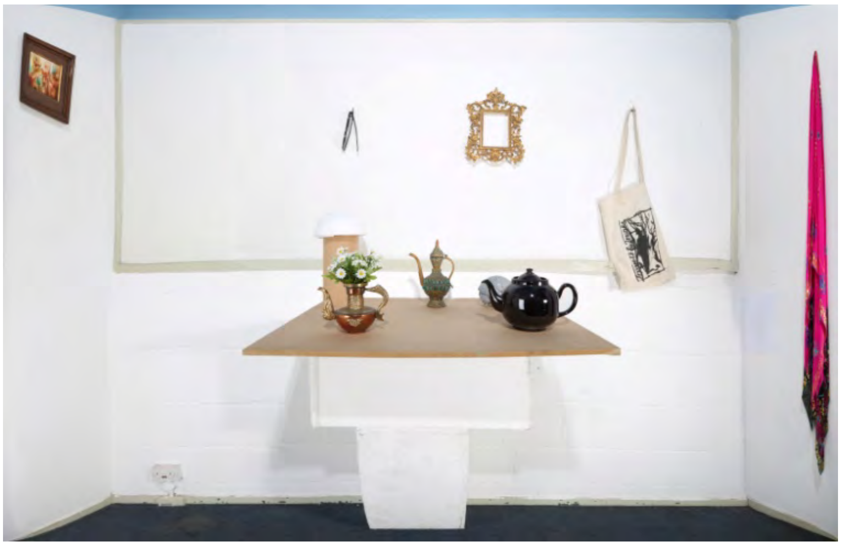


Figure 10. Compression image - 20_c: This is a zero blur stimulus with the oriental teapot placed at a distance of 20cm from the wall. The image has a larger visual field which is compressed towards peripheral limits, making objects appear wider within the fixation area.

Using the scene drawings as a guide, once the four foundation images were adjusted with the depicted compression layout, the visual differences between the foundation and compression image become quite noticeable (Figure 11).

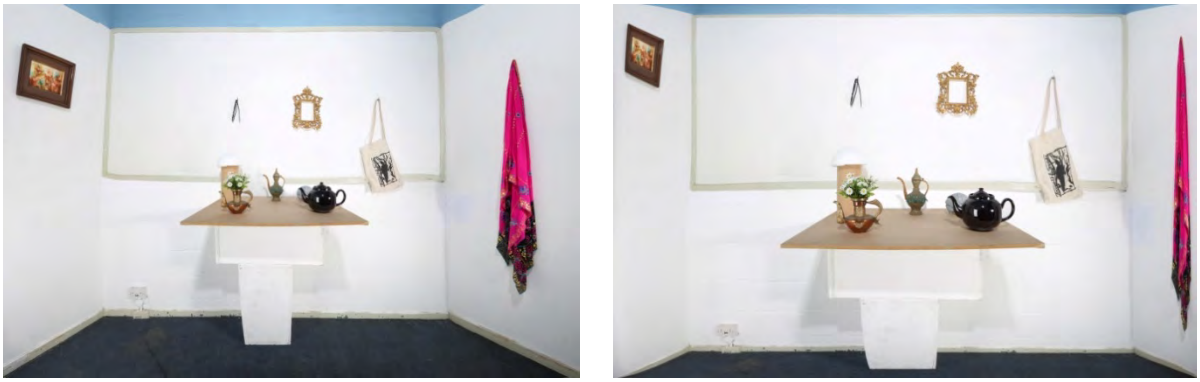


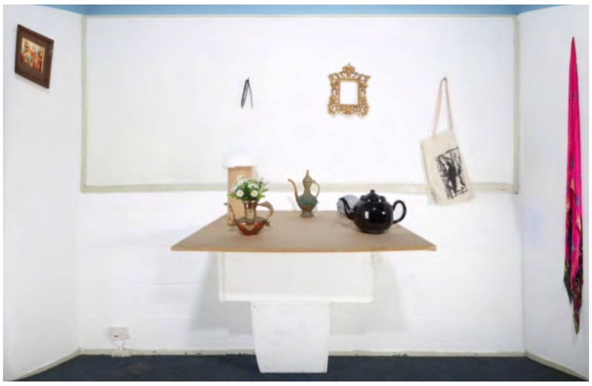
Figure 11. Two noticeable adjustments visible between the foundation and compression image are an enlarging of objects within the fixation area, and the compression of peripheral information.

Firstly, by widening the area of interest, the objects situated here become enlarged; this seems to increase their forefront prominence in comparison to the original foundation image. Secondly, the enlarging of objects in the intended focus area reduces the amount of surrounding image space; with the scope of peripheral information fitted into this space, through a method of increased compression.

In summary, it was concluded that a line of sight photograph was not capable of forming a large enough visual field to match our own, but the production of a foundation image provided a vehicle for the full scope of our visual field, to be formed within a comparable optical layout. Then, through close comparison of a scene drawing made from an equivalent camera location, the foundation images optical layout of the visual field was resized in two distinct areas. This saw an enlarging of objects in the intended focus area, in conjunction with an increasing compression of visual information, towards the peripheral borders of the image. The mutual association of these two areas gives a Fovography picture its basic shape, and are theorised as being core in replicating the experiential layout of our human visual field within a Normal 2D media. It was therefore necessary to first create a foundation image, so that a compression image effect could be applied to the scope of the human visual field. This meant that the original foundation image had the same amount of visual information, although disproportionate in comparison to the compression image. Nevertheless, the recorded field of view from a single photograph would be less, in comparison to both of these full field of view images, but with an optical scale being the same as the original foundation image.

After careful consideration it was decided inadequate to compare an original foundation image, against its compression state, for the visual tasks. This was based on the premise that if the foundation image was viewed, the results might reflect only the size increase of the table and objects on it, within the compression image; rather than the increased field of view and peripheral compression, in comparison to a normal photograph. It therefore became necessary to enlarge the original foundation image, and as a result the size of the table and objects on it, matched those in the compression image (Figure 12). Once this had been done, the original foundation image was cropped to match the size of the compression image, shrinking its visual field closer to that of a normal photograph. This adjustment to the original foundation image, would now allow a more truthful comparison to be made between the spatial qualities of a normal photograph (optical image), and the increased visual field produced by the Fovography image effect of compression. It is important to highlight that the compression visual effect of enlarging objects in the fixation, would no longer be seen.

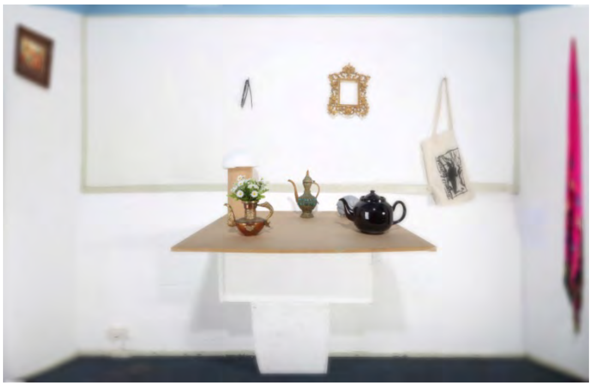
Figure 12. Oriental teapot focus object - Normal image - 20_n. This is an enlarged foundation image, which is cropped to the size of the compression image to reduce its field of view.



Oriental teapot focus object - Compression image - 20_c. This image is designed to have an experiential field of view, which includes a compression effect.

The paired Normal and Compression image types, each of which had a changed focus object positioned at a different distance from the wall were deliberately designed with zero blur (infinite Depth of Field (iDOF). This made it straightforward when assigning both of these images types with equal blur (DOF), and the Fovography image effect of peripheral blur; where the measure of blur is increased towards the periphery of a picture (Figure 13).

Figure 13. Normal image with equal blur (DOF). This image uses the oriental teapot as the focus object - 20_neb.



Compression image with experiential field of view and peripheral blur effect. This image also uses the oriental teapot as the focus object - 20_cpb

In addition to the already discussed use of blur as a visual effects in pictures, such as DOF, Hillaire et al. (2008) explored the real-time effectiveness of DOF, and peripheral blur in aiding navigation in virtual environments (VE). The use of DOF as a depth cue in human vision is already widely accepted (Atchinson and Smith cited in Hillaire et al., 2008), with objects either side of a sharp point of focus becoming increasingly blurred, signifying their increased detachment. This is why virtual images (CAD) that do not use DOF tend to look unreal, and is a main failure of real-time rendering of virtual reality. The simulation of optical DOF was pioneered by Potmesil and Chakravarty (cited in Hillaire et al., 2008); where a Circle of

Confusion (CoC) is defined, then using an algorithm appropriate levels of blur are applied to pixels based on their virtual depth within the image. Other realistic vision rendering processes similar to DOF have since been developed to match that of the human eye (Barsky, cited in Hillaire et al., 2008). In addition to DOF, pictures have also been made to mimic human peripheral blur; screening coarser acuity of the eye, from the fovea to visual margins (Anstis, cited in Hillaire et al., 2008), and motion blur used to express objects in motion (Max and Lerner, cited in Hillaire et al., 2008).

Hillaire et al. (2008, p.2) proposes that peripheral blur applied to pictures simulates the decreased sharpness of objects viewed towards the margins of human vision, and is supplemental and independent of DOF. This is emphasized with a statement relating to computer gaming, “the main objective of the peripheral blur effect is also to incite the user to look through the visor, i.e., inside the focus area”. Rokits (cited in Hillaire et al., 2008, p.2) put forward the use of visual blur effects in real-time virtual reality, through point of focus eye tracking systems; stating that blur effects were, “especially important in VR applications”. Kenny et al (cited in Hillaire et al., 2008) supports the importance of image blur by reporting that first person shooter (FPS) games, held participants’ attention in the centre of the screen, for 82% of the game play.

The application of real-time DOF in the experiments by Hillaire et al. (2008), were used to simulate the defocus of objects in front of, and behind the focus point within a 3D space. Participants viewed this, using a normal image format, which as discussed earlier, has a smaller field of view in comparison to normal vision. In addition to DOF, peripheral blur was also applied; simulating increased blurring levels on objects towards the extremities of the human visual field. The introduction of these combined blur effects within video games, provided nearly half of the participants with increased performance, and enjoyment of the gaming experience; without any negative effects found on performance. However the performance comparison of a normal field of view image against a compression image, both without blur effects, has not yet been compared alongside the introduction of DOF or peripheral blur on their own, within a Normal or a Compression image type. It is hoped that participants involved in the first two image comparison tasks, will show an intrinsic spatial differences between the Normal and Compression image types, in conjunction with the application of DOF and peripheral blur image effects.

In view of the fact that DOF is extensively used as a depth cue and gaze director, in both film and photography, it was decided important to apply this blur effect to a compression image type, in order to see if there was any influence caused by the differences in field of view. Both the Normal and Compression image types were given the same intensity of DOF, leaving only the sought object unaffected by zero blur (Figure 14).

Figure 14. Shows Normal image (Left) and Compression image (Right), with zero blur covering the sought object, and the same level of DOF (uniform equal blur) throughout the rest of the image.

The peripheral blur image effect was deliberately given a generously proportioned area of zero blur; this made the five attention objects on the table unambiguous, and equally visible for selection. The onset of peripheral blur has been accentuated in Figure 15, showing its starting point of detection, at an equal distance, encircling the sought object, positioned in the centre of the table surrounded by the attention objects. The strength of blur was increased towards the image border, where its peripheral intensity matched that seen throughout the DOF image effect. It is this gradual rise in peripheral blur which the Fovography theory suggests more closely mimics our visual attentiveness, with perceived objects increasing in distance from a fixation becoming progressively more blurred towards the edges of our visual field.

Figure 15. Shows circles with no infill to accentuate the large area of zero blur set for a Normal image (Left) and Compression Image (Right), with peripheral blur; making the five attention objects on the table clearly defined.

The performance comparison of a normal field of view picture against a compression picture, both without blur effects would be compared alongside the introduction of DOF and peripheral blur on their own within Normal and Compression pictures. In total, twenty four stimuli were made, from six conditions being repeated for each of the four sought focus objects, positioned in the centre of the table at different distances from the wall. Each focus object contained three Normal and three Compression image types. These produced six conditions comprising of, a Normal and Compression image with zero blur, a Normal and Compression image with equal blur, and a Normal and Compression image with peripheral blur (TABLE 2).

Conditions	Condition key
Normal (zero blur)	N
Normal with equal blur (DOF)	Neb
Normal with peripheral blur	Npb
Compression (zero blur)	C
Compression with equal blur (DOF)	Ceb
Compression with peripheral blur	Cpb

TABLE 2. The six conditions were duplicated for each of the four sought focus objects to produce 24 stimuli, each coded using the sought focus object distance and the condition key E.g. Stimuli 20_n.

It is hoped that participants involved in the first two image comparison tasks, will find differences between the Normal and Compression image types, in conjunction with the application of DOF and peripheral blur image effects.

Perception Studies Involving Real World Objects and 2D Imaged Objects

Ling and Hurlbert (2004) discuss how real world objects in previous visual investigations, have been shown to be characterised by a range of physical qualities, such as texture, and 3D shape. However, these studies rarely look into the relational effect caused by physical qualities, such as colour, and size; which experiments by Ling and Hurlbert (2004) managed to accomplish with real objects. Their experimental design, used projectors to control colour on a range of different sized objects, within an experimental box. This method was used instead of displaying 3D objects on 2D screens; because even with current radiosity programs (suggested to simulate more naturalistic luminosity outputs of 3D scenes), there are issue about pictorial cues differing from viewing geometry, which form conflicting binocular disparity cues (Hurlburt, cited in Ling and Hurlbert, 2004).

Real objects are unlike the 2D, homogeneously coloured, homogeneously bright surfaces that appear in “Mondrian” displays and other simulated images typically used for research into colour appearance.
(Ling and Hurlbert, 2004, p.721)

The results of colour difference on size perception showed a significant affect between colour saturation, and perceived size of objects; with the physical qualities of colour and size acting together in determining object similarity. However, this size effect caused by the physical qualities of objects, were discounted in the first two parts of the study. Even though the objects in the scene differ in colour, size and shape, the visual tasks being performed would involve comparing each condition as a whole, rather than the properties of one object against another.

Both perceptual, and stored colour studies, have shown that the physical contribution of colour, aids in object recognition; however, there is no definitive understanding to which physical properties are the most essential (Mapelli and Behrmann, 1997). On one side, edge-based theories suggest that shape is primarily responsible for object representation (Biederman and Ju, cited in Mapelli and Behrmann, 1997); with surface qualities used when objects are occluded, the same size, or detail is reduced (Witkin and Tenenbaum; Grossberg and Mingolla; Riddoch and Humphreys; Ullman, cited in Mapelli and Behrmann, 1997). Surface based theories on the other hand, suggest a preference for object recognition in early visual processing “establishing a primal and $2^{1/2}$D sketch of an image” (Marr, cited in Mapelli and Behrmann, 1997, p.237); along with the standpoint that mutual interaction of contour and surface cues bring about object recognition (Farah et al., cited in Mapelli and Behrmann, 1997).

Whichever theory we might favour to be the most fitting pathway for influencing object recognition, neither is expected to be a key distracter from the visual tasks set in either the first or second part of the Fovograph study. This is because the correct naming of a sought fixation object is not needed over a close description, and an assigned measurement of depth is required only for a suggested object. It is of interest to note that contrasting chromatic, and achromatic pictures of common objects, have been shown to be identified at the same time intervals (Biederman and Ju, cited in Mapelli and Behrmann, 1997). In addition, falsely coloured objects have been shown to be recognised with the same time intervals as when they are shown in their perceptual colour (Davidoff and Ostergaard, cited in Mapelli and Behrmann, 1997, p.238) “We think of no other visual characteristic of an object with so little effect on object recognition”.

In their efforts to uncover the perceptual and stored physical contributions of colour, in aiding object recognition, Mapelli and Behrmann (1997) based their study around a participant (JW) with normal colour processing, but impairment object recognition due to brain damage. It was found that the participant performed better at recognising displayed 3D colour objects in comparison to black and white objects; with the inclusion of a label similar to the object, improving the recognition of coloured objects further.

> The joint effects of perceptual and stored colour, however, only arose when JW had sufficient information about the object’s shape so that he was not totally debilitated.
> (Mapelli and Behrmann, 1997, p.9)

It was concluded that edge-based information over colour information, is the main factor in object recognition, even though in the presence of colour, the participant made use of this information to make colour-first object deductions.

...therefore, that surface colour on its own is not a particularly useful cue in object recognition and, as such, the data is more consistent with edge based theories of recognition where the primary information about the objects’s identity is conveyed through its boundary and configural information.
(Mapelli and Behrmann, 1997, p.9)

An important aspect of extending visual understanding and selection of important visual information, is largely linked to our pre-attentive processing of environmental information, which is filtered by its relevance to real time attention (Wolfe, 2000). Colour selection is often used as a method of choice in visual studies, because of its pre-attentive processing (Egeth et al.; Kaptein, Theeuwes and Van der Heijden; Poisson and Wilkinson; Wolfe et al; Hillman et al., cited in Wolfe, 2000), and because of its effectiveness in preference prediction (Backs and Van Orden, cited in Wolfe, 2000). However, it has been shown that combinations of object surface colour reduce visual guidance (Wolfe et al., cited in Wolfe, 2000), and it becomes much easier to discover an object that is made up of one colour surrounded by another (Bilsky and Wolfe; Friedman-Hill and Bilsky, cited in Wolfe, 2000). Even though the five attention objects positioned on the table, included objects which contained combinations of surface colour, and ones that only had a single colour, the white background by and large was contrasting with all of these objects; the exception being the white dome, positioned on top of the cardboard tube.

Top-down and Bottom-up attention was touched upon in the conclusion made by Ling and Hurlbert (2004). They proposed that because objects involved in the experiment were not familiar solid shapes, colour and form information processing was part of our Bottom-up (early stage) representation of objects. Top-down attention is seen as voluntary, and can either be spatial of feature specific (Beauchamp, Cox, and Deyoe; Bressler et al.; Giesbrecht et al., cited in Pinto et al., 2013); whereas Bottom-up attention is involuntary and uncontrolled (Schreij, Owens, & Theeuwes, cited in Pinto et al., 2013). Even though both Top-down and Bottom-up processing would be taking place for participants to identify with imaged objects, it was thought that the diversity of recognizable objects, along with their shape and colour, would continue to provide none bias results for the sought object selection task and the depth measurement task.

> Proponents of the contingent capture hypothesis argue that attentional capture is never truly bottom-up, since top-down settings always affect whether certain items capture attention.
> (Folk et al, cited in Pinto et al., 2013, p.9)

Through visual search and attention capture tasks, Pinto et al. (2013) found reasons to suggest that both of these types of attention are processed independently of each other, while being mutually involved in conscious perception.

> Perhaps bottom-up attention is very quickly deployed, in a knee-jerking fashion, during the feed forward sweep of incoming sensory information through the brain (so in the first 100–150 ms). Top-down attention may only be able to play a role at later stages of information processing, perhaps during the stage where neural feedback loops start to play an important role (after 100 ms).
> (Pinto et al., 2013, p.9)

Previous object detection studies (Biederman et al.; Boyce et al. cited in Davenport, 2007) have shown a likelihood of response bias from false answers (guesses), when either a yes or no answer is required to match an object to a scene. In addition, eye tracking studies (Friedman; d'Ydewalle et al., cited in Davenport, 2007) have shown that inconsistent objects are fixated on, longer than consistent objects. An object detection study (Biederman, Mezzanotte and Rabinowitz, cited in Davenport, 2007) showed that viewing objects placed in likely backgrounds, were more accurately viewed than objects out of context to the background. Using the premise that objects are rarely seen on their own, and without environmental context, Davenport (2007) performed a recognition study into the consistency effects between objects in scenes. This investigation explored the contextual influence between photographed scenes, with matching and dissimilar objects in related and unrelated backgrounds. The conclusion he drew from this experiment was that, "...backgrounds influence how objects are perceived and that objects influence the perception of other objects and their backgrounds" (Davenport, 2007, p.9).

With further reference to Davenport (2007, p.9) "...scenes are processed holistically, with mutually constraining object and background processing". It was determined that the previously mentioned response bias, of consistency effects between objects in scenes, would be removed from the first two tasks in the third study; because the stimulus included a variety of different objects, and a white washed background wall which created an out of character environment. In addition, because the scene objects and the background were unrelated throughout the stimuli, it is thought that viewing times would become more consistent between objects, without the application of a blur. Furthermore, the false answer bias of giving a yes or no answer to viewed stimulus would also be removed with a descriptive selection of an object or a depth measurement (cm).

It was also suggested by Wolfe (2000), that errors found in visual experiments are largely due to the eccentricity of stimuli, and low resolution quality, more than data analysis. "If the stimuli are of adequate size, then it should be possible to identify a single item as a target or distracter in a brief exposure (e.g. 200 msec) at any location in the display" (Wolfe, 2000, p13). It was therefore important for stimuli to be displayed at an appropriate viewing size, and high resolution, because participants would need to be attending to an image comfortably to make reasonable discriminations between a sought object (target), and distracter objects. Visual search has been shown to be modified by the hierarchy (scale) of objects, when a task involves selecting either small or large objects (Wolfe, Chun and Friedman-Hill, cited in Wolfe

2000). However, there has not been shown to be a predisposition to one object scale over another in visual search (Wolfe et al., cited in Wolfe, 2000).

> In search experiments, multiple items are presented one at a time. This raises the possibility of lateral interactions between items, notably mutual interference (Berger & McLeod, 1996; Cohen & Ivry, 1991). These effects of crowding are more marked in the periphery, than they are near the fovea.
> (He et al., cited in Wolfe, 2000, p.14).

Because the area of object search and decision making is within a small and centralised area (table objects) in the study stimuli, an increased effect of crowding on peripheral vision over the fovea area (He et al., cited in Wolfe, 2000) is not likely to develop into a study bias. Nor is participant's gaze, which is expected to be drawn towards the centre of a display, during visual search tasks (Findlay; Zelinsky et al., cited in Wolfe 2000). The effects of crowding are suggested to be reduced, when objects are widely spaced out (Wolfe, 2000). This happens to be the case for stimuli made for Study one and two, with the number and arrangement of background objects across the back wall being few and well-spaced.

As well as pre-attention effects on attention, Wolfe (2000) discusses post attention, and the lack of evidence that this visual phase affects attention that much, because perceptual interpretation has already taken place.

> The visual percept becomes attentive when attention is deployed to the object and post-attentive when attention departs that object for some other object. By definition, much of a percept of a scene must become post-attentive over time.
> (Wolfe, 2000, p.48)

In repeated search tasks, participants searching the same display for different targets, know more about the range of stimuli used, however results have shown that selection speeds (visual search) don't improve with the knowledge (memory search) of target locations (Wolfe, Klempen and Dahlen, cited in Wolfe 2000). Furthermore, the unobserved differences between two images, known as change blindness (Rensink, cited in Wolfe, 2000, p.50) is an example of our inability to save an image to memory, and the steep falloff rate of the retention of attention. "Changes are seen when the observer's attention remains with an object while it changes". Therefore, the repetition and reorganisation of attention table objects in the stimuli, is not expected to benefit or hinder participants in their time taken to perform visual tasks.

In summary, Wolfe (2000, p.56) highlights that what we know about vision is largely due to attention based experimentation. "...most if not all of the visual control of behaviour requires attention", yet visual stimulus has been revealed to be perceived either pre attentively or post attentively.

> …evidence suggests that focal attention can be directed to one, or perhaps a few objects at any one time. The number of possible targets for attention in a visual scene is usually many times that number.
> (Wolfe, 2000, p.56)

To summarize, the five attention table objects are kept constant across the stimuli, with image effects taking place to form altered 2D images, for attention driven tasks which require concentration. These visual tasks are neither based on object recognition through visual search using varying colour and familiarity, nor are size comparisons of dissimilar objects expected to present a bias in participant answers. "Attention is in the business of "exporting vision to the mind" (Cavanagh, cited in Wolfe, 2000, p56).

Fovography Experiment 1

The visual task attached to Part one, asked participants to choose the foremost attended to object, within each displayed stimulus.

Design and Summary of Visual Task

A repeated-measures design was used, with participants making up four groups, and each group using exclusive screening combinations of the same stimuli (Appendices 11.2). Participants would be asked to verbally select their foremost attended to object within each stimulus (Appendices 11.3). This task was used to compile a count, to direct participant's fixations to the sought attention object in each condition.

Stimuli

The six Conditions were duplicated for the cm distances (20cm, 30cm, 40cm, and 50cm) that each of the focus objects were positioned from the wall. This gave participants four attempts to select the sought object for each of the six Conditions; viewing 24 stimuli in the task.

Procedure

The study session was started once a successful visual calibration was made, and the participant was asked to read the opening instructions. This described choosing an object of prominence that their focus was directed towards for each stimulus. These instructions were also verbally explained, along with the reassurance that they were to progress in their own time, whilst repeating the task for the remaining 23 stimuli.

Findings

The Normal equal blur (NEB) condition achieved a 99% success rate, for participants selecting the sought object of attention. This was nearly the same for the Compression equal blur (CEB) condition, which also achieved a high selection rate (95%) for the sought object of attention (Table 3).

Condition	c	ceb	cpb	n	neb	npb
Object success rate - \128	51	122	38	41	127	45
Object success rate - %	40	95	30	32	99	35

Table 3. The task of choosing a focus object was repeated over four distances for each of the six conditions. Participants therefore had the opportunity to achieve a maximum of six correct focus object selections at each distance. With their being 32 participants, this gave a total score of 128 possible selections for each Condition.

The results were used to generate a mean bar chart showing an overview of participant's ability to choose the sought object of attention; across the four distances within each condition (Figure 16).

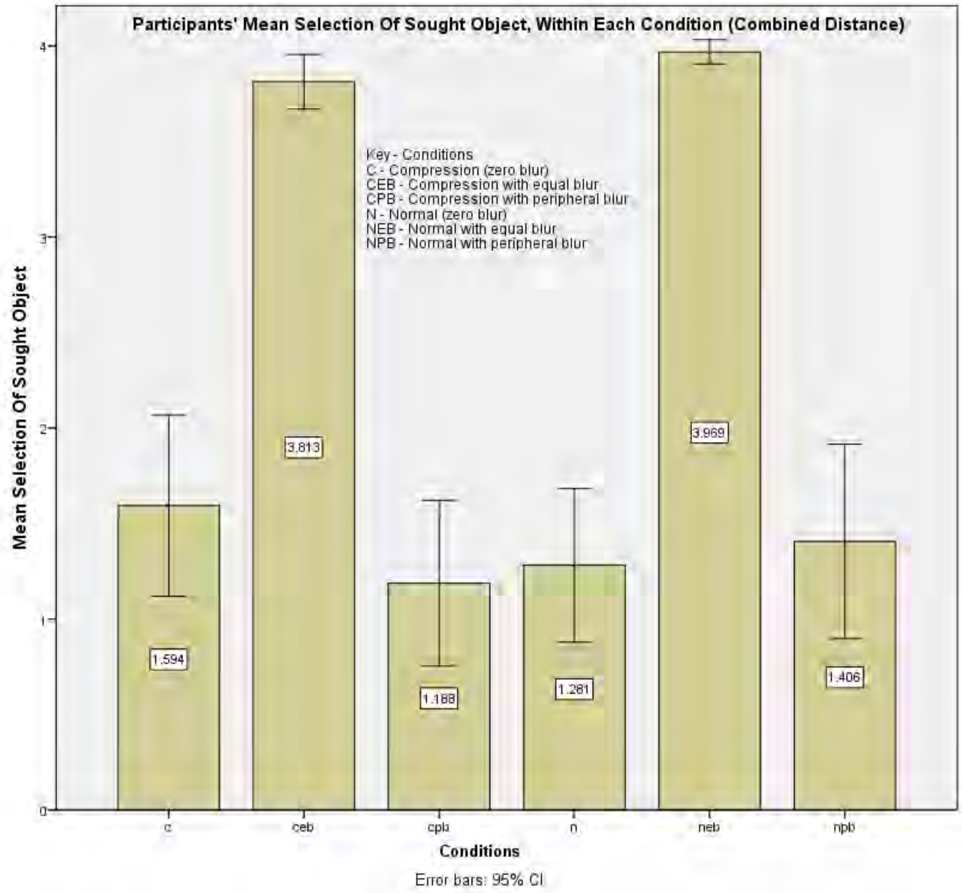


Figure 16. A Bar chart showing participants' Mean success at selecting the sought object, across four distances for each Condition.

Because the results gave a non-normal distribution for the Conditions, a 4x6 Repeated Measures ANOVA was carried out. This showed that the main effect (Huynh-Feldt correction) within-subjects was highly significant for the factor Condition: F (4.241, 131.486) = 69.59, p= .001 (Appendices 11.4).

To follow up this finding, Bonferroni Post-hoc tests were carried out to identify the within-subject relationships for the factor Condition. This showed a significant interaction (p<.05) between Compression (Condition 1, Mean=.391), and Compression equal blur (Condition 2, Mean=.968). The same result was also found between Compression and Normal equal blur (Condition 5, Mean=.992). It was the case that only Compression equal blur and Normal equal blur showed a significant interaction towards Conditions (Compression peripheral blur (Condition 3, Mean=.297), Normal (Condition 4, Mean=.320), and Normal peripheral blur (Condition 6, Mean=.352), but the pair-wise comparison between themselves did not show significance (p>.05) (Appendices 11.5).

These initial Condition results, suggest that equal blur is the main contributing image effect, directing participants' attention to a sought object; irrespective of it being applied to a Normal or a Compression image.

The main effect (Huynh-Feldt correction) within-subjects was also highly significant for the factor Distance: F (2.880, 89.269) = 6.389, p= .001 (Appendices 11.4). Bonferroni Post-hoc tests were again carried out to identify the within-subjects relationships for the factor Distance. This showed a significant interaction (p<.05) between 20cm (Distance 1 Mean=.458), and 30cm (Distance 2 Mean=.625); also an interaction between 20cm and 50cm (Distance 4 Mean=.589). None of the other pair-wise comparisons showed significance (all p>.05) (Appendices 11.6).

The preliminary Distance results, suggest that participants had greatest difficulty in selecting the sought attention object at 20cm, which was the Oriental teapot.

The Huynh-Feldt correction also showed that the two-way interaction between the factors Condition and Distance, produced a significant effect: F (11.290, 350.004) = 2.471, p= .005 (Appendices 11.4). The profile plot (Figure 17) shows the Mean selection of the sought attention object, for each condition across the four distances.

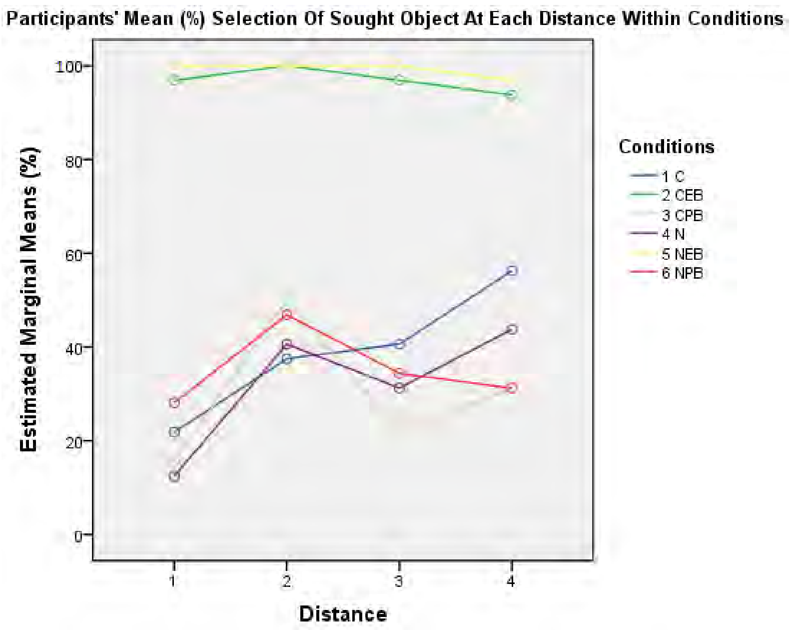


Figure 17. A Profile plot showing participants' Mean selection of the sought object of attention, across the four distances for each Condition.

To interpret the interaction, a survey of simple main effects, and (where appropriate) simple pair-wise comparison analysis was conducted. The simple effects analysis of Distance within each level combination of Condition, showed a significant effect taking place for Compression: F (3, 29) = 3.445, p=.029, Compression peripheral blur: F (3, 29) = 4.229, p=.013, and Normal: F (3, 29) = 4.352, p=.012 (Appendices 11.7).

Simple pair-wise comparison analysis was then carried out using Distance interactions, to see which pairs significantly differed for each Condition. Compression, showed a significant result (p=.003) between 20cm and 50cm; Compression peripheral blur gave a significant interaction (p=.001) between the distances 20cm and 30cm, and between the distances 30cm and 40cm (p=.010). The Normal condition, also produced significant results between the distances 20cm and 30cm (p=.005), as well as 20cm and 50cm (Appendices 11.8).

A simple effects analysis of Condition within each level combination of Distance, showed a highly significant effect taking place at each Distance, with 20cm: F (5, 27) = 67.669, p=.001, 30cm: F (4, 28) = 21.200, p=.001, 40cm: F (5, 27) = 31.411, p=.001 and 50cm: F (5, 27) = 17.718, p=.001 (Appendices 11.9).

Simple pair-wise comparison analysis was carried out using the interactions between Conditions, to see which pairs significantly differed for each Distance. For the Distances:- 20cm, 30cm, and 40cm, Compression equal blur and Normal equal blur produced a significant interaction (p=.001) when compared against each Condition. There was no significant interaction found between Compression equal blur and Normal equal blur, and none of the other Condition comparisons showed significant interactions (all p>.05). The fourth distance, 50cm, provided additional interactions, which were between Compression and Compression peripheral blur (p=.009), and Compression and Normal peripheral blur (p=.009) (Appendices 11.10).

The interactions between Conditions:- Compression, Compression equal blur, Compression peripheral blur, Normal, Normal equal blur, and Normal peripheral blur; in part suggest that an object positioned 20cm from the back wall (further back in the scene), is more difficult to select as a sought object of attention, in comparison to a larger distance (Further forwards in the scene) in the same Condition. Even though no significant Distance interaction was produced for Normal peripheral blur, its Mean sought object success rate also had the lowest count at 20cm.

Furthermore, it is important to highlight the variation between Distance interactions for participants' ability to select the sought attention object across all the previously mentioned Conditions, except Compression equal blur and Normal equal blur. This is because the Normal and Compression Conditions received the highest selection for the sought object of attention at 50cm, with this Mean being significantly greater than for 20cm. The results for the Peripheral blur image effect, when viewed either as a Normal or Compression image, were significantly less proficient in directing attention to a sought object at a distance furthest forwards, in comparison with a Compression Condition. Additionally, Compression is the only Condition that shows a linear trend; with an increased selection of the sought object, as it is positioned further towards the forefront of a scene.

For Compression peripheral blur and Normal peripheral blur, the highest selection of the sought object of attention was at 30cm. However, this count proved only to be significant for the Compression peripheral blur Condition, and it involved the object measurements either side (20cm and 40cm). There are a various other differences that could be highlighted, but ultimately, and of upmost importance, is that the equal blur image effect proved to be exceptional in directing participants' attention towards a sought object; irrespective of its foreground or background location, and whether it was viewed as a Normal or Compression image.

Summary

The analysis of participant data for Part one, has shown that neither a Normal nor a Compression image type (with a full experiential field of view) conveys visual information to improve attention towards a sought object. Furthermore, it would seem that when the same image effect is applied to both image types (and lack of image effect) the selection of sought object is generally similar.

It was anticipated that the Normal and Compression image types would gain higher object success rates with the influence of peripheral blur, but this was not the case.

However, peripheral blurred stimuli were intentionally designed to offer only minor enquiry into its attention directing ability, with emphasis being on the importance of the spatial qualities of Compression. It is therefore proposed that if a less generously proportioned area of zero blur had been used in Normal peripheral blur and Compression peripheral blur images, an improved sought object success rate, similar to equal blur, would have been achieved.

Fovography Experiment 2

The visual task attached to Part two would ask participants to give a measurement (cm), which they believed best represents the distance between an attended to object, and the back of the scene.

Design and Summary of Visual Task

Participants would be asked to take an educated guess of the distance (cm) from the front of a sought object (shown with a green dot) to the back wall, using the same 24 stimuli viewed in Part one (Figure 18 shows two of these Conditions, a Normal image and a compressed image). For repeated-measures purposes, a second exclusive stimuli screening combination for each participant group would be used (Appendices 11.11), and once again each judgment would be given verbally, making participant interaction straightforward.

This second task would generate a record of participants’ guessed measurements (cm), for each of the four sought object distances used across each Condition. The collected measurements would ultimately allow performance comparisons to be made between all six Conditions with regard to their ability to produce a closer experiential depth within an image (real environment distance).

Figure 18. A Normal and Compressed image with a green dot placed on the sought object from Part one. These two images are from the set that has the Oriental teapot focus object, which is positioned 20cm away from the wall.

Stimuli

With the exception of a green dot being used to elect a focus object, the stimuli being viewed in Part two were the same as in Part one. This meant that participants had four attempts to estimate the distance from the object to the wall, for each of the six conditions (Table 4).

Focus object (Green dot)	Distance from the wall (cm) - Stimulus code					
Oriental teapot	20N	20Neb	20Npb	20C	20Ceb	20Cpb
Black teapot	30N	30Neb	30Npb	30C	30Ceb	30Cpb
Plastic brain	40N	40Neb	40Npb	40C	40Ceb	40Cpb
Cardboard tube & dome	50N	50Neb	50Npb	50C	50Ceb	50Cpb

Table 4. The six Conditions remain duplicated for each of the cm distances (20cm, 30cm, 40cm, and 50cm), each of which having a different focus object – This gave each participant 24 stimuli to view throughout the task.

Procedure

Before each participant continued with Part two of the study, they viewed a cm measurement reference; which used an already familiar table object (Oriental teapot) from the first task (Figure 119). This object was positioned on a piece of paper, at various marked (calibrated) distances from a second monitor, which represented the back of the scene. In each new location, the correct measurement (cm) from the front of the object to the monitor was made clear. This learning activity was carried out to reinforce a reliable measurement scale (cm). Once the participant was satisfied with their ability to give an accurate distance, the object was moved out of sight and the calibrated paper was covered over.

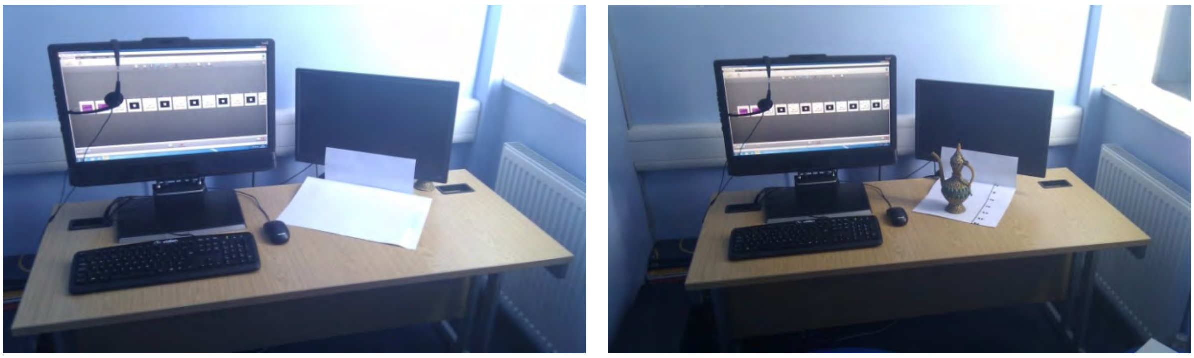


Figure 19. Once participants had finished Part one of the study, a piece of paper with incremental measurements drawn on it was uncovered, and a reference object was placed alongside.

The participants then began Part two of the study session and the instructions for the second task were displayed on the eye tracker monitor. The instructions asked for a verbal cm measurement to be given, that best matched the distance from the front of the object marked with a green dot, to the back wall. The task was also verbally explained, and it was emphasized that they were to progress in their own time for the following 24 stimuli.

Findings

Descriptive statistics were produced, using the measurements that participants assigned across the four object distances for each Condition (Appendices 11.12). This data showed that as the focused on object (identified with the green dot) increased in distance (cm) from the wall, so did the participants' Mean measurement. In addition, as the object focused on, in each Condition, increased in distance from the wall, the standard deviation showed a variation from the Mean chosen measurement being spread over a larger range of values (Figure 20). This established that as the distance increased between the object and the back wall, participants became more uncertain (less grouped) in assigning a distance to this space; supported by a wider spread of chosen measurements. However, participants' Mean closeness in estimating the real environment measurement (cm), between the object of attention and the back wall, shows signs of improvement as the distance gap widens.

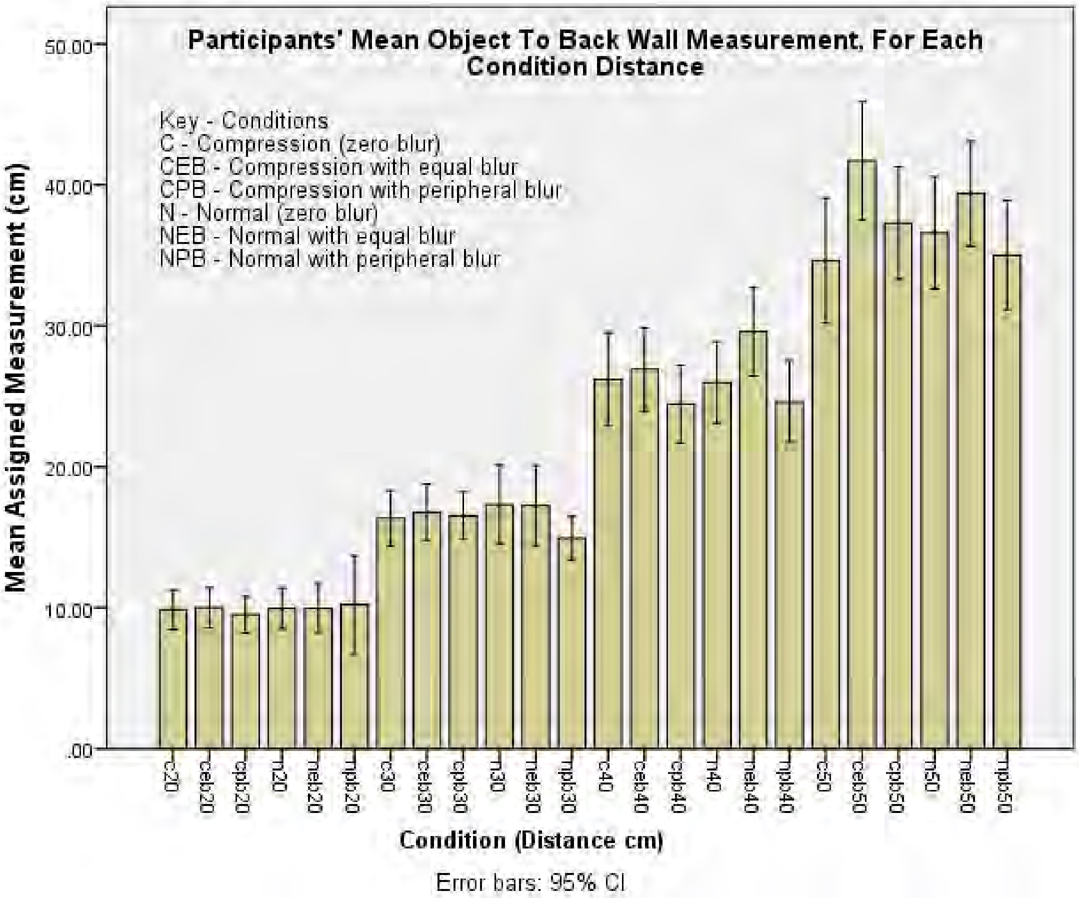


Figure 20. A Bar graph showing participants' Mean measurements (cm), they thought best represented the distance from the front of a nominated object at four different distances from the back of a scene; with each distance being viewed using six different image Conditions.

A 4x6 Repeated Measures ANOVA was performed on the object distance data, as a percentage inaccuracy (%cm) from the real environment measurement. This showed that the main effect (Huynh-Feldt correction) within-subjects was significant for the factor Condition: F (3.45, 106.94) = 4.54, p = 0.03 (Appendices 11.13).

A Bonferonni Post-hoc test showed that within-subjects for the factor Condition, there were significant ($p<0.05$) interactions between Compression equal blur (Condition 2, Mean = 37.79) and Compression peripheral blur (Condition 3, Mean = 41.71), and Compression equal blur and Normal peripheral blur (Condition 6 Mean = 46.03). However, none of the other pair-wise comparisons showed significance (all $p>.05$) (Appendices 11.14).

The Mean results for each Condition, demonstrate that the equal blur image effect assists participants in obtaining a closer factual in-between measurement (cm).

However, Normal equal blur (Condition 2, Mean = 37.793) did not produce any significant interactions, whereas Compression equal blur was significantly better than the Normal and Compression image types with peripheral blurring. Additionally, it was surprising to find that both image types, with equal or peripheral blur, did not produce a significant interaction in comparison to the zero blur image effect of Compression (Condition 1, Mean = 41.919) and Normal (Condition 4, Mean = 40.876).

The main effect (Huynh-Feldt correction) within-subjects was also highly significant for the factor Distance: $F (1.958, 60.706) = 53.031$, $p = 0.01$ (Appendices 11.13).

A Bonferonni Post-hoc test showed that within-subjects for the factor Distance, produced a significant interaction ($p<.05$) between all pair-wise comparisons: 20cm (Distance 1, Mean = 52.995), 30cm (Distance 2, Mean = 46.476), 40cm (Distance 3 Mean = 36.771), and 50cm (Distance 4 Mean = 28.469) (Appendices 11.15).

The Mean results for Distance show a greater inaccuracy for in-between measurements (%cm), as the sought object of attention, is positioned closer to the back wall. Moreover, significant interactions between each adjacent Distance (E.g. 20cm and 30cm) irrespective of its Condition, suggests that the factor Distance influences the recount accuracy of the factual in-between measurement (cm).

However, the Huynh-Feldt correction showed that the two-way interaction between the factors Condition and Distance, did not produce a significant effect: $F (5.343, 165.631) = 1.456$, $p= .203$ (Appendices 11.13). The profile plot (Figure 21) shows the participants' Mean object distance data, as a percentage inaccuracy (%cm), for each Distance, across the six Conditions.

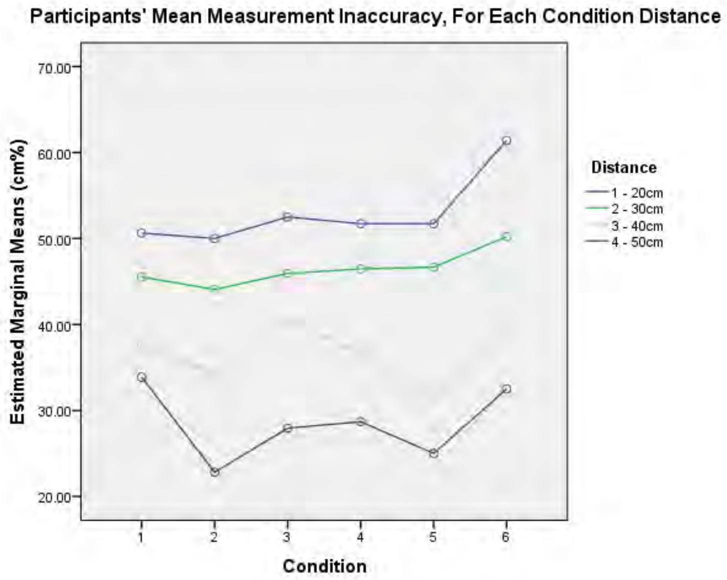


Figure 21. A Profile plot showing participants' Mean distance inaccuracy as a percentage (%cm) from the factual in-between measurement (cm), when viewing each Distance, across the six Conditions.

In order to interpret this interaction, a survey of simple main effects and pair-wise comparison analysis, were conducted. The Simple effects analysis of Distance within each level combination of Condition, showed a highly significant effect taking place across all Conditions: Compression: F (3, 29) = 6.70, p = .001, Compression equal blur F (3, 29) = 18.26, p = .001, Compression peripheral blur F (3, 29) = 14.23, p = .001, Normal F (3, 29) = 12.74, p = .001, Normal equal blur F (3, 29) = 15.56, p = .001, and Normal peripheral blur F (3, 29) = 15.38, p = .001 (Appendices 11.16).

Simple pair-wise comparison analysis was then carried out using Distance interactions, to find out which pairs significantly differed for each Condition. This showed the Compression Condition having a significant interaction (p<.05) between all Distance combinations, except for the 40cm and 50cm pairing. This was similar for Compression peripheral blur, which produced significant interactions (p<.05) for all Distance combinations apart from the 30cm and 40cm pairing. The Conditions: Compression equal blur, Normal, Normal equal blur, and Normal peripheral blur, however, showed significant interactions (p<.05) between all the distance combinations (Appendices 11.17).

For each Condition, the mean difference (I-J) in interactions between Distance: 20cm, 30cm, 40cm, and 50cm; showed that with an object positioned closer to the back wall (further back in the scene) it is more difficult to judge the factual in-between measurement (cm), in comparison to a larger distance (Further forwards in the scene). Even though Distance interactions were non-significant on two occasions, a lower percentage inaccuracy was still evident from the Mean difference (I-J) for the larger distance.

Following these results, simple effects analysis of Conditions, within each level combination of Distance was carried out; these results showed a significant effect taking place at 40cm $F(5, 27) = 5.36$, $p = 0.02$, and 50cm $F(5, 27) = 4.43$, $p = 0.04$ (Appendices 11.18).

Further simple pair-wise comparison analysis was carried out using the interactions between Conditions, to see which pairs significantly differed for each Distance. This showed no significant interaction between Conditions at 20cm, and one significant interaction ($p=.045$) at 30cm, between Compression equal blur and Normal peripheral blur. However, at 40cm, significant interactions ($p<.05$) were found between Compression equal blur and Compression peripheral blur, and Normal equal blur and all other Conditions, except for Compression equal blur ($p>.05$). Finally at 50cm, significant interactions ($p<.05$) were seen between the Conditions: Compression and Compression equal blur, Normal and Normal equal blur. There were also significant interactions ($p<.05$) between Compression equal blur and Compression peripheral blur, Normal and Normal peripheral blur. In addition, there was also a significant difference between Normal equal blur and Normal peripheral blur Condition (Appendices 11.19).

The Mean difference (I-J) for interactions between Conditions, predominantly showed that Compression equal blur produced the best factual in-between measurement (cm) at 20cm. This was also the case at 30cm, with the interaction between Compression equal blur and Normal peripheral blur showing a significant interaction. Whilst Normal equal blur showed increased accuracy over Normal peripheral blur at 20cm and 30cm, this was not the case over the Compression or Normal Condition at 30cm. The Compression peripheral blur was shown to perform better than Normal peripheral blur, which consistently produced the worst factual in-between measurement (cm) at 20cm and 30cm. Additionally, Compression peripheral blur was also shown to perform better than the Normal and Normal equal blur Condition at 30cm. These interactions changed at 40cm and 50cm, with the Mean difference (I-J) for interactions between Conditions, showing Normal equal blur to be producing a closer factual in-between measurement (cm). Compression equal blur achieved this at 20cm and 30cm. Furthermore, the Normal and Compression image types with equal blur, both showed significant improvements towards the factual in-between measurement (cm), in comparison to the peripheral blur image effect. The Compression and Normal Conditions were also out-performed by the equal blur image effect.

Possible Implications - Summary

The analysis of participant data for Part two showed a high predilection towards Compression equal blur, over Normal equal blur at 20cm and 30cm, whilst Compression equal blur superseded Compression peripheral blur. Normal equal blur was out performed by all Compression and Normal image types. The interactions between Conditions at 20cm and 30cm, were unable to identify a Condition which was reliably improving the participants' chosen distance, closer to the factual in-between measurement (cm). However, when the attention object was moved forwards, increasing the distance to 40cm and 50cm, the Condition preference, one over another, altered, and the number of significant interactions also increased. The performance of Normal equal blur was shown to exceed that of Compression equal blur at 40cm, and vice versa at 50cm, nevertheless neither interaction was significant. A main difference found at 40cm and 50cm, was that equal blur in both image types, provided significant interactions in comparison to the peripheral blur image effect. Additionally, but without significant interaction, the Compression Conditions outperformed the peripheral blur image effect at 40cm and 50cm, and the Normal Condition outperformed the peripheral blur image effect at 40cm, but only outperformed Normal peripheral blur at 50cm.

If we check back at the unforeseen significant interactions between each adjacent Distance (E.g. 20cm and 30cm), these showed, that irrespective of the Condition, there was an improved factual in-between measurement (cm) as the attention object moved further forwards in the scene. It would seem that in addition to this interaction at 40cm and 50cm, the equal blur image effect becomes more optimised, which further assists participants' ability to choose a more accurate distance, to the factual in-between measurement (cm). However, this task showed no preference towards either a Normal or a Compression image type. In addition, neither image type with zero blur or the peripheral blur image effect, led to a greater performance of factual measurement. It is again suggested, that if a less generously proportioned area of zero blur, had been used in the Normal peripheral blur and the Compression peripheral blur Conditions, their measurement performance might have shown similarities to the equal blur image effect; and in doing so, their significant differences would be removed.

Conclusion - Fovography Experiment 1

The first experiment compared the ability of six different Conditions (Compression, Compression DOF, Compression Peripheral blur, Normal, Normal DOF, and Normal Peripheral blur), to draw attention to a sought focus object; which was positioned at four different distances (20cm, 30cm, 40cm and 50cm) from the back of the scene in each Condition.

The study was based on the comparison of the familiar Normal optical image, and pictorial depth cue DOF; together with the spatial awareness pictorial cues, Compression and Peripheral blur, that were seen as being core to a Fovograph image. Analysis of the results showed that introduction of DOF, significantly improved the selection of the sought object over the Compression image effect, and the Normal image on their own. Furthermore DOF had a significantly higher task performance than Peripheral blur, and the task performance of the Compression image effect fell, when Peripheral blur was introduced.

It was anticipated that the Normal and Compression Conditions, would gain higher object success rates with the introduction of peripheral blur; this was only true for the Normal Condition. However, the value of peripheral blur was intentionally designed to offer only minimal enquiry into its attention directing ability, with importance put on the spatial qualities of Compression. It is therefore proposed that if a less generously proportioned area of zero blur had been used, an improved sought object success rate similar to DOF, would have been achieved by the Normal Peripheral blur and Compression Peripheral blur Conditions.

The Mean Task performance also indicates that a sought object positioned at 20cm from the back wall (further back in the scene), is more difficult to direct attention towards, in comparison to a larger distance (further forwards in the scene) in the same condition; however there was no significant indication of this.

Ultimately, and of most importance, is that DOF proved to be exceptional in directing attention towards a sought object; irrespective of its foreground or background location, and whether it was viewed as a Normal or Compression image.

Conclusion - Fovography Experiment 2

The second experiment involved participants suggesting a measurement (cm), that best represented the distance from a sought object (marked with a green dot), to the back of the scene. The collected measurements ultimately allowed performance comparisons to be made between the previously used Conditions; concerning their ability to provide a real environment distance, and a closer experiential depth within an image.

The main significant interactions established, were between each adjacent Distance (E.g. 20cm and 30cm), with an improved factual in-between measurement (cm) being achieved as the attention object moved further forwards in the scene, irrespective of the Condition. However, at 40cm and 50cm the performance of DOF became greater which further assisted participant's ability to choose a closer distance to the factual in-between measurement (cm). Furthermore, neither the Compression Condition nor the Normal Condition on their own, or with the Peripheral blur added led to a greater performance of factual measurement.

This second task continued to show an improvement in performance by adding DOF, and additionally because the attention object was further forward in the scene.

11.2 Repeated measures screening combinations of stimuli

Group 1					
20c 1st	20ceb	20cpb	20n	20neb	20npb
30c	30ceb	30cpb	30n	30neb	30npb
40c	40ceb	40cpb	40n	40neb	40npb
50c	50ceb	50cpb	50n	50neb	50npb
Group 4					
20c	20ceb	20cpb	20n	20neb	20npb
30c	30ceb	30cpb	30n	30neb	30npb
40c	40ceb	40cpb	40n	40neb	40npb
50c	50ceb	50cpb	50n	50neb	50npb 1st
Group 5					
20c 1st	20ceb	20cpb	20n	20neb	20npb
30c	30ceb	30cpb	30n	30neb	30npb
40c	40ceb	40cpb	40n	40neb	40npb
50c	50ceb	50cpb	50n	50neb	50npb
Group 6					
20c	20ceb	20cpb	20n	20neb	20npb
30c	30ceb	30cpb	30n	30neb	30npb
40c	40ceb	40cpb	40n	40neb	40npb
50c	50ceb	50cpb	50n	50neb	50npb 1st

11.3 Experiment stimuli


set20_n crop


set20_neb crop


set20_npb crop


set30_n crop


set30_neb crop


set30_npb crop


set40_n crop

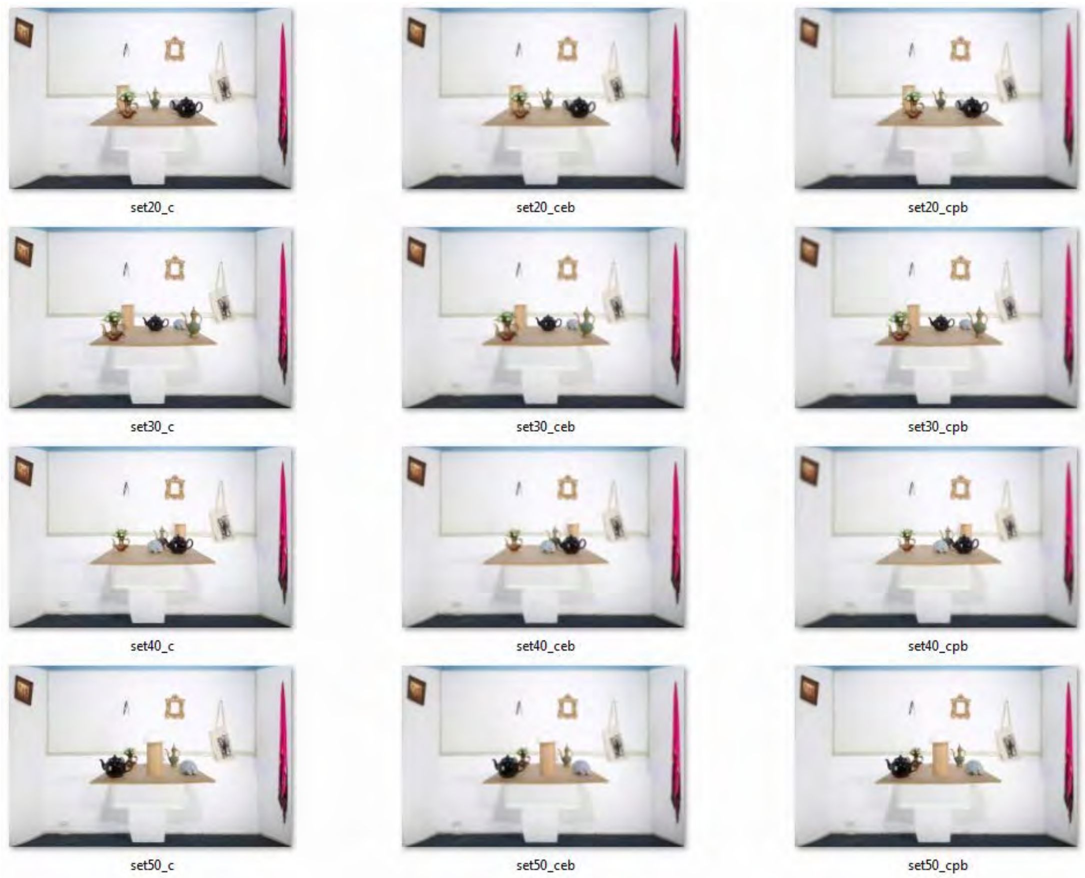

set40_neb crop


set40_npb crop


set50_n crop


set50_neb crop


set50_npb crop



11.4 4x6 Repeated Measures ANOVA (Huynh-Feldt correction)

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

condition	distance	Dependent Variable
1	1	c20
	2	c30
	3	c40
	4	c50
2	1	ceb20
	2	ceb30
	3	ceb40
	4	ceb50
3	1	cpb20
	2	cpb30
	3	cpb40
	4	cpb50
4	1	n20

	2	n30
	3	n40
	4	n50
5	1	neb20
	2	neb30
	3	neb40
	4	neb50
6	1	npb20
	2	npb30
	3	npb40
	4	npb50

Descriptive Statistics

	Mean	Std. Deviation	N
c20	.2187	.42001	32
c30	.3750	.49187	32
c40	.4062	.49899	32
c50	.5625	.50402	32
ceb20	.9687	.17678	32
ceb30	1.0000	.00000	32
ceb40	.9687	.17678	32
ceb50	.9375	.24593	32
cpb20	.1563	.36890	32
cpb30	.5000	.50800	32
cpb40	.2188	.42001	32
cpb50	.3125	.47093	32
n20	.1250	.33601	32
n30	.4062	.49899	32
n40	.3125	.47093	32
n50	.4375	.50402	32
neb20	1.0000	.00000	32
neb30	1.0000	.00000	32
neb40	1.0000	.00000	32
neb50	.9687	.17678	32
npb20	.2812	.45680	32
npb30	.4688	.50701	32
npb40	.3437	.48256	32
npb50	.3125	.47093	32

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
condition	Pillai's Trace	.885	41.696[b]	5.000	27.000	.000	.885
	Wilks' Lambda	.115	41.696[b]	5.000	27.000	.000	.885

	Hotelling's Trace	7.722	41.696[b]	5.000	27.000	.000	.885
	Roy's Largest Root	7.722	41.696[b]	5.000	27.000	.000	.885
distance	Pillai's Trace	.546	11.621[b]	3.000	29.000	.000	.546
	Wilks' Lambda	.454	11.621[b]	3.000	29.000	.000	.546
	Hotelling's Trace	1.202	11.621[b]	3.000	29.000	.000	.546
	Roy's Largest Root	1.202	11.621[b]	3.000	29.000	.000	.546
condition * distance	Pillai's Trace	.804	4.660[b]	15.000	17.000	.002	.804
	Wilks' Lambda	.196	4.660[b]	15.000	17.000	.002	.804
	Hotelling's Trace	4.112	4.660[b]	15.000	17.000	.002	.804
	Roy's Largest Root	4.112	4.660[b]	15.000	17.000	.002	.804

a. Design: Intercept
Within Subjects Design: condition + distance + condition * distance

b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
condition	.154	54.416	14	.000	.737	.848	.200
distance	.747	8.668	5	.123	.872	.960	.333
condition * distance	.000	253.047	119	.000	.542	.753	.067

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: condition + distance + condition * distance

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
condition	Sphericity Assumed	70.710	5	14.142	69.590	.000	.692
	Greenhouse-Geisser	70.710	3.683	19.198	69.590	.000	.692

	Huynh-Feldt	70.710	4.241	16.671	69.590	.000	.692
	Lower-bound	70.710	1.000	70.710	69.590	.000	.692
Error(condition)	Sphericity Assumed	31.499	155	.203			
	Greenhouse-Geisser	31.499	114.180	.276			
	Huynh-Feldt	31.499	131.486	.240			
	Lower-bound	31.499	31.000	1.016			
distance	Sphericity Assumed	2.983	3	.994	6.389	.001	.171
	Greenhouse-Geisser	2.983	2.617	1.140	6.389	.001	.171
	Huynh-Feldt	2.983	2.880	1.036	6.389	.001	.171
	Lower-bound	2.983	1.000	2.983	6.389	.017	.171
Error(distance)	Sphericity Assumed	14.475	93	.156			
	Greenhouse-Geisser	14.475	81.117	.178			
	Huynh-Feldt	14.475	89.269	.162			
	Lower-bound	14.475	31.000	.467			
condition * distance	Sphericity Assumed	3.712	15	.247	2.471	.002	.074
	Greenhouse-Geisser	3.712	8.131	.457	2.471	.013	.074
	Huynh-Feldt	3.712	11.290	.329	2.471	.005	.074
	Lower-bound	3.712	1.000	3.712	2.471	.126	.074
Error(condition*distance)	Sphericity Assumed	46.579	465	.100			
	Greenhouse-Geisser	46.579	252.068	.185			
	Huynh-Feldt	46.579	350.004	.133			
	Lower-bound	46.579	31.000	1.503			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	condition	distance	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
condition	Linear		.019	1	.019	.088	.768	.003
	Quadratic		.787	1	.787	3.954	.056	.113
	Cubic		.146	1	.146	1.066	.310	.033
	Order 4		69.754	1	69.754	224.768	.000	.879

	Order 5		.003	1	.003	.020	.889	.001
	Linear		6.613	31	.213			
	Quadratic		6.171	31	.199			
Error(condition)	Cubic		4.246	31	.137			
	Order 4		9.621	31	.310			
	Order 5		4.848	31	.156			
		Linear	.907	1	.907	5.733	.023	.156
distance		Quadratic	.689	1	.689	4.905	.034	.137
		Cubic	1.388	1	1.388	8.241	.007	.210
		Linear	4.902	31	.158			
Error(distance)		Quadratic	4.353	31	.140			
		Cubic	5.221	31	.168			
		Linear	.509	1	.509	6.002	.020	.162
	Linear	Quadratic	.094	1	.094	.962	.334	.030
		Cubic	.000	1	.000	.001	.972	.000
		Linear	.030	1	.030	.191	.665	.006
	Quadratic	Quadratic	.037	1	.037	.305	.585	.010
		Cubic	.186	1	.186	1.250	.272	.039
		Linear	.614	1	.614	10.100	.003	.246
condition * distance	Cubic	Quadratic	.127	1	.127	2.341	.136	.070
		Cubic	.083	1	.083	1.637	.210	.050
		Linear	.804	1	.804	10.349	.003	.250
	Order 4	Quadratic	.161	1	.161	3.671	.065	.106
		Cubic	.804	1	.804	6.798	.014	.180
		Linear	.179	1	.179	1.336	.257	.041
	Order 5	Quadratic	.010	1	.010	.079	.781	.003
		Cubic	.075	1	.075	1.045	.315	.033
		Linear	2.629	31	.085			
	Linear	Quadratic	3.024	31	.098			
		Cubic	4.812	31	.155			
		Linear	4.826	31	.156			
	Quadratic	Quadratic	3.778	31	.122			
		Cubic	4.613	31	.149			
Error(condition*distance)		Linear	1.885	31	.061			
	Cubic	Quadratic	1.676	31	.054			
		Cubic	1.578	31	.051			
		Linear	2.407	31	.078			
	Order 4	Quadratic	1.357	31	.044			
		Cubic	3.664	31	.118			
	Order 5	Linear	4.159	31	.134			
		Quadratic	3.944	31	.127			

	Cubic	2.226	31	.072			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	235.189	1	235.189	367.244	.000	.922
Error	19.853	31	.640			

11.5 Bonferonni Post-hoc tests within-subjects for the factor condition

Estimated Marginal Means

1. Condition

Estimates

Measure: MEASURE_1

condition	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	.391	.059	.270	.512
2	.969	.015	.938	.999
3	.297	.053	.188	.405
4	.320	.049	.220	.421
5	.992	.008	.976	1.008
6	.352	.062	.224	.479

Pairwise Comparisons

Measure: MEASURE_1

(I) condition	(J) condition	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.578*	.063	.000	-.778	-.378
	3	.094	.057	1.000	-.087	.275
	4	.070	.049	1.000	-.086	.227
	5	-.602*	.061	.000	-.797	-.407
	6	.039	.068	1.000	-.178	.257
2	1	.578*	.063	.000	.378	.778
	3	.672*	.053	.000	.503	.841
	4	.648*	.051	.000	.485	.811
	5	-.023	.017	1.000	-.078	.031
	6	.617*	.062	.000	.418	.816
3	1	-.094	.057	1.000	-.275	.087
	2	-.672*	.053	.000	-.841	-.503

	4	-.023	.054	1.000	-.196	.149
	5	-.695*	.054	.000	-.866	-.525
	6	-.055	.063	1.000	-.256	.146
4	1	-.070	.049	1.000	-.227	.086
	2	-.648*	.051	.000	-.811	-.485
	3	.023	.054	1.000	-.149	.196
	5	-.672*	.052	.000	-.837	-.507
	6	-.031	.058	1.000	-.216	.153
5	1	.602*	.061	.000	.407	.797
	2	.023	.017	1.000	-.031	.078
	3	.695*	.054	.000	.525	.866
	4	.672*	.052	.000	.507	.837
	6	.641*	.063	.000	.439	.842
6	1	-.039	.068	1.000	-.257	.178
	2	-.617*	.062	.000	-.816	-.418
	3	.055	.063	1.000	-.146	.256
	4	.031	.058	1.000	-.153	.216
	5	-.641*	.063	.000	-.842	-.439

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.885	41.696[a]	5.000	27.000	.000	.885
Wilks' lambda	.115	41.696[a]	5.000	27.000	.000	.885
Hotelling's trace	7.722	41.696[a]	5.000	27.000	.000	.885
Roy's largest root	7.722	41.696[a]	5.000	27.000	.000	.885

Each F tests the multivariate effect of condition. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

11.6 Bonferonni Post-hoc tests within-subjects for the factor distance

2. Distance

Estimates

Measure: MEASURE_1

distance	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	.458	.032	.394	.523

2	.625	.040	.543	.707
3	.542	.037	.465	.618
4	.589	.042	.504	.673

Pairwise Comparisons

Measure: MEASURE_1

(I) distance	(J) distance	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.167*	.031	.000	-.254	-.080
	3	-.083	.035	.144	-.182	.016
	4	-.130*	.039	.012	-.239	-.021
2	1	.167*	.031	.000	.080	.254
	3	.083	.044	.393	-.040	.206
	4	.036	.046	1.000	-.093	.166
3	1	.083	.035	.144	-.016	.182
	2	-.083	.044	.393	-.206	.040
	4	-.047	.045	1.000	-.174	.080
4	1	.130*	.039	.012	.021	.239
	2	-.036	.046	1.000	-.166	.093
	3	.047	.045	1.000	-.080	.174

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.546	11.621[a]	3.000	29.000	.000	.546
Wilks' lambda	.454	11.621[a]	3.000	29.000	.000	.546
Hotelling's trace	1.202	11.621[a]	3.000	29.000	.000	.546
Roy's largest root	1.202	11.621[a]	3.000	29.000	.000	.546

Each F tests the multivariate effect of distance. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

11.7 Effects analysis of distance within each level combination of condition

5. Condition * Distance

Estimates

Measure: MEASURE_1

condition	distance	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound

1	1	.219	.074	.067	.370
	2	.375	.087	.198	.552
	3	.406	.088	.226	.586
	4	.563	.089	.381	.744
2	1	.969	.031	.905	1.032
	2	1.000	.000	1.000	1.000
	3	.969	.031	.905	1.032
	4	.938	.043	.849	1.026
3	1	.156	.065	.023	.289
	2	.500	.090	.317	.683
	3	.219	.074	.067	.370
	4	.313	.083	.143	.482
4	1	.125	.059	.004	.246
	2	.406	.088	.226	.586
	3	.313	.083	.143	.482
	4	.438	.089	.256	.619
5	1	1.000	.000	1.000	1.000
	2	1.000	.000	1.000	1.000
	3	1.000	.000	1.000	1.000
	4	.969	.031	.905	1.032
6	1	.281	.081	.117	.446
	2	.469	.090	.286	.652
	3	.344	.085	.170	.518
	4	.313	.083	.143	.482

Multivariate Tests

condition		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
1	Pillai's trace	.263	3.445[a]	3.000	29.000	.029	.263
	Wilks' lambda	.737	3.445[a]	3.000	29.000	.029	.263
	Hotelling's trace	.356	3.445[a]	3.000	29.000	.029	.263
	Roy's largest root	.356	3.445[a]	3.000	29.000	.029	.263
2	Pillai's trace	.125	1.381[a]	3.000	29.000	.268	.125
	Wilks' lambda	.875	1.381[a]	3.000	29.000	.268	.125
	Hotelling's trace	.143	1.381[a]	3.000	29.000	.268	.125
	Roy's largest root	.143	1.381[a]	3.000	29.000	.268	.125
3	Pillai's trace	.304	4.229[a]	3.000	29.000	.013	.304
	Wilks' lambda	.696	4.229[a]	3.000	29.000	.013	.304
	Hotelling's trace	.437	4.229[a]	3.000	29.000	.013	.304
	Roy's largest root	.437	4.229[a]	3.000	29.000	.013	.304
4	Pillai's trace	.310	4.352[a]	3.000	29.000	.012	.310

	Wilks' lambda	.690	4.352[a]	3.000	29.000	.012	.310
	Hotelling's trace	.450	4.352[a]	3.000	29.000	.012	.310
	Roy's largest root	.450	4.352[a]	3.000	29.000	.012	.310
5	Pillai's trace	.031	1.000[a]	1.000	31.000	.325	.031
	Wilks' lambda	.969	1.000[a]	1.000	31.000	.325	.031
	Hotelling's trace	.032	1.000[a]	1.000	31.000	.325	.031
	Roy's largest root	.032	1.000[a]	1.000	31.000	.325	.031
6	Pillai's trace	.135	1.514[a]	3.000	29.000	.232	.135
	Wilks' lambda	.865	1.514[a]	3.000	29.000	.232	.135
	Hotelling's trace	.157	1.514[a]	3.000	29.000	.232	.135
	Roy's largest root	.157	1.514[a]	3.000	29.000	.232	.135

Each F tests the multivariate simple effects of distance within each level combination of the other effects shown. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

11.8 Pairwise comparison analysis using interactions between distances Pairwise Comparisons

Measure: MEASURE_1

condition	(I) distance	(J) distance	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
						Lower Bound	Upper Bound
1	1	2	-.156	.091	.096	-.342	.029
		3	-.188	.095	.056	-.380	.005
		4	-.344*	.106	.003	-.561	-.127
	2	1	.156	.091	.096	-.029	.342
		3	-.031	.084	.712	-.202	.140
		4	-.188	.105	.083	-.401	.026
	3	1	.188	.095	.056	-.005	.380
		2	.031	.084	.712	-.140	.202
		4	-.156	.111	.169	-.383	.070
	4	1	.344*	.106	.003	.127	.561
		2	.188	.105	.083	-.026	.401
		3	.156	.111	.169	-.070	.383
2	1	2	-.031	.031	.325	-.095	.032
		3	.000	.045	1.000	-.092	.092
		4	.031	.055	.572	-.080	.143
	2	1	.031	.031	.325	-.032	.095
		3	.031	.031	.325	-.032	.095
		4	.063	.043	.161	-.026	.151
	3	1	.000	.045	1.000	-.092	.092

		2	-.031	.031	.325	-.095	.032
		4	.031	.055	.572	-.080	.143
	4	1	-.031	.055	.572	-.143	.080
		2	-.063	.043	.161	-.151	.026
		3	-.031	.055	.572	-.143	.080
3	1	2	-.344*	.096	.001	-.540	-.147
		3	-.063	.089	.488	-.244	.119
		4	-.156	.079	.057	-.318	.005
	2	1	.344*	.096	.001	.147	.540
		3	.281*	.103	.010	.072	.491
		4	.188	.095	.056	-.005	.380
	3	1	.063	.089	.488	-.119	.244
		2	-.281*	.103	.010	-.491	-.072
		4	-.094	.104	.374	-.306	.118
	4	1	.156	.079	.057	-.005	.318
		2	-.188	.095	.056	-.380	.005
		3	.094	.104	.374	-.118	.306
4	1	2	-.281*	.092	.005	-.470	-.093
		3	-.188	.095	.056	-.380	.005
		4	-.313*	.105	.005	-.526	-.099
	2	1	.281*	.092	.005	.093	.470
		3	.094	.122	.447	-.155	.342
		4	-.031	.114	.786	-.264	.202
	3	1	.188	.095	.056	-.005	.380
		2	-.094	.122	.447	-.342	.155
		4	-.125	.098	.211	-.325	.075
	4	1	.313*	.105	.005	.099	.526
		2	.031	.114	.786	-.202	.264
		3	.125	.098	.211	-.075	.325
5	1	2	.000	.000	.	.000	.000
		3	.000	.000	.	.000	.000
		4	.031	.031	.325	-.032	.095
	2	1	.000	.000	.	.000	.000
		3	.000	.000	.	.000	.000
		4	.031	.031	.325	-.032	.095
	3	1	.000	.000	.	.000	.000
		2	.000	.000	.	.000	.000
		4	.031	.031	.325	-.032	.095
	4	1	-.031	.031	.325	-.095	.032
		2	-.031	.031	.325	-.095	.032
		3	-.031	.031	.325	-.095	.032
6	1	2	-.188	.095	.056	-.380	.005
		3	-.063	.077	.423	-.219	.094

	4	-.031	.095	.745	-.225	.163
	1	.188	.095	.056	-.005	.380
2	3	.125	.108	.255	-.095	.345
	4	.156	.101	.134	-.051	.363
	1	.063	.077	.423	-.094	.219
3	2	-.125	.108	.255	-.345	.095
	4	.031	.084	.712	-.140	.202
	1	.031	.095	.745	-.163	.225
4	2	-.156	.101	.134	-.363	.051
	3	-.031	.084	.712	-.202	.140

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

11.9 Effects analysis of condition within each level combination of distance

4. Condition * Distance

Estimates

Measure: MEASURE_1

condition	distance	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	.219	.074	.067	.370
	2	.375	.087	.198	.552
	3	.406	.088	.226	.586
	4	.563	.089	.381	.744
2	1	.969	.031	.905	1.032
	2	1.000	.000	1.000	1.000
	3	.969	.031	.905	1.032
	4	.938	.043	.849	1.026
3	1	.156	.065	.023	.289
	2	.500	.090	.317	.683
	3	.219	.074	.067	.370
	4	.313	.083	.143	.482
4	1	.125	.059	.004	.246
	2	.406	.088	.226	.586
	3	.313	.083	.143	.482
	4	.438	.089	.256	.619
5	1	1.000	.000	1.000	1.000
	2	1.000	.000	1.000	1.000
	3	1.000	.000	1.000	1.000
	4	.969	.031	.905	1.032

6	1	.281	.081	.117	.446
	2	.469	.090	.286	.652
	3	.344	.085	.170	.518
	4	.313	.083	.143	.482

Multivariate Tests

distance		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
1	Pillai's trace	.926	67.669[a]	5.000	27.000	.000	.926
	Wilks' lambda	.074	67.669[a]	5.000	27.000	.000	.926
	Hotelling's trace	12.531	67.669[a]	5.000	27.000	.000	.926
	Roy's largest root	12.531	67.669[a]	5.000	27.000	.000	.926
2	Pillai's trace	.752	21.200[a]	4.000	28.000	.000	.752
	Wilks' lambda	.248	21.200[a]	4.000	28.000	.000	.752
	Hotelling's trace	3.029	21.200[a]	4.000	28.000	.000	.752
	Roy's largest root	3.029	21.200[a]	4.000	28.000	.000	.752
3	Pillai's trace	.853	31.411[a]	5.000	27.000	.000	.853
	Wilks' lambda	.147	31.411[a]	5.000	27.000	.000	.853
	Hotelling's trace	5.817	31.411[a]	5.000	27.000	.000	.853
	Roy's largest root	5.817	31.411[a]	5.000	27.000	.000	.853
4	Pillai's trace	.766	17.718[a]	5.000	27.000	.000	.766
	Wilks' lambda	.234	17.718[a]	5.000	27.000	.000	.766
	Hotelling's trace	3.281	17.718[a]	5.000	27.000	.000	.766
	Roy's largest root	3.281	17.718[a]	5.000	27.000	.000	.766

Each F tests the multivariate simple effects of condition within each level combination of the other effects shown. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

11.10 Pairwise comparison analysis using interactions between conditions

Pairwise Comparisons

Measure: MEASURE_1

distance	(I) condition	(J) condition	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
						Lower Bound	Upper Bound
1	1	2	-.750*	.078	.000	-.909	-.591
		3	.063	.077	.423	-.094	.219
		4	.094	.094	.325	-.097	.285

		5	-.781*	.074	.000	-.933	-.630
		6	-.063	.100	.536	-.266	.141
	2	1	.750*	.078	.000	.591	.909
		3	.813*	.070	.000	.670	.955
		4	.844*	.065	.000	.711	.977
		5	-.031	.031	.325	-.095	.032
		6	.688*	.083	.000	.518	.857
	3	1	-.063	.077	.423	-.219	.094
		2	-.813*	.070	.000	-.955	-.670
		4	.031	.084	.712	-.140	.202
		5	-.844*	.065	.000	-.977	-.711
		6	-.125	.087	.161	-.302	.052
	4	1	-.094	.094	.325	-.285	.097
		2	-.844*	.065	.000	-.977	-.711
		3	-.031	.084	.712	-.202	.140
		5	-.875*	.059	.000	-.996	-.754
		6	-.156	.079	.057	-.318	.005
	5	1	.781*	.074	.000	.630	.933
		2	.031	.031	.325	-.032	.095
		3	.844*	.065	.000	.711	.977
		4	.875*	.059	.000	.754	.996
		6	.719*	.081	.000	.554	.883
	6	1	.063	.100	.536	-.141	.266
		2	-.688*	.083	.000	-.857	-.518
		3	.125	.087	.161	-.052	.302
		4	.156	.079	.057	-.005	.318
		5	-.719*	.081	.000	-.883	-.554
2	1	2	-.625*	.087	.000	-.802	-.448
		3	-.125	.108	.255	-.345	.095
		4	-.031	.105	.768	-.246	.183
		5	-.625*	.087	.000	-.802	-.448
		6	-.094	.122	.447	-.342	.155
	2	1	.625*	.087	.000	.448	.802
		3	.500*	.090	.000	.317	.683
		4	.594*	.088	.000	.414	.774
		5	.000	.000	.	.000	.000
		6	.531*	.090	.000	.348	.714
	3	1	.125	.108	.255	-.095	.345
		2	-.500*	.090	.000	-.683	-.317
		4	.094	.094	.325	-.097	.285

		5	-.500*	.090	.000	-.683	-.317
		6	.031	.105	.768	-.183	.246
	4	1	.031	.105	.768	-.183	.246
		2	-.594*	.088	.000	-.774	-.414
		3	-.094	.094	.325	-.285	.097
		5	-.594*	.088	.000	-.774	-.414
		6	-.063	.100	.536	-.266	.141
	5	1	.625*	.087	.000	.448	.802
		2	.000	.000	.	.000	.000
		3	.500*	.090	.000	.317	.683
		4	.594*	.088	.000	.414	.774
		6	.531*	.090	.000	.348	.714
	6	1	.094	.122	.447	-.155	.342
		2	-.531*	.090	.000	-.714	-.348
		3	-.031	.105	.768	-.246	.183
		4	.063	.100	.536	-.141	.266
		5	-.531*	.090	.000	-.714	-.348
3	1	2	-.563*	.089	.000	-.744	-.381
		3	.188	.114	.110	-.045	.420
		4	.094	.113	.414	-.137	.325
		5	-.594*	.088	.000	-.774	-.414
		6	.063	.109	.572	-.161	.286
	2	1	.563*	.089	.000	.381	.744
		3	.750*	.078	.000	.591	.909
		4	.656*	.085	.000	.482	.830
		5	-.031	.031	.325	-.095	.032
		6	.625*	.087	.000	.448	.802
	3	1	-.188	.114	.110	-.420	.045
		2	-.750*	.078	.000	-.909	-.591
		4	-.094	.094	.325	-.285	.097
		5	-.781*	.074	.000	-.933	-.630
		6	-.125	.098	.211	-.325	.075
	4	1	-.094	.113	.414	-.325	.137
		2	-.656*	.085	.000	-.830	-.482
		3	.094	.094	.325	-.097	.285
		5	-.688*	.083	.000	-.857	-.518
		6	-.031	.084	.712	-.202	.140
	5	1	.594*	.088	.000	.414	.774
		2	.031	.031	.325	-.032	.095
		3	.781*	.074	.000	.630	.933
		4	.688*	.083	.000	.518	.857
		6	.656*	.085	.000	.482	.830
	6	1	-.063	.109	.572	-.286	.161

		2	-.625*	.087	.000	-.802	-.448
		3	.125	.098	.211	-.075	.325
		4	.031	.084	.712	-.140	.202
		5	-.656*	.085	.000	-.830	-.482
4	1	2	-.375*	.108	.002	-.595	-.155
		3	.250*	.090	.009	.067	.433
		4	.125	.117	.292	-.113	.363
		5	-.406*	.099	.000	-.608	-.204
		6	.250*	.090	.009	.067	.433
	2	1	.375*	.108	.002	.155	.595
		3	.625*	.087	.000	.448	.802
		4	.500*	.090	.000	.317	.683
		5	-.031	.055	.572	-.143	.080
		6	.625*	.087	.000	.448	.802
	3	1	-.250*	.090	.009	-.433	-.067
		2	-.625*	.087	.000	-.802	-.448
		4	-.125	.098	.211	-.325	.075
		5	-.656*	.085	.000	-.830	-.482
		6	.000	.100	1.000	-.205	.205
	4	1	-.125	.117	.292	-.363	.113
		2	-.500*	.090	.000	-.683	-.317
		3	.125	.098	.211	-.075	.325
		5	-.531*	.100	.000	-.736	-.327
		6	.125	.098	.211	-.075	.325
	5	1	.406*	.099	.000	.204	.608
		2	.031	.055	.572	-.080	.143
		3	.656*	.085	.000	.482	.830
		4	.531*	.100	.000	.327	.736
		6	.656*	.096	.000	.460	.853
	6	1	-.250*	.090	.009	-.433	-.067
		2	-.625*	.087	.000	-.802	-.448
		3	.000	.100	1.000	-.205	.205
		4	-.125	.098	.211	-.325	.075
		5	-.656*	.096	.000	-.853	-.460

Based on estimated marginal means

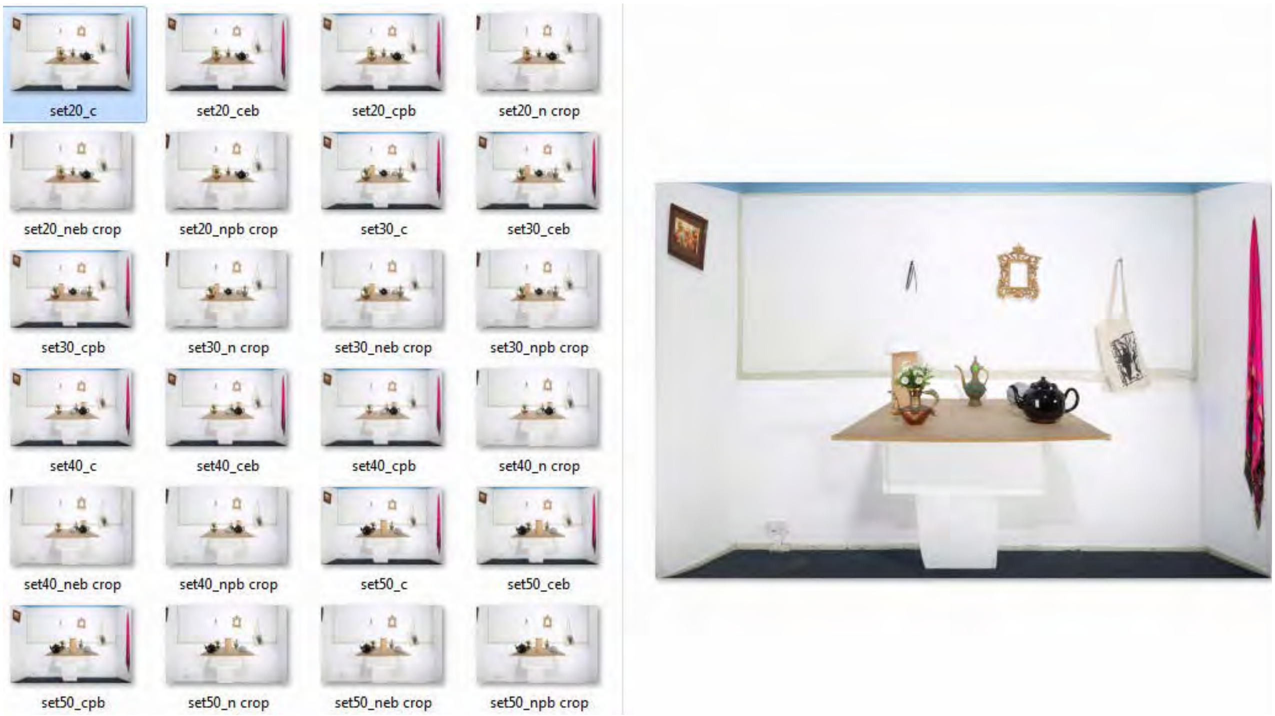
*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

11.11 Repeated measures screening combinations of stimuli and stimuli

Group 1	5				
20c	20ceb	20cpb	20n	20neb	20npb 1st
30c	30ceb	30cpb	30n	30neb	30npb
40c	40ceb	40cpb	40n	40neb	40npb
50c	50ceb	50cpb	50n	50neb	50npb
Group 4	5				
20c 1st	20ceb	20cpb	20n	20neb	20npb
30c	30ceb	30cpb	30n	30neb	30npb
40c	40ceb	40cpb	40n	40neb	40npb
50c	50ceb	50cpb	50n	50neb	50npb
Group 5	5				
20c	20ceb	20cpb	20n	20neb	20npb
30c	30ceb	30cpb	30n	30neb	30npb
40c	40ceb	40cpb	40n	40neb	40npb
50c 1st	50ceb	50cpb	50n	50neb	50npb
Group 6	5				
20c	20ceb	20cpb	20n	20neb	20npb
30c	30ceb	30cpb	30n	30neb	30npb
40c	40ceb	40cpb	40n	40neb	40npb
50c	50ceb	50cpb	50n	50neb	50npb 1st

Stimuli



11.12 Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
c20	32	5.00	20.00	9.8750	3.91647
c30	32	8.00	30.00	16.3438	5.51016
c40	32	10.00	50.00	26.1875	9.19129
c50	32	10.00	75.00	34.6250	12.32556
ceb20	32	5.00	20.00	10.0000	3.96761
ceb30	32	5.00	30.00	16.7813	5.51675
ceb40	32	10.00	50.00	26.9063	8.18086
ceb50	32	20.00	70.00	41.7188	11.61266
cpb20	32	5.00	20.00	9.5000	3.61002
cpb30	32	10.00	30.00	16.5312	4.66963
cpb40	32	10.00	50.00	24.4375	7.64932
cpb50	32	20.00	65.00	37.2813	11.04312
n20	32	5.00	25.00	9.9688	3.98776
n30	32	10.00	50.00	17.3125	7.74362
n40	32	15.00	50.00	25.9688	8.05018
n50	32	15.00	70.00	36.5937	11.05954
neb20	32	5.00	25.00	9.9688	4.70747
neb30	32	10.00	50.00	17.2500	7.86991
neb40	32	15.00	50.00	29.5625	8.67305
neb50	32	20.00	80.00	39.3750	10.37600
npb20	32	5.00	60.00	10.2188	9.61428
npb30	32	10.00	25.00	14.9375	4.26492
npb40	32	15.00	50.00	24.6250	8.04323
npb50	32	20.00	70.00	35.0000	10.77632
Valid N (listwise)	32				

11.13 4x6 Repeated Measures ANOVA (Huynh-Feldt correction)

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

condition	distance	Dependent Variable
1	1	c20per
	2	c30per
	3	c40per
	4	c50per
2	1	ceb20per
	2	ceb30per
	3	ceb40per
	4	ceb50per
3	1	cpb20per
	2	cpb30per
	3	cpb40per
	4	cpb50per
4	1	n20per
	2	n30per
	3	n40per

	4	n50per
5	1	neb20per
	2	neb30per
	3	neb40per
	4	neb50per
6	1	npb20per
	2	npb30per
	3	npb40per
	4	npb50per

Descriptive Statistics

	Mean	Std. Deviation	N
c20per	50.6250	19.58233	32
c30per	45.5208	18.36721	32
c40per	37.6563	17.17953	32
c50per	33.8750	19.98023	32
ceb20per	50.0000	19.83805	32
ceb30per	44.0625	18.38915	32
ceb40per	34.2969	17.61179	32
ceb50per	22.8125	16.89328	32
cpb20per	52.5000	18.05011	32
cpb30per	45.9375	15.87890	32
cpb40per	40.4687	15.41676	32
cpb50per	27.9375	18.70990	32
n20per	51.7187	15.27223	32
n30per	46.4583	16.86840	32
n40per	36.6406	17.01054	32
n50per	28.6875	18.17201	32
neb20per	51.7187	19.74063	32
neb30per	46.6667	17.45450	32
neb40per	31.5625	12.02735	32
neb50per	25.0000	15.86231	32
npb20per	61.4062	29.79052	32
npb30per	50.2083	14.21639	32
npb40per	40.0000	16.66801	32
npb50per	32.5000	17.41338	32

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
condition	Pillai's Trace	.422	3.946[b]	5.000	27.000	.008	.422

	Wilks' Lambda	.578	3.946[b]	5.000	27.000	.008	.422
	Hotelling's Trace	.731	3.946[b]	5.000	27.000	.008	.422
	Roy's Largest Root	.731	3.946[b]	5.000	27.000	.008	.422
distance	Pillai's Trace	.777	33.715[b]	3.000	29.000	.000	.777
	Wilks' Lambda	.223	33.715[b]	3.000	29.000	.000	.777
	Hotelling's Trace	3.488	33.715[b]	3.000	29.000	.000	.777
	Roy's Largest Root	3.488	33.715[b]	3.000	29.000	.000	.777
condition * distance	Pillai's Trace	.616	1.816[b]	15.000	17.000	.119	.616
	Wilks' Lambda	.384	1.816[b]	15.000	17.000	.119	.616
	Hotelling's Trace	1.602	1.816[b]	15.000	17.000	.119	.616
	Roy's Largest Root	1.602	1.816[b]	15.000	17.000	.119	.616

a. Design: Intercept

Within Subjects Design: condition + distance + condition * distance

b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
condition	.182	49.581	14	.000	.615	.690	.200
distance	.339	32.121	5	.000	.616	.653	.333
condition * distance	.000	336.004	119	.000	.299	.356	.067

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: condition + distance + condition * distance

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
condition	Sphericity Assumed	5359.400	5	1071.880	4.538	.001	.128

	Greenhouse-Geisser	5359.400	3.073	1743.961	4.538	.005	.128
	Huynh-Feldt	5359.400	3.450	1553.577	4.538	.003	.128
	Lower-bound	5359.400	1.000	5359.400	4.538	.041	.128
Error(condition)	Sphericity Assumed	36611.165	155	236.201			
	Greenhouse-Geisser	36611.165	95.267	384.302			
	Huynh-Feldt	36611.165	106.941	342.349			
	Lower-bound	36611.165	31.000	1181.005			
distance	Sphericity Assumed	66940.855	3	22313.618	53.031	.000	.631
	Greenhouse-Geisser	66940.855	1.847	36251.466	53.031	.000	.631
	Huynh-Feldt	66940.855	1.958	34183.706	53.031	.000	.631
	Lower-bound	66940.855	1.000	66940.855	53.031	.000	.631
Error(distance)	Sphericity Assumed	39131.465	93	420.768			
	Greenhouse-Geisser	39131.465	57.244	683.595			
	Huynh-Feldt	39131.465	60.706	644.603			
	Lower-bound	39131.465	31.000	1262.305			
condition * distance	Sphericity Assumed	2890.751	15	192.717	1.456	.118	.045
	Greenhouse-Geisser	2890.751	4.489	643.967	1.456	.214	.045
	Huynh-Feldt	2890.751	5.343	541.040	1.456	.203	.045
	Lower-bound	2890.751	1.000	2890.751	1.456	.237	.045
Error(condition*distance)	Sphericity Assumed	61549.555	465	132.365			
	Greenhouse-Geisser	61549.555	139.158	442.299			
	Huynh-Feldt	61549.555	165.631	371.605			
	Lower-bound	61549.555	31.000	1985.470			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	condition	distance	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
condition	Linear		929.361	1	929.361	2.318	.138	.070
	Quadratic		1645.446	1	1645.446	5.176	.030	.143

	Cubic		212.271	1	212.271	.943	.339	.030
	Order 4		2531.570	1	2531.570	14.145	.001	.313
	Order 5		40.751	1	40.751	.701	.409	.022
Error(condition)	Linear		12430.929	31	400.998			
	Quadratic		9854.486	31	317.887			
	Cubic		6976.576	31	225.051			
	Order 4		5548.326	31	178.978			
	Order 5		1800.848	31	58.092			
distance		Linear	66586.135	1	66586.135	88.036	.000	.740
		Quadratic	152.594	1	152.594	.436	.514	.014
		Cubic	202.125	1	202.125	1.295	.264	.040
Error(distance)		Linear	23446.904	31	756.352			
		Quadratic	10847.577	31	349.922			
		Cubic	4836.983	31	156.032			
condition * distance	Linear	Linear	966.340	1	966.340	2.599	.117	.077
		Quadratic	84.929	1	84.929	.658	.423	.021
		Cubic	33.715	1	33.715	.437	.513	.014
	Quadratic	Linear	36.294	1	36.294	.125	.726	.004
		Quadratic	425.068	1	425.068	3.220	.083	.094
		Cubic	16.071	1	16.071	.289	.595	.009
	Cubic	Linear	249.435	1	249.435	1.787	.191	.054
		Quadratic	38.637	1	38.637	.320	.575	.010
		Cubic	353.171	1	353.171	1.936	.174	.059
	Order 4	Linear	448.453	1	448.453	2.501	.124	.075
		Quadratic	22.478	1	22.478	.375	.545	.012
		Cubic	185.759	1	185.759	3.497	.071	.101
	Order 5	Linear	1.771	1	1.771	.022	.883	.001
		Quadratic	7.098	1	7.098	.169	.684	.005
		Cubic	21.532	1	21.532	.300	.588	.010
Error(condition*distance)	Linear	Linear	11527.429	31	371.853			
		Quadratic	3999.086	31	129.003			
		Cubic	2391.821	31	77.156			
	Quadratic	Linear	8999.061	31	290.292			
		Quadratic	4092.394	31	132.013			
		Cubic	1724.818	31	55.639			
	Cubic	Linear	4328.292	31	139.622			
		Quadratic	3737.586	31	120.567			
		Cubic	5656.117	31	182.455			
	Order 4	Linear	5558.569	31	179.309			
		Quadratic	1856.555	31	59.889			
		Cubic	1646.744	31	53.121			

		Linear	2501.114	31	80.681			
	Order 5	Quadratic	1304.650	31	42.085			
		Cubic	2225.319	31	71.784			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	1302211.535	1	1302211.535	385.503	.000	.926
Error	104716.553	31	3377.953			

11.14 Bonferonni Post-hoc tests within-subjects for the factor condition

Estimated Marginal Means

1. Condition

Estimates

Measure: MEASURE_1

condition	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	41.919	2.684	36.446	47.393
2	37.793	2.575	32.542	43.044
3	41.711	2.353	36.911	46.511
4	40.876	2.347	36.089	45.664
5	38.737	2.209	34.232	43.242
6	46.029	2.420	41.092	50.965

Pairwise Comparisons

Measure: MEASURE_1

(I) condition	(J) condition	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	4.126	1.581	.208	-.903	9.155
	3	.208	1.835	1.000	-5.626	6.043
	4	1.043	1.522	1.000	-3.797	5.883
	5	3.182	1.801	1.000	-2.546	8.911
	6	-4.109	2.652	1.000	-12.542	4.324
2	1	-4.126	1.581	.208	-9.155	.903
	3	-3.918*	1.098	.018	-7.411	-.425
	4	-3.083	1.220	.253	-6.964	.797
	5	-.944	1.598	1.000	-6.025	4.137
	6	-8.236*	2.571	.047	-16.412	-.060

	1	-.208	1.835	1.000	-6.043	5.626
	2	3.918*	1.098	.018	.425	7.411
3	4	.835	1.051	1.000	-2.506	4.175
	5	2.974	1.865	1.000	-2.955	8.903
	6	-4.318	2.463	1.000	-12.151	3.516
	1	-1.043	1.522	1.000	-5.883	3.797
	2	3.083	1.220	.253	-.797	6.964
4	3	-.835	1.051	1.000	-4.175	2.506
	5	2.139	1.636	1.000	-3.063	7.341
	6	-5.152	2.376	.568	-12.707	2.402
	1	-3.182	1.801	1.000	-8.911	2.546
	2	.944	1.598	1.000	-4.137	6.025
5	3	-2.974	1.865	1.000	-8.903	2.955
	4	-2.139	1.636	1.000	-7.341	3.063
	6	-7.292	2.464	.088	-15.126	.543
	1	4.109	2.652	1.000	-4.324	12.542
	2	8.236*	2.571	.047	.060	16.412
6	3	4.318	2.463	1.000	-3.516	12.151
	4	5.152	2.376	.568	-2.402	12.707
	5	7.292	2.464	.088	-.543	15.126

Based on estimated marginal means

*. The mean difference is significant at the .05 level. b. Adjustment for multiple comparisons: Bonferroni.

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.422	3.946[a]	5.000	27.000	.008	.422
Wilks' lambda	.578	3.946[a]	5.000	27.000	.008	.422
Hotelling's trace	.731	3.946[a]	5.000	27.000	.008	.422
Roy's largest root	.731	3.946[a]	5.000	27.000	.008	.422

Each F tests the multivariate effect of condition. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

11.15 Bonferonni Post-hoc tests within-subjects for the factor distance

2. Distance

Estimates

Measure: MEASURE_1

distance	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	52.995	2.325	48.254	57.736

2	46.476	2.453	41.473	51.478
3	36.771	2.359	31.959	41.583
4	28.469	2.680	23.003	33.934

Pairwise Comparisons

Measure: MEASURE_1

(I) distance	(J) distance	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	6.519*	1.591	.002	2.036	11.002
	3	16.224*	1.918	.000	10.819	21.629
	4	24.526*	2.489	.000	17.513	31.539
2	1	-6.519*	1.591	.002	-11.002	-2.036
	3	9.705*	1.820	.000	4.576	14.833
	4	18.007*	2.830	.000	10.031	25.983
3	1	-16.224*	1.918	.000	-21.629	-10.819
	2	-9.705*	1.820	.000	-14.833	-4.576
	4	8.302*	1.605	.000	3.778	12.826
4	1	-24.526*	2.489	.000	-31.539	-17.513
	2	-18.007*	2.830	.000	-25.983	-10.031
	3	-8.302*	1.605	.000	-12.826	-3.778

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.777	33.715[a]	3.000	29.000	.000	.777
Wilks' lambda	.223	33.715[a]	3.000	29.000	.000	.777
Hotelling's trace	3.488	33.715[a]	3.000	29.000	.000	.777
Roy's largest root	3.488	33.715[a]	3.000	29.000	.000	.777

Each F tests the multivariate effect of distance. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

3. condition * distance

Measure: MEASURE_1

condition	distance	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	50.625	3.462	43.565	57.685

	2	45.521	3.247	38.899	52.143
	3	37.656	3.037	31.462	43.850
	4	33.875	3.532	26.671	41.079
2	1	50.000	3.507	42.848	57.152
	2	44.063	3.251	37.433	50.692
	3	34.297	3.113	27.947	40.647
	4	22.813	2.986	16.722	28.903
3	1	52.500	3.191	45.992	59.008
	2	45.937	2.807	40.213	51.662
	3	40.469	2.725	34.910	46.027
	4	27.938	3.307	21.192	34.683
4	1	51.719	2.700	46.213	57.225
	2	46.458	2.982	40.377	52.540
	3	36.641	3.007	30.508	42.774
	4	28.688	3.212	22.136	35.239
5	1	51.719	3.490	44.601	58.836
	2	46.667	3.086	40.374	52.960
	3	31.563	2.126	27.226	35.899
	4	25.000	2.804	19.281	30.719
6	1	61.406	5.266	50.666	72.147
	2	50.208	2.513	45.083	55.334
	3	40.000	2.947	33.991	46.009
	4	32.500	3.078	26.222	38.778

4. Condition * Distance

Estimates

Measure: MEASURE_1

condition	distance	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	50.625	3.462	43.565	57.685
	2	45.521	3.247	38.899	52.143
	3	37.656	3.037	31.462	43.850
	4	33.875	3.532	26.671	41.079
2	1	50.000	3.507	42.848	57.152
	2	44.063	3.251	37.433	50.692
	3	34.297	3.113	27.947	40.647
	4	22.813	2.986	16.722	28.903
3	1	52.500	3.191	45.992	59.008
	2	45.937	2.807	40.213	51.662
	3	40.469	2.725	34.910	46.027
	4	27.938	3.307	21.192	34.683
4	1	51.719	2.700	46.213	57.225

	2	46.458	2.982	40.377	52.540
	3	36.641	3.007	30.508	42.774
	4	28.688	3.212	22.136	35.239
5	1	51.719	3.490	44.601	58.836
	2	46.667	3.086	40.374	52.960
	3	31.563	2.126	27.226	35.899
	4	25.000	2.804	19.281	30.719
6	1	61.406	5.266	50.666	72.147
	2	50.208	2.513	45.083	55.334
	3	40.000	2.947	33.991	46.009
	4	32.500	3.078	26.222	38.778

11.16 Effect analysis of distance within each level combination of condition

Multivariate Tests

condition		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
1	Pillai's trace	.409	6.700[a]	3.000	29.000	.001	.409
	Wilks' lambda	.591	6.700[a]	3.000	29.000	.001	.409
	Hotelling's trace	.693	6.700[a]	3.000	29.000	.001	.409
	Roy's largest root	.693	6.700[a]	3.000	29.000	.001	.409
2	Pillai's trace	.654	18.255[a]	3.000	29.000	.000	.654
	Wilks' lambda	.346	18.255[a]	3.000	29.000	.000	.654
	Hotelling's trace	1.888	18.255[a]	3.000	29.000	.000	.654
	Roy's largest root	1.888	18.255[a]	3.000	29.000	.000	.654
3	Pillai's trace	.596	14.232[a]	3.000	29.000	.000	.596
	Wilks' lambda	.404	14.232[a]	3.000	29.000	.000	.596
	Hotelling's trace	1.472	14.232[a]	3.000	29.000	.000	.596
	Roy's largest root	1.472	14.232[a]	3.000	29.000	.000	.596
4	Pillai's trace	.569	12.741[a]	3.000	29.000	.000	.569
	Wilks' lambda	.431	12.741[a]	3.000	29.000	.000	.569
	Hotelling's trace	1.318	12.741[a]	3.000	29.000	.000	.569
	Roy's largest root	1.318	12.741[a]	3.000	29.000	.000	.569
5	Pillai's trace	.617	15.562[a]	3.000	29.000	.000	.617
	Wilks' lambda	.383	15.562[a]	3.000	29.000	.000	.617
	Hotelling's trace	1.610	15.562[a]	3.000	29.000	.000	.617
	Roy's largest root	1.610	15.562[a]	3.000	29.000	.000	.617
6	Pillai's trace	.614	15.382[a]	3.000	29.000	.000	.614
	Wilks' lambda	.386	15.382[a]	3.000	29.000	.000	.614
	Hotelling's trace	1.591	15.382[a]	3.000	29.000	.000	.614
	Roy's largest root	1.591	15.382[a]	3.000	29.000	.000	.614

11.17 Pairwise comparison analysis using interactions between distances

5. Condition * Distance

Estimates

Measure: MEASURE_1

condition	distance	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	50.625	3.462	43.565	57.685
	2	45.521	3.247	38.899	52.143
	3	37.656	3.037	31.462	43.850
	4	33.875	3.532	26.671	41.079
2	1	50.000	3.507	42.848	57.152
	2	44.063	3.251	37.433	50.692
	3	34.297	3.113	27.947	40.647
	4	22.813	2.986	16.722	28.903
3	1	52.500	3.191	45.992	59.008
	2	45.937	2.807	40.213	51.662
	3	40.469	2.725	34.910	46.027
	4	27.938	3.307	21.192	34.683
4	1	51.719	2.700	46.213	57.225
	2	46.458	2.982	40.377	52.540
	3	36.641	3.007	30.508	42.774
	4	28.688	3.212	22.136	35.239
5	1	51.719	3.490	44.601	58.836
	2	46.667	3.086	40.374	52.960
	3	31.563	2.126	27.226	35.899
	4	25.000	2.804	19.281	30.719
6	1	61.406	5.266	50.666	72.147
	2	50.208	2.513	45.083	55.334
	3	40.000	2.947	33.991	46.009
	4	32.500	3.078	26.222	38.778

Pairwise Comparisons

Measure: MEASURE_1

condition	(I) distance	(J) distance	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
						Lower Bound	Upper Bound
1	1	2	5.104*	2.404	.042	.201	10.007
		3	12.969*	2.998	.000	6.854	19.084
		4	16.750*	3.986	.000	8.621	24.879
	2	1	-5.104*	2.404	.042	-10.007	-.201
		3	7.865*	2.730	.007	2.296	13.433

		4	11.646*	3.906	.006	3.679	19.612
	3	1	-12.969*	2.998	.000	-19.084	-6.854
		2	-7.865*	2.730	.007	-13.433	-2.296
		4	3.781	2.877	.198	-2.087	9.650
	4	1	-16.750*	3.986	.000	-24.879	-8.621
		2	-11.646*	3.906	.006	-19.612	-3.679
		3	-3.781	2.877	.198	-9.650	2.087
2	1	2	5.937*	2.379	.018	1.085	10.790
		3	15.703*	3.294	.000	8.984	22.422
		4	27.188*	3.571	.000	19.905	34.470
	2	1	-5.937*	2.379	.018	-10.790	-1.085
		3	9.766*	3.304	.006	3.026	16.505
		4	21.250*	3.369	.000	14.378	28.122
	3	1	-15.703*	3.294	.000	-22.422	-8.984
		2	-9.766*	3.304	.006	-16.505	-3.026
		4	11.484*	2.881	.000	5.608	17.361
	4	1	-27.188*	3.571	.000	-34.470	-19.905
		2	-21.250*	3.369	.000	-28.122	-14.378
		3	-11.484*	2.881	.000	-17.361	-5.608
3	1	2	6.563*	2.098	.004	2.284	10.841
		3	12.031*	3.019	.000	5.873	18.189
		4	24.563*	3.654	.000	17.111	32.014
	2	1	-6.563*	2.098	.004	-10.841	-2.284
		3	5.469	3.232	.101	-1.123	12.061
		4	18.000*	3.406	.000	11.052	24.948
	3	1	-12.031*	3.019	.000	-18.189	-5.873
		2	-5.469	3.232	.101	-12.061	1.123
		4	12.531*	2.861	.000	6.697	18.366
	4	1	-24.563*	3.654	.000	-32.014	-17.111
		2	-18.000*	3.406	.000	-24.948	-11.052
		3	-12.531*	2.861	.000	-18.366	-6.697
4	1	2	5.260*	2.492	.043	.177	10.343
		3	15.078*	2.881	.000	9.203	20.953
		4	23.031*	3.852	.000	15.174	30.888
	2	1	-5.260*	2.492	.043	-10.343	-.177
		3	9.818*	2.550	.001	4.616	15.019
		4	17.771*	3.287	.000	11.068	24.474
	3	1	-15.078*	2.881	.000	-20.953	-9.203
		2	-9.818*	2.550	.001	-15.019	-4.616
		4	7.953*	2.713	.006	2.421	13.485
	4	1	-23.031*	3.852	.000	-30.888	-15.174
		2	-17.771*	3.287	.000	-24.474	-11.068

		3	-7.953*	2.713	.006	-13.485	-2.421
		2	5.052*	2.236	.031	.492	9.612
	1	3	20.156*	3.047	.000	13.941	26.371
		4	26.719*	3.995	.000	18.571	34.866
		1	-5.052*	2.236	.031	-9.612	-.492
	2	3	15.104*	2.779	.000	9.436	20.772
5		4	21.667*	3.825	.000	13.866	29.467
		1	-20.156*	3.047	.000	-26.371	-13.941
	3	2	-15.104*	2.779	.000	-20.772	-9.436
		4	6.563*	2.383	.010	1.702	11.423
		1	-26.719*	3.995	.000	-34.866	-18.571
	4	2	-21.667*	3.825	.000	-29.467	-13.866
		3	-6.563*	2.383	.010	-11.423	-1.702
		2	11.198*	5.487	.050	.008	22.388
	1	3	21.406*	5.933	.001	9.305	33.508
		4	28.906*	5.503	.000	17.684	40.129
		1	-11.198*	5.487	.050	-22.388	-.008
	2	3	10.208*	2.187	.000	5.748	14.669
6		4	17.708*	2.995	.000	11.600	23.817
		1	-21.406*	5.933	.001	-33.508	-9.305
	3	2	-10.208*	2.187	.000	-14.669	-5.748
		4	7.500*	2.400	.004	2.606	12.394
		1	-28.906*	5.503	.000	-40.129	-17.684
	4	2	-17.708*	2.995	.000	-23.817	-11.600
		3	-7.500*	2.400	.004	-12.394	-2.606

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

11.18 Effect analysis of condition within each level combination of distance

Multivariate Tests

distance		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
1	Pillai's trace	.140	.880[a]	5.000	27.000	.508	.140
	Wilks' lambda	.860	.880[a]	5.000	27.000	.508	.140
	Hotelling's trace	.163	.880[a]	5.000	27.000	.508	.140
	Roy's largest root	.163	.880[a]	5.000	27.000	.508	.140
2	Pillai's trace	.135	.846[a]	5.000	27.000	.530	.135
	Wilks' lambda	.865	.846[a]	5.000	27.000	.530	.135

	Hotelling's trace	.157	.846[a]	5.000	27.000	.530	.135
	Roy's largest root	.157	.846[a]	5.000	27.000	.530	.135
3	Pillai's trace	.498	5.360[a]	5.000	27.000	.002	.498
	Wilks' lambda	.502	5.360[a]	5.000	27.000	.002	.498
	Hotelling's trace	.993	5.360[a]	5.000	27.000	.002	.498
	Roy's largest root	.993	5.360[a]	5.000	27.000	.002	.498
4	Pillai's trace	.451	4.429[a]	5.000	27.000	.004	.451
	Wilks' lambda	.549	4.429[a]	5.000	27.000	.004	.451
	Hotelling's trace	.820	4.429[a]	5.000	27.000	.004	.451
	Roy's largest root	.820	4.429[a]	5.000	27.000	.004	.451

Each F tests the multivariate simple effects of condition within each level combination of the other effects shown. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

11.19 Pairwise comparison analysis using interactions between conditions

Pairwise Comparisons

Measure: MEASURE_1

distance	(I) condition	(J) condition	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
						Lower Bound	Upper Bound
1	1	2	.625	3.052	.839	-5.599	6.849
		3	-1.875	3.320	.576	-8.647	4.897
		4	-1.094	3.432	.752	-8.094	5.907
		5	-1.094	2.775	.696	-6.753	4.565
		6	-10.781	6.687	.117	-24.419	2.857
	2	1	-.625	3.052	.839	-6.849	5.599
		3	-2.500	1.753	.164	-6.076	1.076
		4	-1.719	2.496	.496	-6.809	3.372
		5	-1.719	2.516	.500	-6.851	3.413
		6	-11.406	6.921	.109	-25.521	2.708
	3	1	1.875	3.320	.576	-4.897	8.647
		2	2.500	1.753	.164	-1.076	6.076
		4	.781	2.155	.719	-3.613	5.176
		5	.781	3.168	.807	-5.680	7.242
		6	-8.906	6.805	.200	-22.785	4.973
	4	1	1.094	3.432	.752	-5.907	8.094
		2	1.719	2.496	.496	-3.372	6.809
		3	-.781	2.155	.719	-5.176	3.613

		5	.000	3.191	1.000	-6.508	6.508
		6	-9.688	6.049	.119	-22.024	2.649
	5	1	1.094	2.775	.696	-4.565	6.753
		2	1.719	2.516	.500	-3.413	6.851
		3	-.781	3.168	.807	-7.242	5.680
		4	.000	3.191	1.000	-6.508	6.508
		6	-9.688	6.294	.134	-22.524	3.149
	6	1	10.781	6.687	.117	-2.857	24.419
		2	11.406	6.921	.109	-2.708	25.521
		3	8.906	6.805	.200	-4.973	22.785
		4	9.688	6.049	.119	-2.649	22.024
		5	9.688	6.294	.134	-3.149	22.524
2	1	2	1.458	1.991	.469	-2.602	5.519
		3	-.417	2.435	.865	-5.384	4.550
		4	-.938	2.363	.694	-5.757	3.882
		5	-1.146	3.120	.716	-7.510	5.218
		6	-4.687	3.030	.132	-10.867	1.492
	2	1	-1.458	1.991	.469	-5.519	2.602
		3	-1.875	2.068	.372	-6.093	2.343
		4	-2.396	2.180	.280	-6.843	2.051
		5	-2.604	2.886	.374	-8.490	3.281
		6	-6.146*	2.937	.045	-12.136	-.155
	3	1	.417	2.435	.865	-4.550	5.384
		2	1.875	2.068	.372	-2.343	6.093
		4	-.521	2.144	.810	-4.893	3.851
		5	-.729	3.265	.825	-7.387	5.929
		6	-4.271	2.598	.110	-9.569	1.027
	4	1	.938	2.363	.694	-3.882	5.757
		2	2.396	2.180	.280	-2.051	6.843
		3	.521	2.144	.810	-3.851	4.893
		5	-.208	2.780	.941	-5.878	5.461
		6	-3.750	2.089	.082	-8.010	.510
	5	1	1.146	3.120	.716	-5.218	7.510
		2	2.604	2.886	.374	-3.281	8.490
		3	.729	3.265	.825	-5.929	7.387
		4	.208	2.780	.941	-5.461	5.878
		6	-3.542	3.357	.300	-10.387	3.304
	6	1	4.687	3.030	.132	-1.492	10.867
		2	6.146*	2.937	.045	.155	12.136
		3	4.271	2.598	.110	-1.027	9.569
		4	3.750	2.089	.082	-.510	8.010
		5	3.542	3.357	.300	-3.304	10.387

3	1	2	3.359	2.881	.252	-2.516	9.235
		3	-2.813	2.362	.243	-7.630	2.005
		4	1.016	1.875	.592	-2.807	4.839
		5	6.094*	2.370	.015	1.259	10.928
		6	-2.344	2.616	.377	-7.678	2.991
	2	1	-3.359	2.881	.252	-9.235	2.516
		3	-6.172*	1.684	.001	-9.606	-2.738
		4	-2.344	2.826	.413	-8.108	3.421
		5	2.734	2.852	.345	-3.082	8.550
		6	-5.703	2.811	.051	-11.437	.031
	3	1	2.813	2.362	.243	-2.005	7.630
		2	6.172*	1.684	.001	2.738	9.606
		4	3.828	2.298	.106	-.858	8.514
		5	8.906*	2.281	.000	4.254	13.559
		6	.469	2.263	.837	-4.147	5.084
	4	1	-1.016	1.875	.592	-4.839	2.807
		2	2.344	2.826	.413	-3.421	8.108
		3	-3.828	2.298	.106	-8.514	.858
		5	5.078*	2.022	.017	.954	9.202
		6	-3.359	2.703	.223	-8.871	2.152
	5	1	-6.094*	2.370	.015	-10.928	-1.259
		2	-2.734	2.852	.345	-8.550	3.082
		3	-8.906*	2.281	.000	-13.559	-4.254
		4	-5.078*	2.022	.017	-9.202	-.954
		6	-8.438*	2.721	.004	-13.988	-2.887
	6	1	2.344	2.616	.377	-2.991	7.678
		2	5.703	2.811	.051	-.031	11.437
		3	-.469	2.263	.837	-5.084	4.147
		4	3.359	2.703	.223	-2.152	8.871
		5	8.438*	2.721	.004	2.887	13.988
4	1	2	11.063*	2.972	.001	5.002	17.123
		3	5.938	3.017	.058	-.215	12.090
		4	5.188*	2.326	.033	.444	9.931
		5	8.875*	2.249	.000	4.289	13.461
		6	1.375	2.617	.603	-3.963	6.713
	2	1	-11.063*	2.972	.001	-17.123	-5.002
		3	-5.125*	1.584	.003	-8.355	-1.895
		4	-5.875*	2.703	.037	-11.388	-.362
		5	-2.188	2.448	.379	-7.181	2.806
		6	-9.688*	2.821	.002	-15.442	-3.933
	3	1	-5.938	3.017	.058	-12.090	.215
		2	5.125*	1.584	.003	1.895	8.355

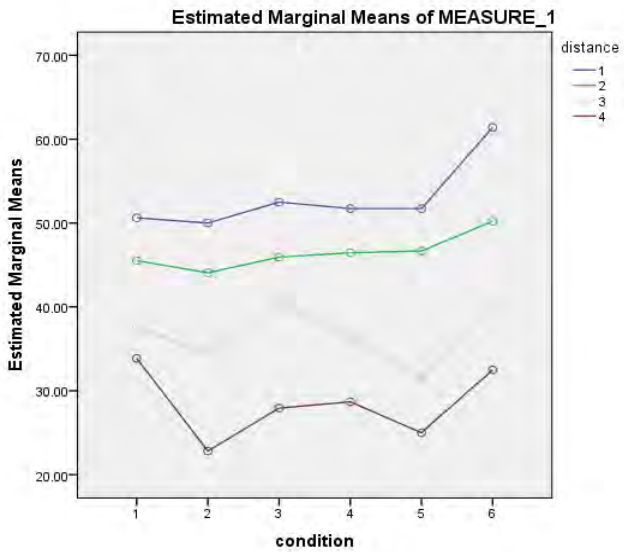
	4	-.750	2.797	.790	-6.454	4.954
	5	2.938	2.902	.319	-2.980	8.855
	6	-4.563	2.847	.119	-10.369	1.244
4	1	-5.188*	2.326	.033	-9.931	-.444
	2	5.875*	2.703	.037	.362	11.388
	3	.750	2.797	.790	-4.954	6.454
	5	3.688	2.148	.096	-.693	8.068
	6	-3.813	2.608	.154	-9.131	1.506
5	1	-8.875*	2.249	.000	-13.461	-4.289
	2	2.188	2.448	.379	-2.806	7.181
	3	-2.938	2.902	.319	-8.855	2.980
	4	-3.688	2.148	.096	-8.068	.693
	6	-7.500*	2.579	.007	-12.761	-2.239
6	1	-1.375	2.617	.603	-6.713	3.963
	2	9.688*	2.821	.002	3.933	15.442
	3	4.563	2.847	.119	-1.244	10.369
	4	3.813	2.608	.154	-1.506	9.131
	5	7.500*	2.579	.007	2.239	12.761

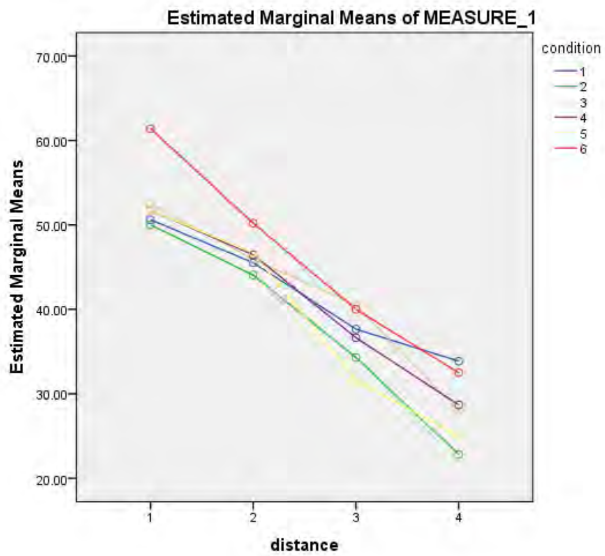
Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Profile Plots





Appendices 12
Baldwin et al., supporting published papers

12.1

i-PERCEPTION
a Pion publication

Comparing artistic and geometrical perspective depictions of space in the visual field

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"The eyes and the visual processes transform the objective world through light stimuli into the *subjective* world of form, spatial relationships and color." (Ogle, 1964, p. 5)

Abstract. What is the best way to depict visual space? Experts argue mathematical perspective is the only accurate method. But artists have pointed out discrepancies between mathematical perspective projections and the way space appears in visual experience, especially when depicting wide angles of view. Mathematical perspective depictions of wide-angle views require uncomfortably close viewing distances or impractical degrees of enlargement, which means they are rarely seen under optimum conditions. In this study we created an artistic rendering of a hemispherical space encompassing the full visual field and compared it to a number of mathematical perspective projections of the same space by asking participants to rate which best matched what they saw. When viewed at a distance rated by participants as comfortable we found the artistic rendering performed significantly better than the mathematically generated projections. But when we repeated the experiment at a closer viewing distance, rated by participants as less comfortable, the mathematical perspective pictures performed better while the artistic rendering did significantly worse. We conclude the artistic rendering better represents the visual field's appearance in pictures to be viewed at more comfortable distances. This undermines the claim that mathematical perspective is the only accurate way to represent visual space.
Keywords: visual field, perspective, art, space perception, wide-angle view

1 Introduction

What is the most accurate way to depict visual space? The normal human visual field extends some 190º laterally and some 125º degrees vertically when the head is still and the eyes are looking ahead (Howard and Rogers, 2012). It is distinct from the 'field of view', which is the region of space visible as the eyes move around in their sockets while the head is still (Pirenne, 1970, p. 35). The visual field is composed from the views of two laterally displaced eyes, which fuse to form an apparently unified image (Ogle, 1964). Most depictions of the visual world in paintings, drawings, photographs, and computer graphics are monocular and represent only a limited section of this visual field (Hagen, 1978). Under certain circumstances, however, it may be desirable or necessary to depict much larger portions of the binocular visual field or field of view. Artists, for example, have tried to represent the expanse of a landscape or cityscape, or the enveloping space of an architectural interior (Herdman, 1835; Hansen, 1973; Flocon & Barre, 1987; Davies, 1992; Gayford, 2007). Designers of head mounted displays and virtual reality systems may also wish to represent the entire visual field to create a more immersive experience (Keller & Colucci, 1998).

Depicting the appearance of the full visual field naturalistically presents a number of challenges. The problems of representing three-dimensional space on a two-dimensional plane have been recognized for many centuries (Alberti, 1991; Kemp, 1990). The traditional method of achieving this, linear or mathematical perspective, is impractical when very wide angles of view need to be represented because the correct viewing position, the centre of perspective (Kingslake, 1992) or centre of projection (Kubovy, 1986), is usually too close to the picture surface for comfort. For example, to represent a horizontal visual field of 164º using a camera with a standard 36 mm full frame sensor and rectilinear lens would require the lens to have a focal length of 2.5 mm, which is impractically short in most circumstances (rectilinear visual field = 2 * arctan (frame size/(focal length * 2)). Blowing the image up to, say, 1000 mm in width puts the centre of perspective, and therefore the correct viewing distance, at just 69 mm from the picture surface (viewing distance = focal length of lens * (width of picture/width of sensor)). This is much less than the 250 mm normally given as the 'least distance of distinct vision' (LDDV) for an adult (Woo and Mah-Leung, 2001), a distance that increases with age (Lockhart and Shi, 2010). Viewed from a greater, more comfortable, distance perspective 'distortion' will become apparent (Kingslake, 1992). By enlarging the picture the viewing distance can be increased, but there are obvious practical limitations. The problem becomes more acute the wider the angle of view depicted. To create an image with a visual angle of 179.4º on the same camera would require a lens with an improbable focal length of 0.1 mm.

Alternatives to rectilinear camera lenses are available for capturing wide angles of view. Fisheye lenses, for example, can span up to 180º but introduce 'barrel distortion', which can look highly unnatural unless the picture is viewed at very close quarters (Ying et al., 2006). Stereographic projection has been proposed as a superior alternative to the fisheye perspective since it preserves the shape of depicted objects more faithfully (Fleck, 1994). Panoramic methods can also be used to capture wide visual fields, and are normally constructed by stitching together multiple shots. But they typically result in very tall or wide image formats, and this can make them undesirable in many situations (Shum & Szeliski, 2000). There are a number of other projections that can be used to represent wide angles of view, many of which were developed for cartography and astronomy where spherical spaces need to be mapped onto two-dimensional planes, among them Mercator, Panini, Sinusoidal, and Equisolid. Each projection will distort and preserve different aspects of the space being depicted and so each has its advantages and disadvantages depending on the application and which spatial properties the user wishes to preserve (Sharpless et al., 2010).

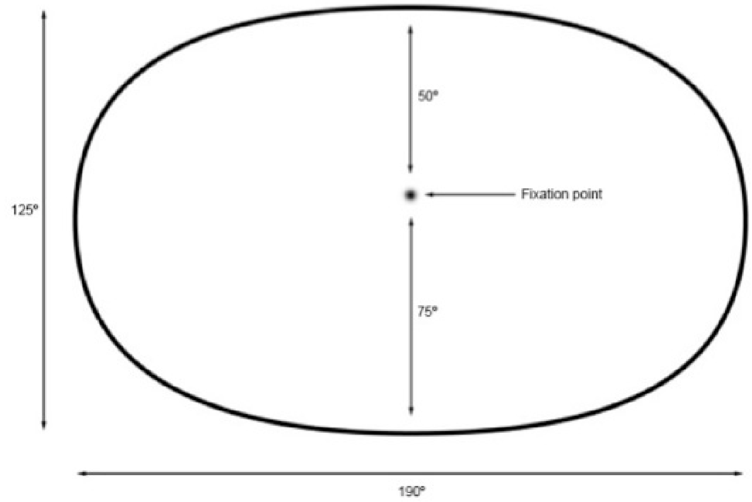

Fig. 1. Elliptical picture space approximating the shape of the binocular visual field, represented as a cyclopean image that fuses the area visible to both eyes when looking ahead at the fixation point. In theory this field extends some 190º horizontally and 125º vertically. The fixation point is located some 75º above the base and 50º below the top of the field, which reflects the physiology of the human eye and face.

The purpose of our research is to find a method of depicting the appearance of the full binocular visual field in a way that appears naturalistic when the resulting pictures are seen from normal viewing distances. We have developed a method of observing and recording the subjective appearance of the visual field through painting and drawing (Pepperell, 2012; Pepperell & Haertel, 2014). We begin by defining an elliptical picture space that approximates the shape and dimensions of the human visual field (Fig. 1). There is some variation between individuals in the perceived extent of the visual field (Koenderink et al., 2008) and different authorities give different values, but for the purposes of this study we take its extent to be approximately 190º laterally and 125º vertically (Howard & Rogers, 2012) and for it to be cyclopean in structure, that is, composed of the fused view of both eyes (Ogle, 1964). An elliptical boundary for the picture space is used as it closer to the perceived shape of the visual field than the conventionally used rectangle (Gibson, 1950).

A fixation point is chosen in the scene and the equivalent point is plotted in the picture space, this normally being located slightly above the horizontal centre, which reflects the fact that the human eye sees more in the lower part of the visual field than the upper (Howard & Rogers, 2012). The perceived contents of the visual field are then mapped onto the picture space such that its boundaries coincide as closely as possible with the boundary of the picture space. To distribute the contents of the visual field across the picture in a way that corresponds to the appearance of the scene the following principles are used: the area of the scene being viewed in central or foveal vision is enlarged compared to how it would appear in an equivalent linear perspective projection and the area seen in peripheral vision is compressed. Similar compositional principles have been employed by artists such John Constable, Vincent van Gogh, and Paul Cézanne when depicting visual space (Pepperell & Haertel, 2014). The degree of enlargement and compression applied in each case is a matter of judgment and depends on a number of factors, including the size of objects being depicted, their proximity to the viewing station, and the distance between the artist and the depiction as it is being made.

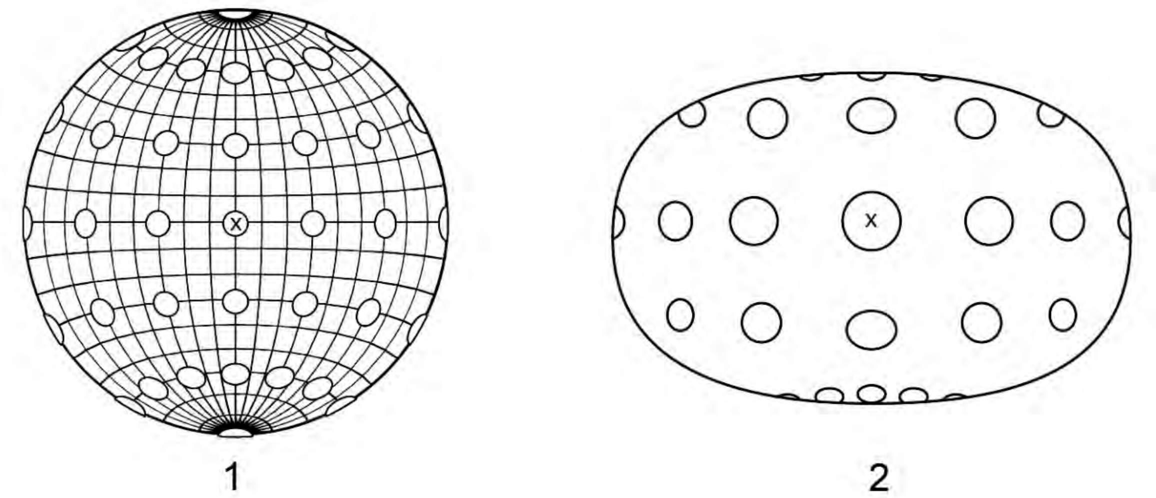

Fig. 2. Diagram comparing a fisheye perspective and artistic depiction of a three-dimensional space composed of evenly spaced discs.

Fig. 2 illustrates the difference between a fisheye lens and artistic depiction of a physical space. Fig. 2.1 shows a diagram of a hemispherical three-dimensional space composed of evenly spaced discs based on a photograph taken using an 8 mm fisheye lens mounted on a full frame (36 mm) DSLR. The camera is pointing directly at the disc marked X, the front of the lens at a distance equivalent to the radius of the hemisphere, and capturing a 180º angle of view both horizontally and vertically. Fig. 2.2 is a drawing of the appearance of the scene, viewed from the same position as the camera's sensor with both eyes while fixating on the marked disc. The elliptical boundary denotes the extent of the visual field. The drawing was made digitally on a computer monitor of 500 mm width at a distance of approximately 600 mm.

2 Experiments

In this study we presented participants with a three-dimensional scene that encompassed their binocular visual field. We then showed them a series of depictions of the scene, including one created according to the method described above, and asked them to rate each one in terms of how closely it matched the way the space appeared to them. We hypothesized the artistic projection would be judged the most accurate depiction of the visual space when viewed at the same station point as the artist who created it.

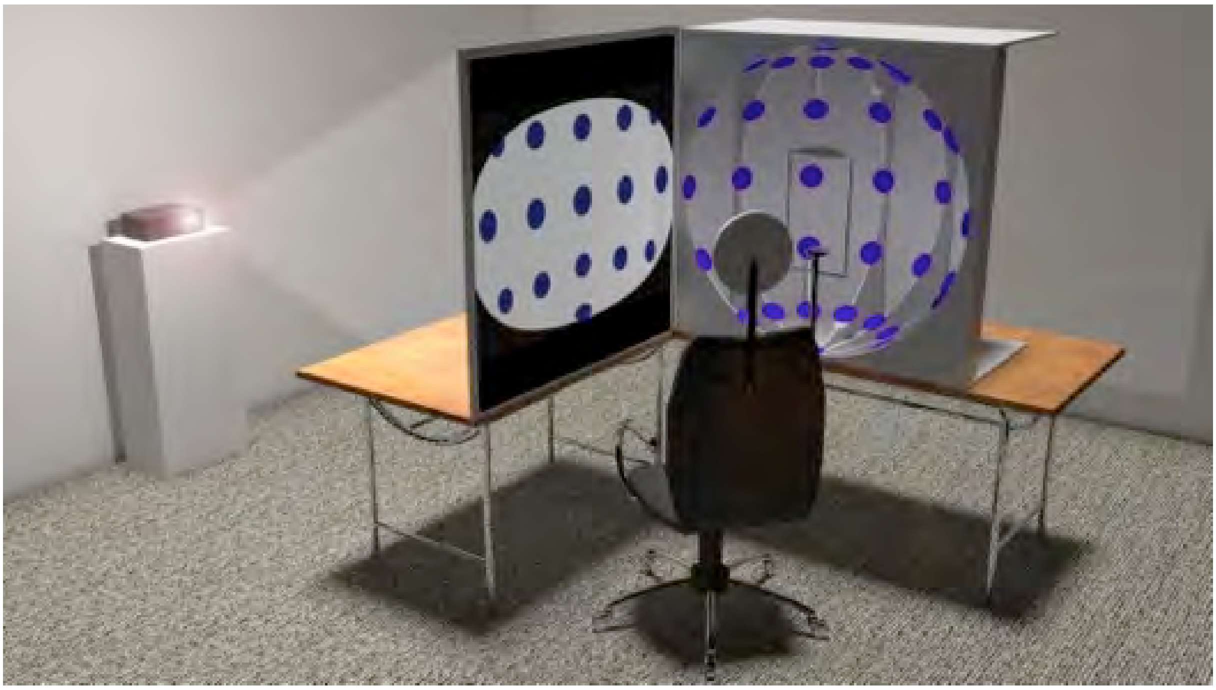

Fig. 3. Illustration of the apparatus used in this study. On the right table is the hemispherical dome and on the left is the rear projection screen on which the stimuli were shown. During the study the front of the dome was covered with an opaque screen to obscure the view of the discs until the participants placed their head in the correct position on the chin rest through an aperture. The head restraint on the chair ensured the participants' heads were in the correct position when looking at the screen (illustration by Alistair Burleigh).

2.1 Apparatus

The apparatus consisted of two components: A hemispherical dome of 900 mm diameter was placed on a table. Inside the dome were a number of blue discs, each 75 mm in diameter. The discs were arranged such that each vertical row was separated by 30º of longitude and each horizontal row was separated by 30º of latitude. A chinrest and a forehead restraint were mounted in the dome such that a viewer placed in the apparatus had an eye-line view directly opposite the central disc (Fig. 3). The centre point between the participants' eyes was located equidistantly from all the discs, i.e. 450mm. In this position the binocular visual field of a person with normal vision was fully encompassed by the apparatus (Fig. 4). The front of the dome was covered with fabric that obscured the view of the inside of the dome until the participant placed his or her head through an aperture.

Placed next to the dome at 90º was a rear projection screen of the same width as the dome. A data projector mounted behind this screen was able to project stimuli of the same diameter as the dome. The projector was positioned and the keystone adjusted to ensure the projected image was completely central and straight. The participants were seated on a revolving chair that allowed them to swap between the viewing position in the dome and the viewing position of the screen. When looking at the screen, a head restraint and chair restraint ensured the participants' eyes were located the same distance from the screen as they were from the discs in the dome, i.e. 450 mm. The light levels in between the dome and the screen were equalized.

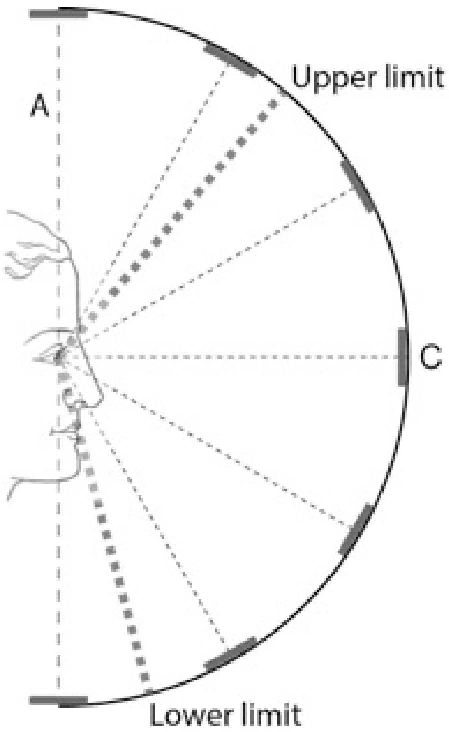

Fig. 4. An illustration of the position of the participant in the dome apparatus, shown in side-view cross-section. The eyes are line with the central disc, labeled C. The dotted line labeled A shows the position of a fabric screen that obscured the view of the discs prior to the participant being properly positioned in the apparatus. The upper and lower limits of the visual field are indicated, upper being 50º above the horizontal centre and lower being 75º below. The eyes of the participant are located 450 mm from the central disc.

2.2 Stimuli

The stimuli consisted of five images presented in Microsoft Powerpoint on the rear projection screen with a width of 900 mm, matching that of the dome, each depicting the same visual space using a different form of projection. Four of these were mathematically generated representations based on projective geometry and one was an artistic rendering created according to the method described above. Each image was framed in the elliptical boundary that approximates the shape and dimensions of the human visual field shown in Fig. 1, and cropped according to its upper and lower limits, as shown in Fig. 4. The mathematical stimuli were generated digitally as it was not possible to mount a physical camera at exactly the same station point as the participants and capture the full span of the space due to the bulk of the camera body and lens. We used the 3D software Blender to model the hemispherical space and rendered out a number of projections using a virtual camera positioned at the same station point as the participants were located in relation to the apparatus. The forms of depiction used were as follows (Fig. 5):

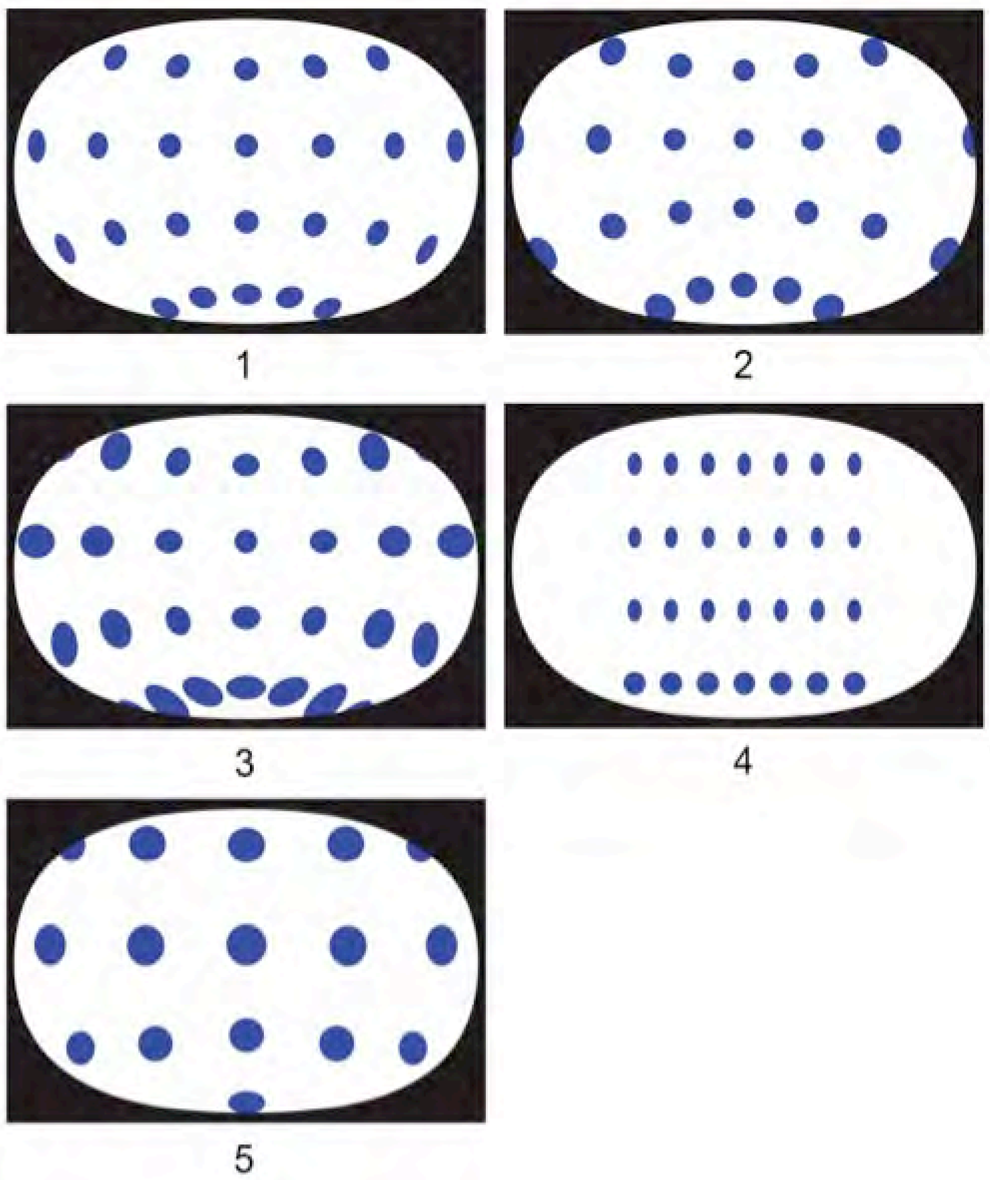

Fig. 5. Stimuli used in experiments: 1. Fisheye; 2. Stereographic; 3. Cyclopean; 4. Equirectangular; 5. Artistic.

Fig. 5.1 Stimulus 1 is a monocular fisheye perspective projection of the scene, generated by a virtual 8mm fisheye lens located at a point directly in line with the central disc, at the mid-point between the eyes, and at the same distance from the central disc as the participants in the apparatus. Fisheye perspective projection is a common method of capturing very wide visual fields, i.e. >90º (Kingslake, 1992; Fleck, 1994), in this case representing a view 190º wide.
Fig. 5.2 Stimulus 2 is a monocular stereographic projection of the scene, generated using a virtual model of the dome in Blender and the geometric manipulation software PTGui. Fleck (1994) argued stereographic projection better preserves the shape and size of objects than fisheye perspective projections and so is a preferable method of representing wide angles of view. Note that the peripheral discs are less squashed in this projection than in the fisheye perspective version.
Fig. 5.3 Stimulus 3 is a cyclopean projection of the scene generated by combining two 8mm fisheye renderings taken with virtual cameras located at the same points occupied by the participant's two eyes in the apparatus, converging on the central disc, and overlaid to form a cyclopean image which is the sum of the two views (Howard and Rogers, 2012). The purpose of using this projection was to simulate the binocular visual field although due to the complexities of binocular vision (Ogle, 1964) this can only be an approximate representation.

Fig. 5.4 Stimulus 4 is a computer-generated equirectangular 360º projection of the same scene, which is obviously perceptually inaccurate. It was included in the study as a distractor stimulus to detect whether participants were effectively discriminating between the different projections and to make it harder for them to guess the ‘correct’ projection. We anticipated this would be given a low accuracy rating.
Fig. 5.5 Stimulus 5 is an artistic rendering of the scene created by observing its appearance when fixating with both eyes on the central disc in the dome. It was drawn in Adobe Illustrator on the rear projection screen while the screen was viewed at the same distance (450 mm) as the central disc was from the eye and while the image was projected at the same horizontal size as the dome (900 mm). Like stimulus 3, this is a cyclopean rendering that approximates the fused view of the scene produced by binocular vision.

The mathematically generated stimuli used in this study are a subset of the many possible projections of three-dimensional space. But in order to keep the experimental procedure manageable we limited the stimuli to five, which included two widely used methods of representing wide angles of view: fisheye perspective and stereographic (Fleck, 1994). Two other possible methods of representing the space were not used. As noted above, rectilinear perspective projections appear excessively distorted when used to represent very wide angles of view, as they require impractically close viewing distances. Panoramic images generate elongated aspect ratios, which would not have fitted within the elliptical picture space used for the rest of the stimuli (Kingslake, 1992).

2.3 Experimental procedure

First the participants completed a questionnaire to determine gender, age (within a decade banding), the condition of their vision, handedness, and how comfortable they found viewing the screen. Viewing comfort was measured on a five-point scale between 1 (very uncomfortable) and 5 (very comfortable) when they were seated in the experimental position located 450 mm from the screen. They were then given the following instructions about the task:

Look into the apparatus, keeping your head still, and focus on the center disk for 30 seconds without looking around.

While you are focusing on the central disc, make a note of how the whole space appears to you, and try to remember it.

If glasses were worn the participants were asked to remove them; we did not want the rims to obscure their peripheral visual field when looking in the dome. They then adopted the viewing position and studied the dome from the specified distance, the opaque screen having prevented them forming a visual impression of the scene from any other distance. Having completed this part of the task after 30 seconds participants were brought out of the apparatus and given further instructions:

You will now be shown 5 images projected on the screen. Before you look at each image you can look into the space for 10 seconds to refresh your memory of how it appears.

View each image and rate how closely it matches the way the space appears to you. Use the scale 1 (very low) to 5 (very high).

Each person looked into the space for a further 10 seconds, and then returned to the seated position in front of the screen. The experimenter ensured the correct position was adopted. They then freely viewed one of the five stimuli and rated how closely it matched their visual impression of the physical space on a five-point scale. The rating was recorded and they moved on to the next image in the sequence. A repeated measures design was used in which the stimuli were shown in two different orders such that half the participants saw order 1 and the other order 2. Once they had completed the cycle, the participants were then offered the opportunity to go back and adjust their ratings. Most took this opportunity and altered one or more of the ratings. They were given as long as they needed to do this, and had the option of looking into the space again if necessary. We wanted to ensure participants were satisfied their ratings had been accurately recorded. Using this general procedure we carried out three experiments. Participants were volunteers and were given no prior indication of the purpose of the experiment, no financial reward was offered, and all gave informed consent.

2.4 Experiment 1

In the first experiment we recorded the responses of 14 participants, 11 female and 3 male. The mean age band was 20-29, 4 needed vision correction, and all were right-handed.

2.5 Results and discussion

A one way-within subjects ANOVA was conducted on the ratings of how closely each participant matched their visual impression of the space in the dome to the stimuli. We found a statistically significant effect between ratings of the stimuli accounting for a large portion of the variance: $F(4,52) = 17.962$, $P < 0.05$, partial $n^2 = .58$. We then conducted a Bonferroni post-hoc test that revealed a preference ($p < .05$) for stimulus 5 (artistic) over stimulus 2 (stereographic), stimulus 3 (cyclopean) and stimulus 4 (equirectangular). Stimulus 5 (artistic) was preferred to stimulus 1 (fisheye) but the margin was not significant ($p = .095$). As expected, stimulus 4 (equirectangular) was rated poorly. A one-way between subjects ANOVA was conducted on the influence of participants' gender, vision condition, age bracket, handedness and stimuli viewing order on the ratings of the stimuli. This revealed no statistically significant effects ($p > .05$). The mean rating for comfort of viewing the screen at 450 mm was 4.0. This experiment revealed a strong preference for stimulus 5 (artistic) as the most accurate depiction of the visual space.
During the experiment two participants reported seeing an after image following their initial 30 second exposure to the dome, although they did not report this during the shorter exposure times in the comparison stage, nor did they report using the after image to guide their ratings of the stimuli. However, we wanted to eliminate the possibility that participants were, consciously or unconsciously, using the after image to judge the depicted disc size.

2.6 Experiment 2

To minimize the potential influence of after images we replaced the central blue disc with a light grey one, and adjusted the stimuli accordingly. Here the chroma and luminance contrast between the disc and the background was much lower, and in pilot tests we found the grey disc induced a weak, blurry after image that faded more rapidly and was almost entirely invisible when looking at the projection screen. Using this modified apparatus we reran Experiment 1 with 14 different participants, 10 female and 4 male. The mean age band was 30-39, 8 needed vision correction, 12 were right-handed and 2 left-handed.

2.7 Results and discussion

A one way-within subjects ANOVA was conducted on the ratings of the stimuli. Again this showed a statistically significant effect accounting for a large portion of the variance: $F(4,52) = 28.566$, $P < .05$, partial $n^2 = .69$. A Bonferroni post-hoc test showed a significant preference ($p < .05$) for stimulus 5 (artistic) over stimulus 2 (stereographic), stimulus 3 (cyclopean) and stimulus 4 (equirectangular). Stimulus 5 (artistic) was preferred to stimulus 1 (fisheye) but not by a significant margin ($p = .055$).

Stimulus 4 was again rated poorly. A one-way between subjects ANOVA was conducted on the influence of participants' gender, age bracket, handedness and stimuli viewing order on the ratings of the stimuli. This revealed no statistically significant effects ($p > .05$) apart from an effect of vision condition, with participants who normally wear glasses giving lower ratings to stimuli 1 (fisheye) (F

(1, 12) = 9.288, $p < .05$) and 3 (cyclopean) (F (1, 12) = 12.025, $p < .05$) than those who did not need vision correction. The mean rating for comfort of viewing the screen was 4.0.

In order to establish whether there was any differential effect between the grey, and blue disc condition we carried out an independent t-test. This showed that while the mean value for each stimulus in the blue condition was slightly higher than in the grey condition there was no statistically significant difference between the two (Fig. 6).

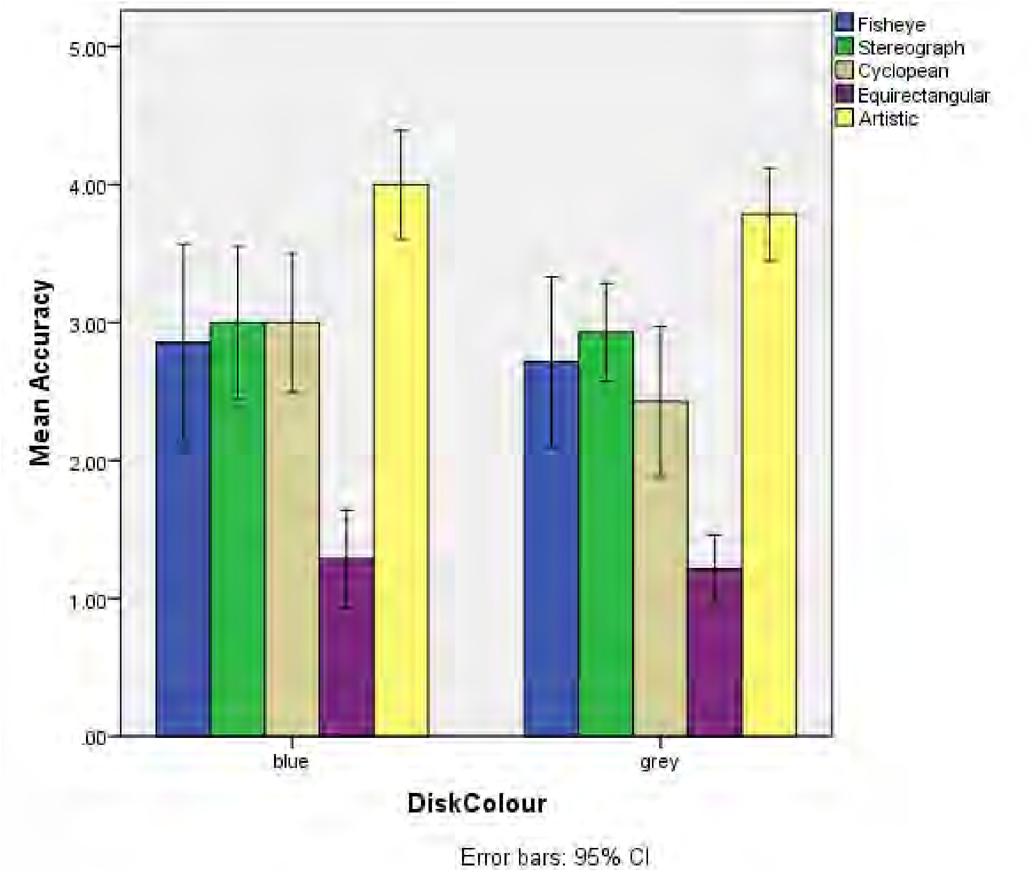

Fig. 6. Graph showing the mean accuracy ratings of each stimulus in the blue and grey disc conditions.

By combining the data from both the blue and grey disc conditions so that the number of participants was 28 we found a large variance: F (4, 108) = 43.913, $p < .05$, partial n2 = .62. A Bonferroni post-hoc test showed a significant preference ($p < .05$) for stimulus 5 (artistic) compared to all the other stimuli (Fig. 7).

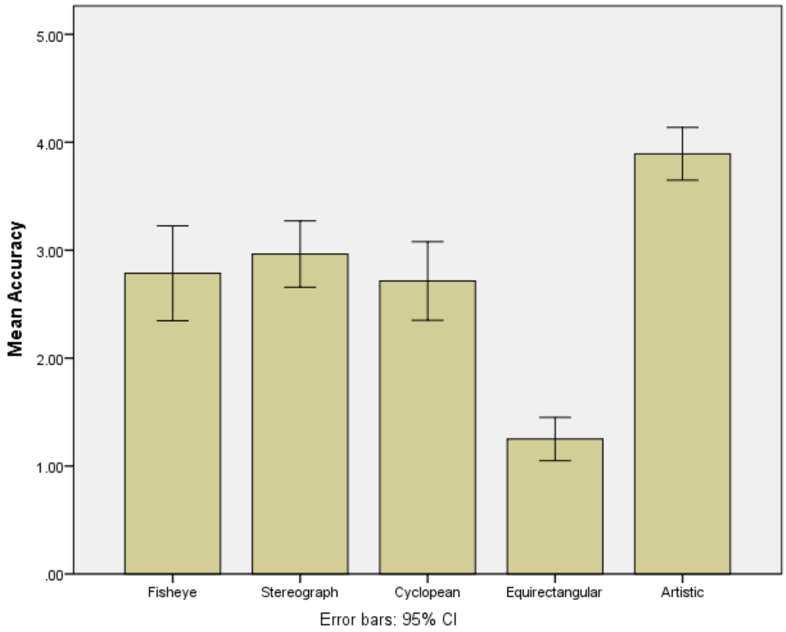

Fig. 7. Graph showing the mean accuracy ratings for the combined set of results from Experiments 1 and 2.

These results show the artistic rendering of the visual space was judged the most accurate depiction by a significant margin. None of the other factors considered, including age, viewing order, disc colour, condition of vision, handedness and gender, seems to have influenced the results. The only exception was the lower ratings given to the fisheye (1) and the cyclopean (3) stimuli by people who needed vision correction in Experiment 2. As we did not record any further detail about their vision, such as whether they were long or short sighted, we are unable at this stage to attribute this result to any particular condition.

It could be argued that Experiments 1 and 2 didn't treat the mathematically generated stimuli fairly because they weren't viewed at their correct centre of perspective, while the artistic stimulus was viewed from the same distance at which it was created. In the case of stimuli 1, 2, and 3 the correct viewing distance was 200 mm, based on the fact they were taken with a virtual lens of 8 mm focal length on a virtual camera with a sensor size of 36 mm and projected at 900 mm in width (viewing distance = focal length of lens * (width of picture/width of sensor)). Being viewed at 450 mm could have accounted for their relatively low ratings compared to the artistic rendering in stimulus 5.

2.8 Experiment 3

To minimize the potential influence of after images we replaced the central blue disc with a light grey one, and adjusted the stimuli accordingly. Here the chroma and luminance contrast between the disc and the background was much lower, and in pilot tests we found the grey disc induced a weak, blurry after image that faded more rapidly and was almost entirely invisible when looking at the projection screen. Using this modified apparatus we reran Experiment 1 with 14 different participants, 10 female and 4 male. The mean age band was 30-39, 8 needed vision correction, 12 were right-handed and 2 left-handed.

2.9 Results and discussion

A one way-within subjects ANOVA was conducted on the ratings of the stimuli. We found a statistically significant effect between ratings of the stimuli accounting for a large portion of the variance: $F(4,52) = 26.120$, $P < 0.05$, partial $n^2 = .668$. A Bonferroni post-hoc test that revealed stimulus 5 (artistic) was rated significantly lower than stimulus 1 (fisheye), stimulus 2 (stereographic), and stimulus 3 (cyclopean) ($p < .05$). Stimulus 5 performed slightly better than stimulus 4 (equirectangular), but the margin was not significant (Fig. 8). A one-way between subjects ANOVA was conducted on the influence of participants' gender, vision condition, age bracket, handedness and stimuli viewing order on the ratings of the stimuli. This revealed no statistically significant effects ($p > .05$). The mean rating for comfort of viewing the screen at 200 mm was 2.57. This experiment revealed a strong preference for stimuli 1, 2, and 3 as being the most accurate depictions of the visual space.

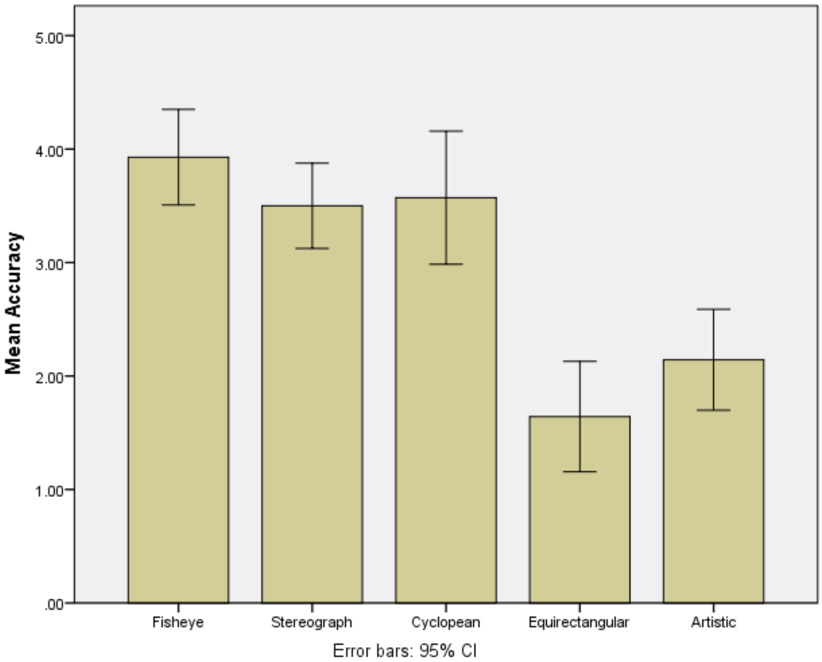

Fig. 8. Graph showing the mean accuracy ratings for each stimulus when viewed at the 200 mm distance.

When we compared the comfort ratings in the grey disc 450 mm viewing condition in Experiment 2 (mean = 4) to the comfort ratings in Experiment 3 (mean = 2.57) using an independent t-test we found the difference was statistically significant ($t = -3.982$, $df = 21.002$, $p < .05$, one tailed) (Fig. 9). The magnitude of the difference of the means (mean difference = 1.4286, 95% CI: -2.17471 to - .68244) was small to medium (Fig. 9).

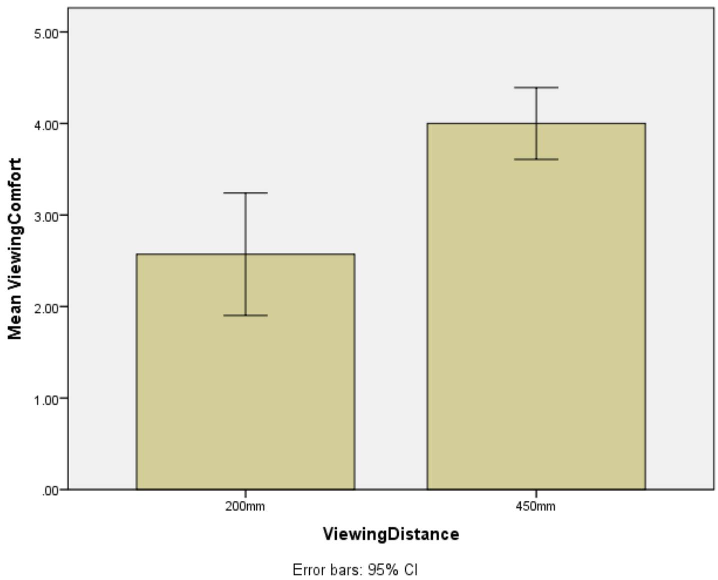

Fig. 9. Graph showing the mean ratings for comfort in the 200 mm viewing condition versus the 450 mm viewing condition.

Comparing the results for stimulus 1 (fisheye), 2 (stereograph) and 3 (cyclopean) in the 200 mm grey disc condition to the 450 mm grey disc condition we found their ratings increased by a significant margin (Stimuli 1 mean difference = 1.21429; Stimulus 2 mean difference = 0.57143; Stimulus 3 mean difference = 1.14286). Stimulus 4 (equirectangular) showed no significant change, while the fall in rating for stimulus 5 (artistic) was also significant (mean difference = -1.64286). The stereograph projection in stimulus 2 was not rated as significantly more accurate than the fisheye perspective projection in stimulus 1. Our study, therefore, does not support the claim made by Fleck (1994) that stereographic projections are superior to fisheye projections in terms of representational accuracy, at least when viewed at the same distance. Finally, it is interesting to note that stimulus 3 (cyclopean) performed very similarly to the other mathematical projections (stimuli 1 and 2) even though it is not a standard form of perspective projection.

3 General discussion

In this study we have shown that an artistic representation of a three-dimensional space encompassing the binocular visual field, viewed from a more comfortable distance, represents the subjective appearance of that space with greater accuracy than a set of mathematically generated projections. We took into account a number of factors that could have affected the results, including age, gender, condition of vision, handedness, presence of after images, order of presentation, and found that none of these had a significant influence, with one exception noted above in Experiment 2. We also found that viewing the mathematically generated projections at closer distances matching the correct centre of perspective greatly improved their ratings, and led to the rating of the artistic version falling significantly. However, participants reported this closer viewing distance as being less comfortable. Our study supports the claims made elsewhere (e.g. Malton, 1775; MacCurdy, 1954; Pirenne, 1970; Kubovy, 1986; Kingsland, 1992; Tyler, in press) that viewing distance is a critical factor in determining the perceived fidelity of representations of visual space.

The change in comfort rating between the two viewing conditions may have been due to a number of factors. The farther viewing distance, 450 mm, lies well beyond the ‘least distance of distinct vision’ of 250 mm (Woo and Mah-Leung, 2001), that is, the minimum gap between eye and object at which focus can be maintained, and so is unlikely to have caused the participants any strain with accommodation. The closer viewing distance of 200 mm falls inside that threshold and may have made focusing harder, especially for older participants, although we found no statistically significant effect of age to confirm this. However, it is also important to take the size of our projection screen into account, which was relatively large given the viewing distance. A study of people viewing large screens, including up to 1200 mm, showed significant changes in body position, neck angle and eye position correlating to the size of the screen (Villanueva et al., 1996). While we controlled for body posture and neck position (both were identical at each viewing distance) it may be the fall in comfort rating reflected a change in eye behavior at the closer distance, perhaps larger shifts in gaze were needed to scan the whole screen. The size of the screen may also explain the fact that the 450 mm viewing condition was not given the highest possible mean comfort rating. Television and home cinema system manufacturers provide varying guidance as to the optimum distance for watching their large screens. For example, Toshiba recommend viewing a 40-inch screen (approximately 1000 mm) at a distance of between 4 and 6.3 feet (1220-1940 mm), which is proportionately greater than the farthest viewing distance used in our study (Toshiba, 2014).

Given that the central disc in stimulus 5 was larger than in any of the other stimuli yet was judged the most accurate depiction at the farther distance In a previous paper it was suggested one of the reasons artists may have enlarged the fixation area and compressed the periphery in their paintings and drawings is that it reflects a general subjective curvature or bulging of visual space (Pepperell & Haertel, 2014; see also Helmholtz’s (1909) study of the distorted checkerboard effect). The present study provides further support for that suggestion, and helps explain why the mathematical perspective pictures better represented the participants’ visual experience when viewed at their correct centre of perspective. If this magnification-compression effect occurs when viewers look in the hemispherical space then it will also occur when viewing the mathematical perspective picture at close range, in which case the perceived sizes of the central discs will appear more alike while the peripheral discs, where most ‘distortion’ is evident when view from afar, will be more compressed and less distinct. Our results here are consistent with this interpretation, which also helps to explain why the artistically rendered stimulus was rated so much lower in the close viewing condition; the magnification-compression effect was being duplicated and therefore over-exaggerated — a case of the ‘El Greco Fallacy’ (Firestone, 2013).

Many experts have claimed linear perspective is the *only* correct way to represent the three-dimensional visual world on a two-dimensional plane as it is based on laws of geometry and the behavior of light (e.g. Gombrich, 1960; Pirenne, 1970; Gibson, 1971; Ward, 1976; Rehkämper, 2003). The job of mathematical perspective, they argue, is not to record how we see a given scene but to present the eye with the same pattern of light that would emanate from the scene. If done correctly the visual system would not be able to tell the difference between the picture and the world it represents. But the technical problems of achieving this in a way that accommodates the full binocular visual field are considerable, and perhaps insurmountable. Linear perspective is only practical if the task is to depict a relatively narrow angle of view seen by one eye. The artistic method of depicting the full binocular visual field studied here is as accurate when viewed from the farther distance as the mathematical projections are when viewed from closer. This means linear perspective is not the only way to accurately represent visual space on a flat plane. Moreover, the artistic projection has the advantage that it can be viewed at a more comfortable distance.

In practice, artists have rarely applied the laws of linear perspective rigorously, not necessarily out of ignorance but because they lead to unacceptable deviations from perceptual norms, as for example when spheres outside the central line of view are rendered as ellipses (Pirenne, 1970; Kubovy, 1986; Kemp, 1990). As a consequence artists have either modified their geometry ad hoc to suit the demands of the composition or developed alternative systems of curvilinear or nonlinear perspective that they claim better represent the appearance of the visual world (Parsey, 1836; Herdman, 1853; Hansen, 1973; Flocon & Barre, 1988; see also Rauschenbach, 1982 on Cézanne and Sharpless et al., 2010 on the painter Panini). Faced with the task of fitting a given slice of the visual world into a fixed picture area in a way that convincingly conveys the impression of that space when viewed from a reasonable distance artists have intuitively recorded the what Ogle called “the *subjective* world of form, spatial relationships and color.” subjective structure of vision rather than its objective optical structure. Our approach to depicting visual space continues this tradition

This investigation of methods of representing visual space is a preliminary and prompts a number of further questions yet to be explored. It would be interesting, for example, to modify the current experiments so that participants are prevented from looking anywhere other than the central disc in the dome and stimuli, perhaps by using eye tracking-linked switches to blank the view if fixation strayed. We had to trust that participants would comply with the instruction to look only at the central disc. But it is likely they glanced elsewhere, and this may have influenced their recall of the layout of the space. It would also be useful to investigate what effect greater viewing distances would have on the ratings of comfort and accuracy, how other forms of mathematical projection than the ones used here might compare, and the difference monocular viewing conditions might make. And, finally, we do not yet know whether drawings of the appearance of the visual field made by other people with sufficient skill and training would yield the same layout as that used in this study. Some provisional tests we have conducted suggest they would, but this is yet to be formally tested. The answers to these questions may have implications for those interested in the structure of visual space and for anyone wishing to generate naturalistic depictions of the full visual field.

4 Conclusion

Our study showed the artistic depiction most accurately matched the visual experience of the space in the dome when viewed at the more comfortable distance. Mathematical projections, on the other hand, performed better at the closer viewing distance but were judged less comfortable to look at. These results undermine the claim that mathematical perspective is the only accurate way to depict visual space. To depict visual space optimally a balance must be struck between the type of projection used, the angle of view to be depicted, and the size and viewing distance of the picture.

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The perceived size and shape of objects in peripheral vision

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Abstract It remains unclear how peripheral vision affects the perceived size and shape of objects. Some authors report objects appear larger in the periphery, some report they appear smaller, and some report size varies considerably. Observations made during an artistic study of visual space led us to hypothesise that objects seen in the visual periphery can appear smaller and more compressed than to those seen in central vision. To test this we conducted three experiments. In the first experiment participants were asked to draw the appearance of a set of discs presented in the visual periphery without constraints on eye movement or exposure time. In the second, participants were asked to match the size of briefly presented peripheral discs to a centrally viewed reference disc, but were unable to look at the peripheral stimulus. In the third experiment participants were asked to report the perceived shape of objects presented briefly in the periphery, also without looking at them directly. In the first experiment the peripheral discs were reported as appearing significantly smaller than the central disc, and as having an elliptical and polygonal shape. In the second experiment participants judged the size of peripheral discs as being significantly smaller when compared to a centrally viewed disc across most of the near periphery, and in the third experiment participants were quite accurate in reporting the peripheral object shape, except in the far periphery. These results suggest objects in the visual periphery appear diminished when presented for long and brief exposures but only undergo shape distortions when presented for longer times.

Keywords: Peripheral vision, size perception, shape perception, visual space, art, attention.

1 Introduction

Visual space is the subjective appearance of physical space (Hershenson, 1999). It can be distinguished from the total visual field, which is the entire region of the world visible to both eyes during any one fixation (Gibson, 1950; Howard & Rogers, 1995). There is widespread agreement that visual space does not correspond faithfully to physical space (Foley et al. 2004; Hatfield, 2003; Indow, 2004; Koenderink & van Doorn, 2008; Ogle, 1964; Wagner, 2006). But the precise ways in which physical space, the visual field and visual space interact are still not fully understood.

This study addresses the structure of visual space, and in particular the perceived size and shape of objects when viewed in the peripheral visual field. Intuitively we might suppose that a disc viewed directly would appear just as big and just as circular when perceived in the periphery. But several studies report conflicting results (Helmholtz, 1865; James, 1890; Stevens, 1908; Zigler et al., 1930; Collier, 1931; Grindley, 1931; Newsome, 1972; Drum, 1977; Schneider et al, 1978; Thompson & Fowler, 1980; Bedell & Johnson, 1984). In an early case, Stevens (1908) found that discs viewed peripherally appeared larger than when viewed in the central region. However, Newsome (1972) obtained the opposite result when he asked participants to adjust the size of a stimulus viewed in the periphery by moving it closer or farther away until it matched that of a reference stimulus viewed centrally. He concluded that objects observed peripherally appear smaller than they do centrally, an effect that increases with eccentricity. Schneider et al. (1978) also reported a diminution of perceived object size in the periphery, but observed the effect along both horizontal and vertical axes of the visual field. Thompson and Fowler (1980) obtained similar results. Bedell & Johnson (1984) found that luminance could alter perceived size of objects in the periphery, with more brighly lit objects tending to be overestimated in size and dimly lit ones underestimated.

A number of studies have investigated the effects of attention on perceived object size in the periphery, with mixed results. In contrast to most of the studies cited above, Tsal and Shalev (1996) found that diverting attention away from a line substantially increased its perceived length, and this was accentuated when the stimuli were seen peripherally. Prinzmetal and Wilson (1997) tried to replicate the effect reported by Tsal and Shalev, but found no evidence that attention shortened the perceived length of the lines. Rather, they reported a slight tendency in the opposite direction. Masin (1999) initially replicated the effect reported by Tsal and Shalev. But further analysis revealed it was unreliable and a second experiment found different participants reported significant amounts of both enlargement and diminution. In a later study designed to control factors that could have confounded previous results Masin (2003) reported that directing attention to a peripheral line increases its perceived size, but was cautious about drawing definitive conclusions due to large variations in the results. He later attributed the varying results of previous studies to the uncertainty of participants' estimates about the size peripheral attended lines (Masin, 2008). He argued there was a greater probability that participants in such experiments were guessing rather than make confident judgments. Consequently, the role attention plays in determining the perceived size of peripheral objects remains unclear. There is, however, more general agreement that attention can alter the appearance of peripheral stimuli in other ways (Carrasco et al. 2004), and that it can expand or warp visual space (Anton-Erxleben et al., 2007; Desimone, 1990; Fortenbaugh et al. 2011; Ono & Watanabe, 2001; Suzuki and Cavanagh, 1997; Wardack et al. 2011; Vickery & Chun, 1994).

Questions about how objects are perceived across the visual field are also important to artists wishing to depict what they see. Artists have long been aware that the appearance of objects changes depending on where and how they are viewed (Du Fresnoy, 1765). The engraver and art critic Roger de Piles noted in his Principles of Painting that "Bodies decrease in both force and colour in proportion as they recede from the straight line, which is the centre of vision" (de Piles, 1708, p. 67). De Piles argued that paintings achieve compositional unity when the pictorial space is organised around a single point of focus. He illustrated this principle in the engraving shown in Figure 1. The balls receding into the distance and into the periphery become increasingly diminished in size and contrast compared to the central one.

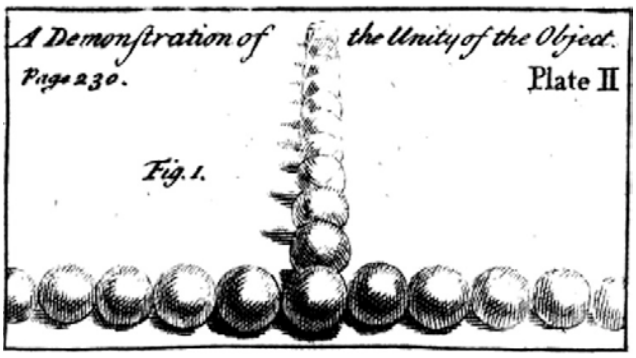

Figure 1 An illustration of the perceived diminution of objects in peripheral vision, taken from an eighteenth century artists' textbook (De Piles, 1708). Note the diminution of the balls in the left and right periphery, which increases with eccentricity.

Several of our own observations about the structure of visual space correspond to the suggestions of de Piles, and some of the psychological literature cited above. The first observation was made during a project in which the aim was to make paintings and drawings that captured the full scope of visual experience associated with a given fixation point in space, including the entire peripheral field (Pepperell, 2012). These depictions differed in a significant and consistent way from linear perspective depictions of the same scenes. In particular, objects in the visual periphery appeared smaller and more compressed compared to those seen centrally. Objects in the horizontal axis appeared to be compressed in width, while objects in the vertical axis appeared to be compressed in height. The second was the finding that the same tendency was evident in the work of other artists, such as Paul Cézanne, Vincent van Gogh, and Canaletto (Pepperell and Haertel, 2014; Mather, 2015). Third was the finding that images generated according the principles described above were judged to more accurately depict a given scene than geometrical perspective depictions of the same scene (Baldwin et al., 2014; Koenderink et al., 2016). Finally, we observed apparent size diminution and shape distortion in the peripheral field when swapping fixation between two identical objects, such as a pair of discs. We noted that after approximately 3 seconds of fixation the disc in the periphery appeared smaller and more elliptical in shape (see Figure 2). Perceiving this apparent size and shape distortion requires effort of a kind familiar to artists when, "shifting experience away from the familiarity of ideas and toward the concrete immediacy of sensory perception", as it is put in one widely used artists' textbook (Curtis, 2002, p. 32). In psychological terms, this is the equivalent of dissociating the proximal stimulus from the perceived structure of the distal object. A recent study by Erkelens (2015) showed that participants were able to do this to a surprising extent when comparing judgments about the perceived length of railway tracks viewed in perspective pictures and in reality. Participants were able to report the apparent length of the tracks due to perspectival information and the physical length of the lines quite independently, even when the magnitiude of difference between them was very large.

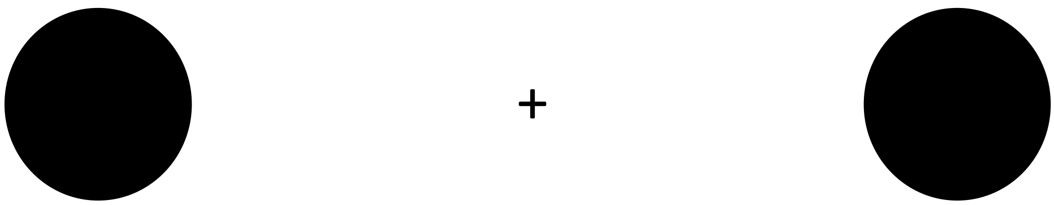

Figure 2 An apparent change in shape and size of peripherally viewed discs. Lining up the centre point between the eyes with the cross, fixate on the centre of either disc but then pay attention to the other, and then do the reverse. After approximately 3 seconds you may notice the disc in your periphery appears significantly smaller, and may even alter its shape. The apparent diminution occurs in both monocular and binocular viewing.

The evidence from the psychological studies cited above and our observations from research in the visual arts led us to hypothesize that objects perceived in the visual periphery can appear smaller than those seen in central vision even when the perceiver knows they are the same size. In addition, we hypothesized that objects can appear compressed in the visual periphery compared to when see in the centre, with objects in the horizontal axis being compressed in width, and objects in the vertical axis being compressed in height. Again, this apparent diminuition can be perceived in spite of the knowledge that the objects are identical. The aim of this study was to test whether participants would report these apparent changes in size and shape when asked to judge the appearance of identical stimuli in different parts of the visual field and under different viewing conditions. If so, it could help to explain why artists have often recorded the appearance of the visual world using these principles.

Most previous studies comparing perception in central and peripheral vision have focused on the horizontal axis of the visual field (e.g. Newsome, 1972; Schneider et al., 1978; Bedell & Johnson, 1984) and on perceived changes in size of objects rather than shape (e.g. Tsal & Shalev, 1996; Masin, 2008). As artists are generally interested in recording the appearance of visual space in both axes, and the perceived shape as well as size of objects, our first experimental design accommodated all these aspects. In Experiment 1 we used a drawing task to record perceived size and shape. Drawing is commonly used by artists to record visual experience. But it is also a well-established method of measuring subjective judgments in psychological experiments (Cohen and Bennett, 1997; Cohen 2005; Mitchell et al. 2005; Perdreau and Cavanagh, 2014). Here it was a convenient way to simulate under controlled conditions the process whereby artists record the appearance of visual space in relation to a fixation object. It also had the virtue of allowing participants a free hand to report whatever they saw without knowing the purpose of the experiment as might be the case if, for example, they were asked to adjust the size or shape of a stimulus to match a reference one.

2 Experiment 1

In Experiment 1 we asked participants to report the appearance of a set of 4 peripherally-viewed discs arranged equidistantly and from the participants. Participants performed a drawing task in order to qualitatively investigate their perception of peripheral vision. The purpose was to discover whether they would report the same apparent diminution and compression we had previously observed in artists when focusing on a point in space and drawing the contents of their visual periphery.

Method

Participants

32 undergraduate and postgraduate students (mean age 21) from a variety of disciplinary backgrounds took part in the experiment. 24 had normal vision and 8 had corrected-to-normal vision. Participants gave informed consent, and were naïve about the purpose of the experiment. The experiment received the approval of the Ethics Committee of Cardiff Metropolitan University and was conducted in accordance with the Declaration of Helsinki (2008). Each received a £5 cafeteria voucher for taking part to the experiment.

Materials

The experimental apparatus was the same used in a previous study (Baldwin et al., 2014). It consisted of a concave hemispherical dome of 900 mm diameter onto the surface of which were fixed 37 discs of 75 mm diameter. We arranged the discs at increments of 30 degrees from the center, both along the horizontal and vertical axis (Figure 3). In this way we ensured the stimuli fell comfortably within the binocular visual field while also covering a relatively wide eccentricity (Howard & Rogers, 1995). Participants were seated with their eyes 45 cm from the centre of the dome, perpendicular to the central disc. In this position each participant’s visual field was fully encompassed by the apparatus. Participants’ heads were constrained by a forehead and a chin rest to ensure consistency of position relative to the centre of the dome. An adjustable chair ensured participants’ eyes were at a uniform height.

The background surface of the dome was white and the discs were blue. An indirect tungsten lamp evenly illuminated the scene and cast no shadows inside the dome. We used a SPER 840020 light meter to measure the luminance of the apparatus, and the constrast between discs and background. The discs had a Weber contrast value against the background of approximately –37% (luminance value of blue discs 7 lux and background 11.5 lux).

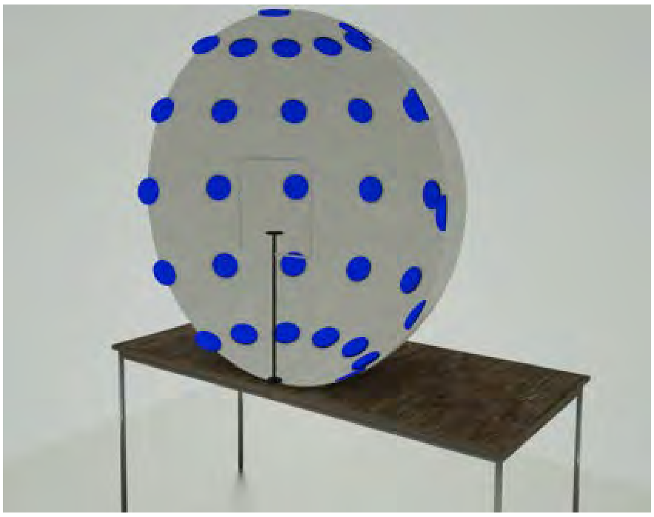

Figure 3 Illustration of the hemispherical dome apparatus used in Experiment 1. It shows the arrangement of the discs and the chin and headrest.

Procedure

Participants who wore glasses were asked to remove them before starting the experiment to prevent the rims occluding their peripheral field.

Once seated in the apparatus, participants were given a brief training session guided by the experimenter. Using a written protocol, the experimenter instructed participants how to pay overt attention to objects in the visual periphery while fixating a central point in the apparatus. The aim of the training was to ensure participants fully understood the experimental task.

Participants were provided with four sheets of paper (420 mm x 420 mm) that had a blue disc of 75 mm diameter printed in the center. It was explained that the printed disc represented the central disc in the apparatus.

During the experiment the participants were asked to fixate on the central disc and pay attention to one of the four peripheral discs, and then to fixate on one of the peripheral discs and pay attention to the central disc. In each case they were asked to make a mental note of how the peripheral disc appeared compared to the fixated disc. The four peripheral discs tested were located: 1) at 30 degrees above and 2) 30 degrees below the central disc, with their central point aligned with the vertical perpendicular line (vertical axis) crossing the center of the central disc, and 3) at 30 degrees to the left and 4) 30 degrees to the right of the central disc, with their central point aligned with the horizontal perpendicular line (horizontal axis) crossing the center of the central disc.

After viewing each of the four peripheral discs participants were asked to make a drawing on the paper that showed how they appeared compared to the central disc, with each drawing on a separate sheet. Participants were allowed to look between the discs as many times and for as long as they wished had as much time as they needed to complete the drawings in order to be satisfied they had accurately represented what they perceived. The average time to complete the task was 15 minutes.

Each drawing was scanned and imported to Adobe Illustrator. Using a vector drawing tool, we placed a rectangular bounding box around the edge of each drawn disc and obtained a measure of the height and the width for each drawing of the peripherally viewed discs.

Results and Discussion

To check whether any bias had been introduced by the requirement to remove participants glasses, we compared the reported shape of the peripheral discs between those who normally wore glasses and those who did not. We expressed this as a Distortion Index (DI), calculated as DI=log (drawing width/drawing height). An independent *t-test* performed between the two groups showed no statistically significant difference (Above_DI: t= -.686, df= 30, $p > .05$; Below_DI: t= -1.055, df= 30, $p > .05$; Left_DI: t= .219, df= 30, $p > .05$; Right_DI: t= 2.076, df= 30, $p > .05$) (Table 1a and 1b).

We also compared the reported size of the peripheral discs between two groups using a Relationship Index (RI) calculated as RI=drawing width*drawing height. Again, no statistically significant difference was recorded by the independent t-test (Above_RI: t= -.616, df= 30, $p > .05$; Below_RI: t= -1.068, df= 30, $p > .05$; Left_RI: t= .599, df= 30, $p > .05$; Right_RI: t= .800, df= 30, $p > .05$) (Table2a and 2b).

Having established there was no significant difference between the reports of those who wore glasses and those who didn't, we investigated to what extent the drawings of the peripherally perceived discs matched the size of the central disc (diameter = 75mm). The results showed a negative bias in all the drawings (average width of vertical discs: -0.17; average height of vertical discs: -0.29; average width of horizontal discs: -0.17; average height of horizontal discs: -0.25) (Table 3). Such results are in line with our prediction that participants would perceive the peripheral discs as smaller than the central one, and as reported in previous studies (Newsome, 1972; Schneider et al., 1978; Thompson and Fowler, 1980).

Table 1a: The table shows for each peripheral discs' DI the p value (Sig), the t value (t) and the degrees of freedom (df).

Peripheral discs	Sig.	t	df
ABOVE_DI	0.6	-0.686	30
BELOW_DI	0.3	-1.055	30
LEFT_DI	0.8	0.219	30
RIGHT_DI	0.5	2.076	30

Table 1b: The table shows for each group (glasses:y=yes and n=no) the Numerosity (N), Mean values (Mean), Standard Deviation (SD), Standard Error Mean (SEM) and Variance (VAR) for the Distortion Index (DI) we calculated on height and width of drawings.

Peripheral discs	Glasses	N	Mean	SD	SEM	VAR
ABOVE_DI	n	24	.07	.14	.03	.02
	y	8	.10	.12	.04	.01
BELOW_DI	n	24	.04	.10	.02	.01
	y	8	.08	.10	.04	.01

LEFT_DI	n	24	-.03	.08	.02	.01
	y	8	-.04	.11	.04	.01
RIGHT_DI	n	24	-.03	.08	.02	.01
	y	8	-.10	.09	.03	.01

Table 2a: The table shows for each peripheral discs' RI the p value (Sig), the t value (t) and the degrees of freedom (df).

Peripheral discs	Sig.	t	df
ABOVE_RI	0.5	-0.616	30
BELOW_RI	0.9	-1.068	30
LEFT_RI	0.6	-.056	30
RIGHT_RI	0.6	.800	30

Table 2b: The table shows for each group (glasses:y=yes and n=no) the Numerosity (N), Mean values (Mean), Standard Deviation (SD), Standard Error Mean (SEM) and Variance (VAR) for the Relationship Index (RI) we calculated on height and width of drawings.

Peripheral discs	Glasses	N	Mean	SD	SEM	VAR
ABOVE_RI	n	24	3323	1251	255	1564258
	y	8	3653	1491	527	2222296
BELOW_RI	n	24	3166	1154	236	1332790
	y	8	3662	1075	380	1156530
LEFT_RI	n	24	3557	1257	257	1581076
	y	8	3587	1470	520	2161843
RIGHT_RI	n	24	3762	1440	294	2072571
	y	8	3284	1550	548	2403708

Table 3: The table lists the Bias, Variance (VAR), Standard Deviation (SD) and Root Mean Square Error (RRMSE) we calculated for each discs' dimension.

	Average Width of Vertical Discs	Average Height od Vertical Discs	Average Width of Horizontal Discs	Average Height of Horizontal Discs
BIAS	-0.17	-0.29	-0.17	-0.25
VAR	214.4	133.64	166.66	142.68
SD	14.64	11.56	12.91	11.94
RRMSE	3.46	2.51	2.68	2.53

To investigate whether there was any change in perceived shape between the peripherally and centrally viewed discs we performed an ANOVA on the mean value of the width and height of the horizontal axis discs (above and below) and on the vertical axis discs (left and right). We predicted there would be a compression effect such that the horizontal discs would be compressed in the horizontal dimension, so diminished in their width, while the vertical discs would be compressed in the vertical dimension, so diminished in their height (Pepperell & Haertel, 2014; Mather, 2015). A 2x2 repeated measures ANOVA (same axis: horizontal width vs vertical height; opposite axis:

horizontal height vs vertical width) was performed on the average width and height of the drawn discs. There was a significant main effect of the same axis: $F(1, 31) = 11.712$, $p < .005$, partial $\eta^2 = .274$. The main effect of the opposite axis was not significant: $F(1, 31) = 2.290$, $p = .1$, partial $\eta 2 = .069$, and there was no significant interaction between the two factors: $F(1, 31) = 2.199$, $p = .1$, partial $\eta 2 = .066$. Figure 4 shows a bar graph of this data. Figure 5 illustrates the overall reported effect, with the four peripheral discs drawn at their mean height and width values as recorded in the drawings.

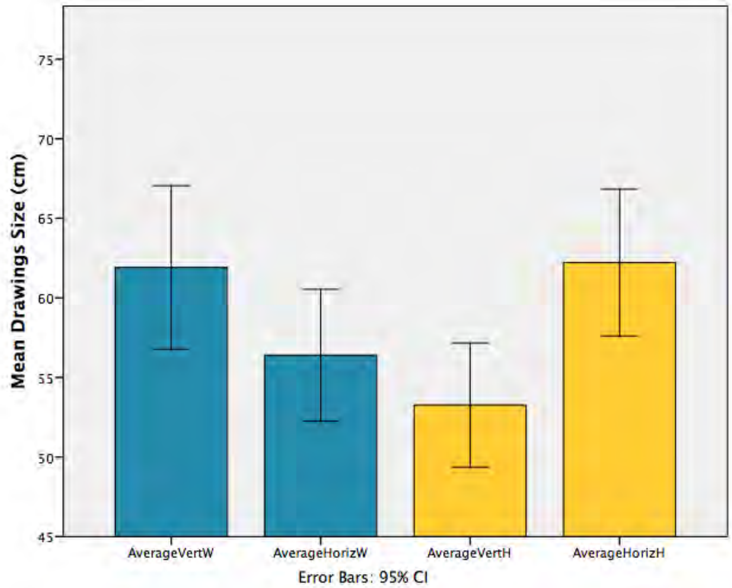

Fig. 4: The graph illustrates the mean height and width of the peripherally drawn discs. The bars show, from the left, average vertical width, average horizontal width, average vertical height, and average horizontal height of the discs as reported by the participants. The actual disc size was 75 mm.

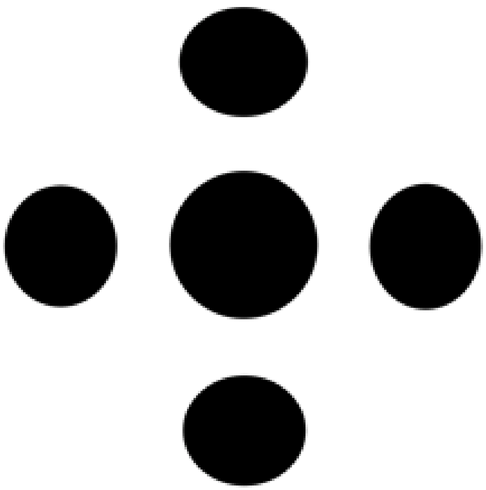

Figure 5 Illustration of the apparent size and shape of the discs viewed peripherally. The four peripheral discs have been modified to reflect their apparent size and shape relative to the central disc based on the mean height and width values reported by participants in Experiment 1.

Eight of the participants explicitly drew the peripheral discs with polygonal rather than curved boundaries. A similar effect has been reported previously in both perception of circular shapes (Khuu, McGraw & Badcock, 2002; Sakurai & Beaudot, 2015) and in afterimages of circular shapes (Ito, 2012). Some samples of participants drawings are included in Figure 6.

The results of Experiment 1 shows that objects freely viewed (without fixation or time constraints) in the periphery can appear to change size and shape, compared to a centrally-viewed reference object that the participants know to be identical. This pattern is consistent with our hypothesis, based on previous scientific findings and artistic studies.

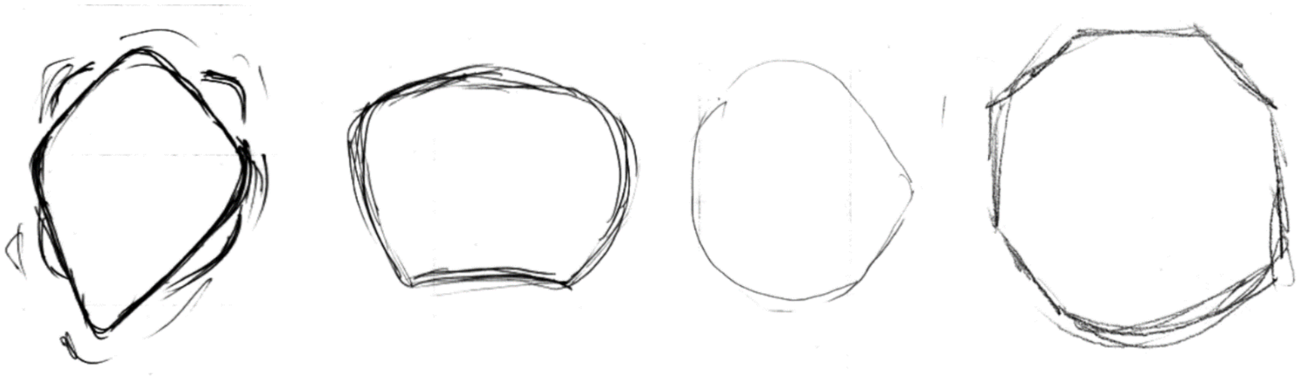

Figure 6 Examples of drawings from four different participants showing the perceived shape of objects seen in the peripheral field, with discs appearing polygonal in shape.

3 Experiment 2

We wanted to discover whether the changes in perceived size and shape reported in Experiment 1 would occur under more strictly controlled conditions and across a wider angle of visual field. We were also mindful of two of the reservations noted by Newsome (1972) about his own study in which he found the same apparent peripheral diminution reported here. First, he was unable to monitor the participants' gaze, and therefore rule out possible influence of errant eye movements. Second, his participants modified the visual angle of the stimulus by moving it backwards and forwards, and so judgements may have been influenced by perceived distance. We also wanted to investigate whether the changes in perceived size and shape occur in the early stages of perception (200ms). To measure, first, size perception we designed an experiment that controlled for eye movements using an eye tracker so participants could not look at the peripheral stimuli directly. Stimulus size was manipulated using a computer controlled video projection on a curved screen. With this arrangement, we were able to control for the possible influence of errant eye movements, stimuli distance, and exposure duration. Based on the results of Experiment 1 and previous studies (Newsome, 1972), we predicted the peripherally attended stimulus would be judged as appearing smaller than the central fixated disc, and would diminish with eccentricity.

Method

Participants

17 participants (7 females, 10 males; mean age=35, range 23-55) gave informed consent before taking part to the experiment. All were recruited from the student and staff population of Cardiff Metropolitan University. All had normal vision, except for five that had corrected-to-normal vision. Participants who wore glasses removed them before starting the experiment to prevent the rims occluding their peripheral field. The experiment was approved by the Ethics Committee of the School of Art and Design, Cardiff Metropolitan University and was conducted in accordance with the Declaration of Helsinki (revised 2008). Each participant received a £5 cafeteria voucher for participating.

Materials

Our aim in this experiment was to test size perception across the entire binocular visual field as the far periphery has been relatively little studied in vision science, although many artists have attempted to record it (Mann & Mann, 2008). We designed our apparatus to present stimuli across a horizontal range of 120 degrees, which approximately corresponds to the scope of the human binocular visual field, and accounts for most of the approximately 180 degrees of the total visual field (Gibson, 1950; Howard & Rogers, 1995; Strasburger, Rentschler & Jüttner, 2011). We wanted to avoid using a flat computer monitor to present the stimuli. Flat monitors make it difficult to maintain consistency in the size and shape of the stimulus projected on the retina, especially at eccentricities of 40 degrees or more (Yu and Rosa, 2010). The technical problems involved in presenting computer controlled stimuli to a wide angle of the visual field partly explain why researchers to date have tended to limit studies of peripheral vision to a relatively narrow range of eccentricities.

The apparatus consisted of a grey curved screen 22cm high and 113cm wide. The constant curvature of the screen was maintained using a semi-circular CNC machine cut frame that had a diameter of 120 cm (see Fig.7). An InFocus IN3128HD (60Hz) projector, fixed on the roof of the lab, was used to project stimuli onto the screen. A mask layer was inserted between the projector's light source and the screen itself to eliminate any light spillage around the screen. The experiment was created using Python and PsychoPy (Peirce, 2007). We gamma corrected the screen using the default PsychoPy function and used a SPER 840020 light meter to measure the luminance of the background and of the stimuli at each eccentricity and adjusted each discs' luminance to maintain a Weber contrast value against the background of -6% across the screen surface (background luminance: .172lux; average stimuli luminance: .161lux). These setting were used in order to minimize the formation of any afterimage due to the luminance of the projection.

We created a range of stimuli that varied from half to double size of a central reference disc. We had to consider the relative distance of the closest peripheral disc compared to the central one. For this reason we did not use the same stimulus size as in Experiment 1 because the borders of the two discs (the central one and the peripheral one at 15 degrees) would have overlapped when the near peripheral disc was at its double scaling size. Stimuli consisted of a series of red discs of nine fixed sizes varying from 0.75cm to 3cm, that is from 50% to 200% of the size of a 1.5cm central reference disc, which subtended 1.43 degrees of visual angle. The shapes were generated in Adobe Illustrator and then laser cut into physical templates that were used to map the final projected digital stimuli at the correct size and shape on the curved screen using Adobe After Effects. Video mapping software, including Adobe After Effects and Mad Mapper (www.madmapper.com), were used to manipulate the projected stimuli. Our apparatus was fitted with an Eyetribe eye tracker (www.theeyetribe.com, Copenhagen) with a temporal resolution of 60Hz. The eye tracker was used to detect if the participants' eyes moved from a central fixation point, in which case the trial was void. A high quality 5m long HDMI cable was used to link all display devices and minimise any computer to display lag. The experiment was coded in PsychoPy using 60 frames per second as a time basis. All extraneous light sources were removed, and participants were seated with their eyes 60 cm from the surface of the screen. We provided an adjustable chair to line up the height of the viewer's eyes with the central fixation point on the screen. Participants' heads were constrained by a forehead and a chin rest fixed to ensure they were all located in the same position relative to the screen.

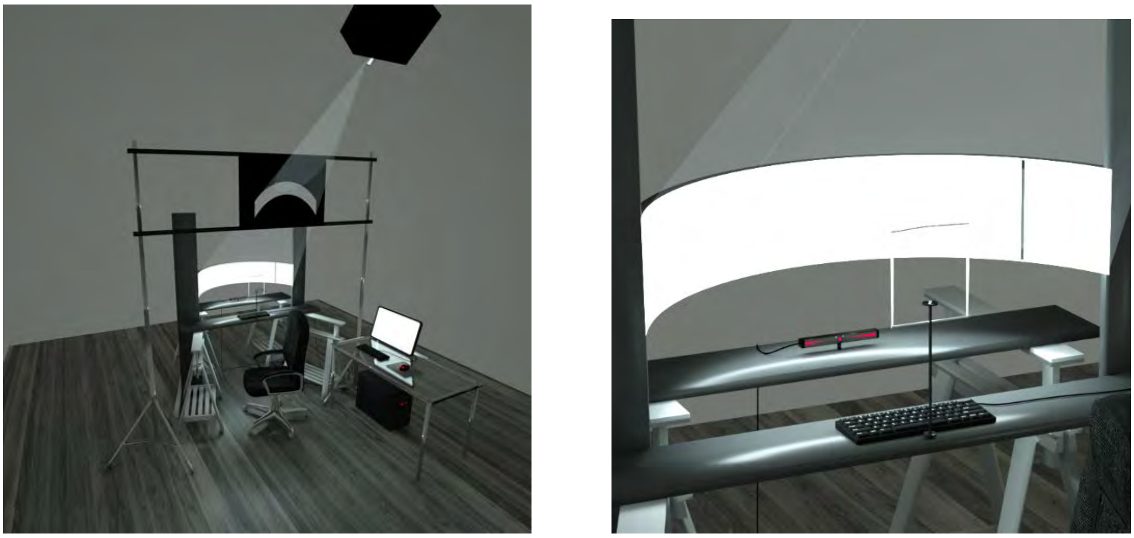

Figure 7. Illustration of curved screen apparatus used in Experiment 2. The left image shows the entire apparatus, including the control computer in the table to the right, and the right image shows in more detail the position of the screen, eye tracker, head restraint, and keyboard used for recording participant response.

Procedure

Before starting the experiment, participants were given a training session to test they were able to perceive the stimuli at all eccentricities and that they understood the task. During the experimental session each trial consisted of the following sequence of events (see Fig.8): first a fixation cross appeared at the centre of the screen for 300ms (18Hz); then the stimuli appeared for 200ms (12Hz), one in the centre of the screen and one in the periphery; then a question mark was shown. Participants performed a forced-choice size discrimination task in which they reported whether the peripherally viewed disc appeared larger or smaller than the centrally fixated disc. For half the participants ‘L’ was used on a keyboard to report the disc appeared larger and ‘A’ for smaller, and this was reversed for the other half.

We presented the stimuli using the Method of Constant Stimuli (MCS). The peripheral stimuli were of the following sizes: 0.75cm, 0.9cm, 1.2cm, 1.35cm, 1.5cm, 1.65cm, 1.8cm, 2.4cm, and 3cm. Each size was randomly presented 10 times at 15 degrees, 30 degrees, 45 degrees and 60 degrees of eccentricity from the central fixation point in both hemi-fields.

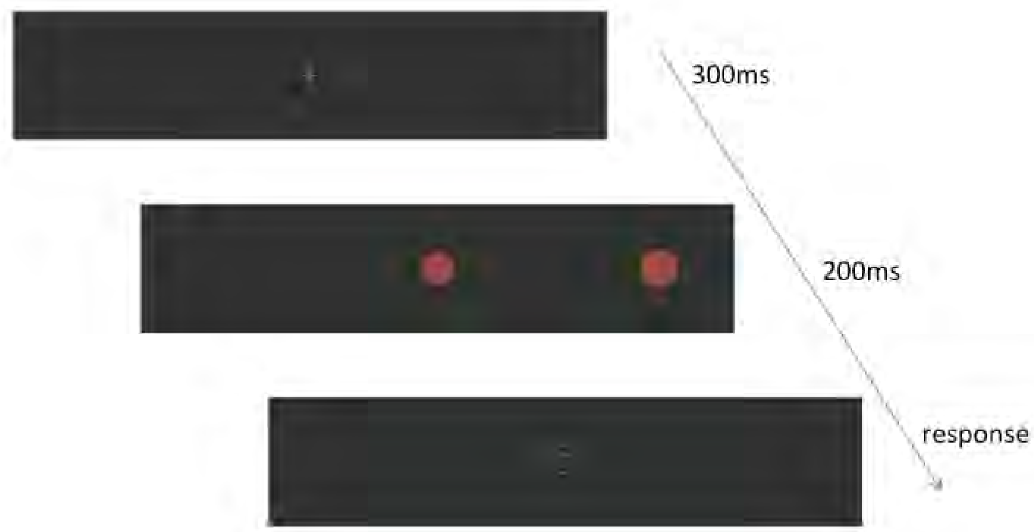

Figure 8: A graphic illustration of the series of events for each trial. First a fixation cross was shown for 300ms, which the participants had to look at for the trial to be valid. Then a central reference disc (appearing at the same positions as the fixation cross) and a peripheral disc were presented for 200ms. Finally, a question mark indicated that participants had to judge whether the peripheral disc was smaller or larger than the central one.

Results and Discussion

We excluded from the data analysis trials in which participants were not looking directly at the central disc and where response time was less than 250ms or greater than 3000ms. We performed a Probit Analysis to calculate the Psychometrical Function (PMF) per each participant. The mean PSE for each eccentricity was: 1.95cm at 15 degrees eccentricity (130% of the central disc); 2.01cm at 30 degrees (134% of the central disc); 1.92cm at 45 degrees (128% of the central disc); and 1.59 at 60 degrees (106% of the central disc) (Fig. 9).

To check whether any bias had been introduced by the requirement to remove participants' glasses, we compared the Point of Subjective Equality (PSE) we obtained from the PMFs at each eccentricity (15, 30, 45 and 60 degrees) between those that wore glasses and those that did not. An independent *t-test* performed between the two groups showed no statistically significant difference (PSE at 15 degrees: $t= -1.817$, $df= 15$, $p> .05$; PSE at 30 degrees: $t= -.651$, $df= 15$, $p> .05$; PSE at 45 degrees: $t=-.914$, $df= 15$, $p> .05$; PSE at 60 degrees: $t= .112$, $df= 15$, $p> .05$).

Having established there was no significant difference between the PSE of those who wore glasses and those who didn't, an ANOVA one-way within subjects was conducted on the Points of Subjective Equality (PSEs). There was a statistically significant effect of eccentricity, accounting for a small portion of the variance: $F (3, 48)= 13.798$, $p< .001$, $\eta^2= .463$. The mean PSE was set at 1.21cm, meaning that people perceived the peripheral discs -19.4% smaller compared to the size of the central reference disc (=1.5cm). A Bonferroni post-hoc test revealed significant differences between the mean value of the PSE at 60 degrees and the ones at the other locations (15, 30 and 45 degrees) ($p< .01$ for all tests). No other comparisons were significant (all ps > .05). Figure 9 shows the mean PSE values for each eccentricity, indicated by modified size of peripheral discs. Accordingly, the PSE showed a positive bias for each eccentricity, as reported in Table 4.

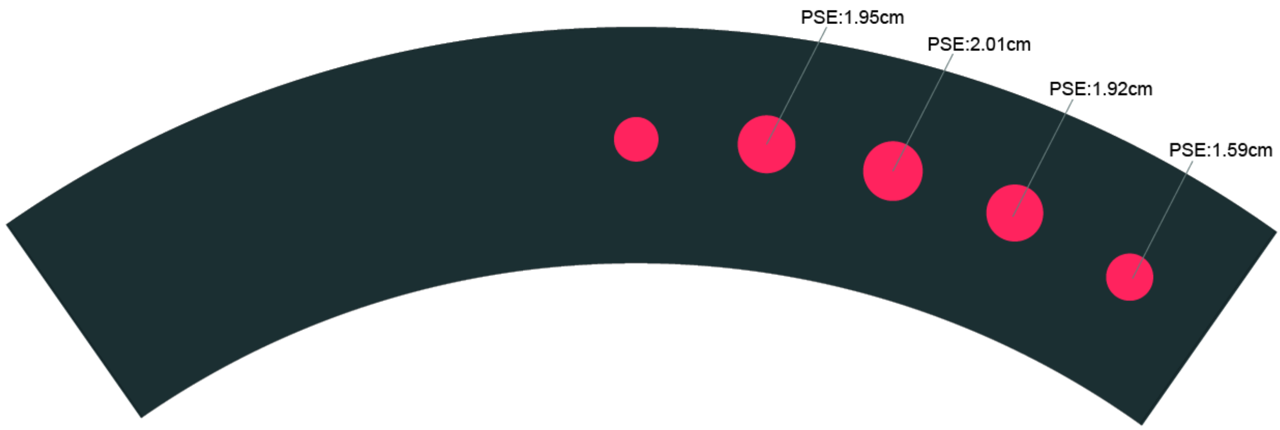

Figure 9: A graphic representation of the mean PSE at each eccentricity. The diameter of peripheral discs has been modified to reflect the mean PSE values calculated based on Experiment 2.

Table 4: The table lists the Bias, Variance (VAR), Standard Deviation (SD) and Root Mean Square Error (RRMSE) we calculated on PSE for each eccentricity.

	15 degrees	30 degrees	45 degrees	60 degrees
BIAS	0.31	0.34	0.29	0.07
VAR	0.63	0.47	0.98	3.22
SD	0.80	0.69	0.99	1.79
RRMSE	2.11	2.13	2.09	1.91

In this experiment we found that people perceived stimuli as smaller when presented at eccentricities of 15, 30, 45 and 60 degrees compared to central vision. This was true in both hemi-fields. However, we were surprised to find the mean PSE value (=1.59cm) at 60 degrees of eccentricity was the closest to the actual size of the central disc (=1.50cm) since we had expected the diminution in perceived size would increase with eccentricity, as reported by Newsome (1972). One possible explanation is due to the way visual acuity decreases with eccentricity, being much reduced in the far periphery (Helmholtz, 1867), and relies increasingly on one eye rather than two. Discs presented at 60 degrees in each hemi-field would be indistinct and lying at the extreme edges of the binocular visual field (Gibson, 1950; Howard & Rogers, 1995), although still visible monocularly at wider eccentricities. If judgments about perceived size are more uncertain at large eccentricities then people may rely more on previous experience rather than on perception to make a decision. Therefore, they may be more likely to assume the peripheral disc is the same size as the central one. Recent work on size perception of peripheral objects by Valsecchi & Gegenfurtner (2016) has shown how the visual system uses constancy principles to maintain an apparently stable visual world, even if the actual size of objects changes between viewing them centrally and peripherally. Another possible explanation is that participants used an a priori internal criterion in which objects perceived in the far periphery are assumed to be closer within their peripersonal space, and therefore appear bigger (Caggiano et al., 2009). Furthermore, although we tried to design the apparatus to ensure all stimuli were presented at an equal distance from the participants' eyes, the actual distance varied slightly with eccentricity due to the spatial separation between the two eyes, which varies from person to person. Discs presented at the extremes edges of the region of binocular overlap would therefore be physically closer to one eye than the other.

4 Experiment 3

Besides variations in perceived size, Experiment 1 also reported two kinds of shape distortion: compression of the disc into an ellipse and conversion of a smooth circular contour to polygonal one. To test whether objects also undergo such shape distortions in the early stages of perception we carried out a third experiment in which participants had to select the perceived shape of a peripherally viewed stimulus from a range of different shapes. It was also possible that the diminution effect reported in Experiment 2 was due to shape distortion: if discs were perceived as ellipses or polygons, as in Experiment 1, then this may have also reduced their apparent overall size. Experiment 3 was designed to reveal the extent to which peripherally viewed objects undergo shape distortion in early stages of perception. Based on the results of Experiment 1 we predicted participants would report a distortion of perceived object shape in the peripheral field.

Method

Participants

10 participants (7 females, 2 males; mean age=22, range 19-28) gave informed consent before taking part to the experiment. All were recruited from the student and staff population of Cardiff Metropolitan University. All had normal vision. The experiment had received approval by the local Ethics Committee of the School of Art and Design, Cardiff Metropolitan University and was

conducted in accordance with the Declaration of Helsinki (revised 2008). Each participant received a £5 cafeteria voucher for participating.

Materials

Experiment 3 was conducted using the same apparatus of used in Experiment 2, but with a different set of stimuli. In the periphery participants were shown either discs or octagons. Octagons were chosen partly because several participants in Experiment 1 reported seeing this shape and also because they most closely resemble a disc, and therefore are the hardest to discriminate. After brief peripheral exposure, participants could select from a series of shapes the one that most closely matched what they perceived. The selection consisted of a disc, a vertically-oriented ellipse, a horizontally-oriented ellipse, an octagon, a hexagon, a pentagon and a triangle (see Fig. 10). We projection mapped all the stimuli shapes to the screen shape following the same procedure as in Experiment 2.

Procedure

People were seated in a dark room at 60cm from the screen. We provided an adjustable chair to line up the height of the viewer's eyes with the central fixation point on the screen. Participants' heads were constrained by a forehead and a chin rest fixed on the external border of the desk, thus ensuring they were all located in the same position relative to the screen.
The experiment was again created using Python and PsychoPy (Peirce, 2007). Once again we coded the stimuli onset using a 60 frames per second display rate. Before starting the experiment, participants were given a training session to ensure they perceived the discs at all eccentricities and understood the task.

We randomly presented a disc or an octagon shape in the periphery in all nine sizes (0.75cm, 0.9cm, 1.2cm, 1.35cm, 1.5cm, 1.65cm, 1.8cm, 2.4cm, and 3cm) six times at each position (three times on the left and three times on the right). The eccentricities were the same as Experiment 1: 15, 30, 45 and 60 degrees.

Each trial consisted in the following set of events (see Fig. 10): at the beginning participants saw a fixation cross (500ms). Then a peripheral stimulus (disc or octagon) was shown in the periphery at a random location (200ms). After the stimulus was presented, a set of the seven shapes in a circular arrangement appeared on the screen. Note that the seven shapes were always rearranged in a random order and had the same width. A cursor appeared at the same point as the fixation cross at the centre of the screen and at the same time the seven shapes were displayed. We asked observers to select one of seven shapes that was most similar to the shape they had seen in the periphery by clicking on it.

We tracked participants' eye movements with the Eyetribe eye tracker (www.theeyetribe.com, Copenhagen) to ensure that participants were looking at the fixation cross at the centre of the screen while making their judgments.

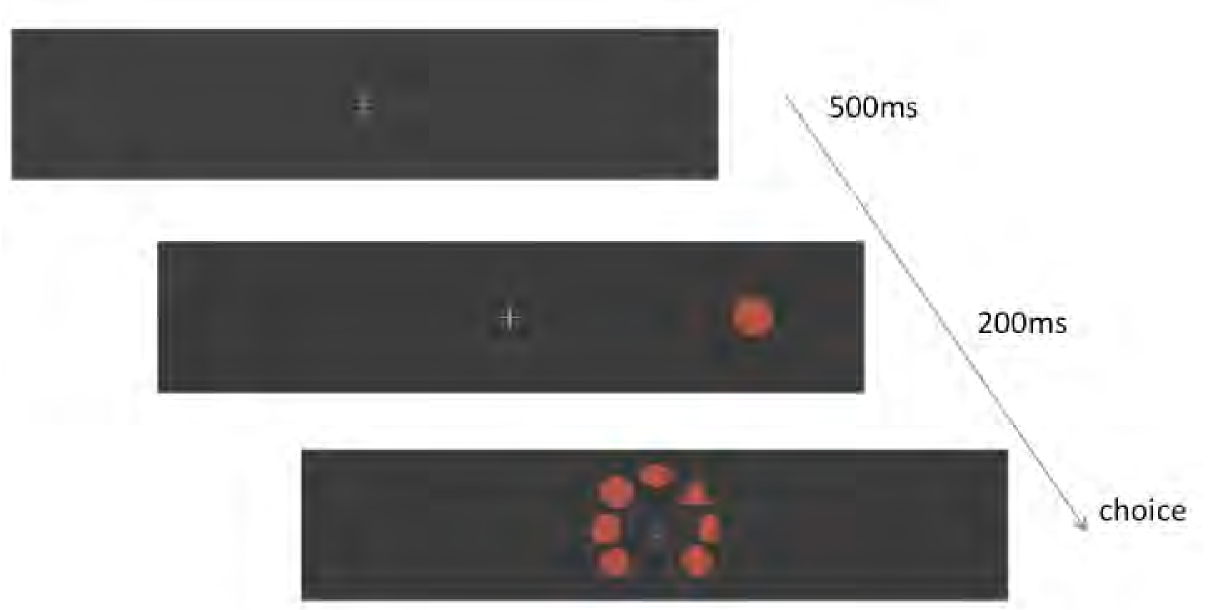

Figure 10: A graphic illustration of the series of events for each trial. First a fixation cross was shown for 500ms, which the participants had to look at for the trial to be valid. Then a peripheral disc was presented for 200ms. Finally, a set of shapes appeared in a random order on the screen with a curson at the center of the screen. Participants had to click on the shape they think was the closest to the one they perceived in the periphery.

Results and Discussion

We excluded from the data analysis trials in which participants were not looking directly at the central disc and where response time was less than 250ms or greater than 3000ms. For each participant we calculated the mean reaction times (RTs) for both conditions in which discs or octagons were presented in the periphery, for all eccentricities. Mean RTs and mean frequencies are respectively reported in Table 5 and 6 for illustrative purposes.

The graphs in Figure 11 show that participants most often selected the shape that matched the one presented in the periphery at near eccentricities (15 and 30 degrees) compared to the farther eccentricities (45 and 60 degrees) where participants' mean frequencies were more evenly distributed across all the shapes. In order to test if this difference was due to a different sensitivity for the two shapes or to an effect of eccentricity, we calculated d' for both discs and octagon at all eccentricities. The mean d' values are reported in Table 7. A 2x2 ANOVA within subjects was conducted that examined the effect of presented shapes (discs *vs.* octagons) and eccentricity (15 *vs* 30 *vs* 45 *vs* 60 degrees) on the relative d' values. There was no statistically significant interaction between the effects of presented shape and eccentricity on d' values: $F\ (3, 24) = .256$, $p > .05$, $\eta^2 = .031$. Simple main effect analysis showed that there was no significant difference in sensitivity between discs and octagons ($F\ (1, 8) = .001$, $p > .05$, $\eta^2 = .000$) but that people were significantly more accurate at closer eccentricities ($F\ (3,24) = 25.624$, $p < .001$, $\eta^2 = .762$).

These results show that up to 45 degrees of eccentricity people can quite accurately discriminate between briefly presented shapes, reporting a higher sensitivity for discs compared to octagons (see Table 7). However, by 60 degrees sensitivity values have rapidly decreased: the overall mean *d'* value for discs was negative, meaning that false alarms rates were higher than the correct responses rates. These results did not confirm our prediction that participants would perceive discs as elliptical, which suggests the effect found in Experiment 1 occurred at a later stage of perception than measured in Experiment 3. The results of Experiment 3 also confirmed that participants in Experiment 2 were able to quite accurately perceive the disc shape of the stimuli and therefore that the diminution effect was not due to apparent shape distortion.

Table 5. The table lists mean reaction times (ms) for the two conditions in which discs and octagons were shown, at each eccentricity (15, 30,45 and 60 degrees). The bottom row (Average) shows the mean reaction times.

	Disc shown		**Octagon shown**	
Eccentricities	Disc choose	Octagon choose	Disc choose	Octagon choose
15 degrees	1241	1217	1427	1309
30 degrees	1273	1244	1220	1318
45 degrees	1204	1157	1379	1264
60 degrees	1258	1342	1282	1255
Average	**1246**	**1269**	**1311**	**1282**

Table 6. The table lists the mean frequencies for each shape (disc, ellipse (horizontally-oriented), ellipse (vertically-oriented), hexagon, octagon, pentagon, triangle) at each eccentricity (15, 30, 45, 60 degrees) in both the condition in which discs and octagons were shown.

	Disc shown				**Octagon shown**			
Shape choice	**15 degrees**	**30 degrees**	**45 degrees**	**60 degrees**	**15 degrees**	**30 degrees**	**45 degrees**	**60 degrees**
Disc	33	21	17	16	8	13	15	14
Ellipse (horizontally-oriented)	2	5	5	5	2	3	4	5
Ellipse (vertically-oriented)	3	4	6	6	2	4	5	6
Hexagon	2	3	6	5	11	7	6	4
Octagon	2	5	7	9	16	12	10	8
Pentagon	2	2	4	4	3	4	2	3
Triangle	1	2	2	2	1	2	2	2

Table 7. The table lists d' values for both shapes (discs and octagons) at each eccentricity (15, 30, 45 and 60 degrees). The last row (Average) shows the mean d' values.

	DISCS d'	**OCTAGONS d'**
15 degrees	1.35	1.36
30 degrees	0.56	0.61
45 degrees	0.14	0.01
60 degrees	-0.01	0.04
Average	**0.46**	**0.42**

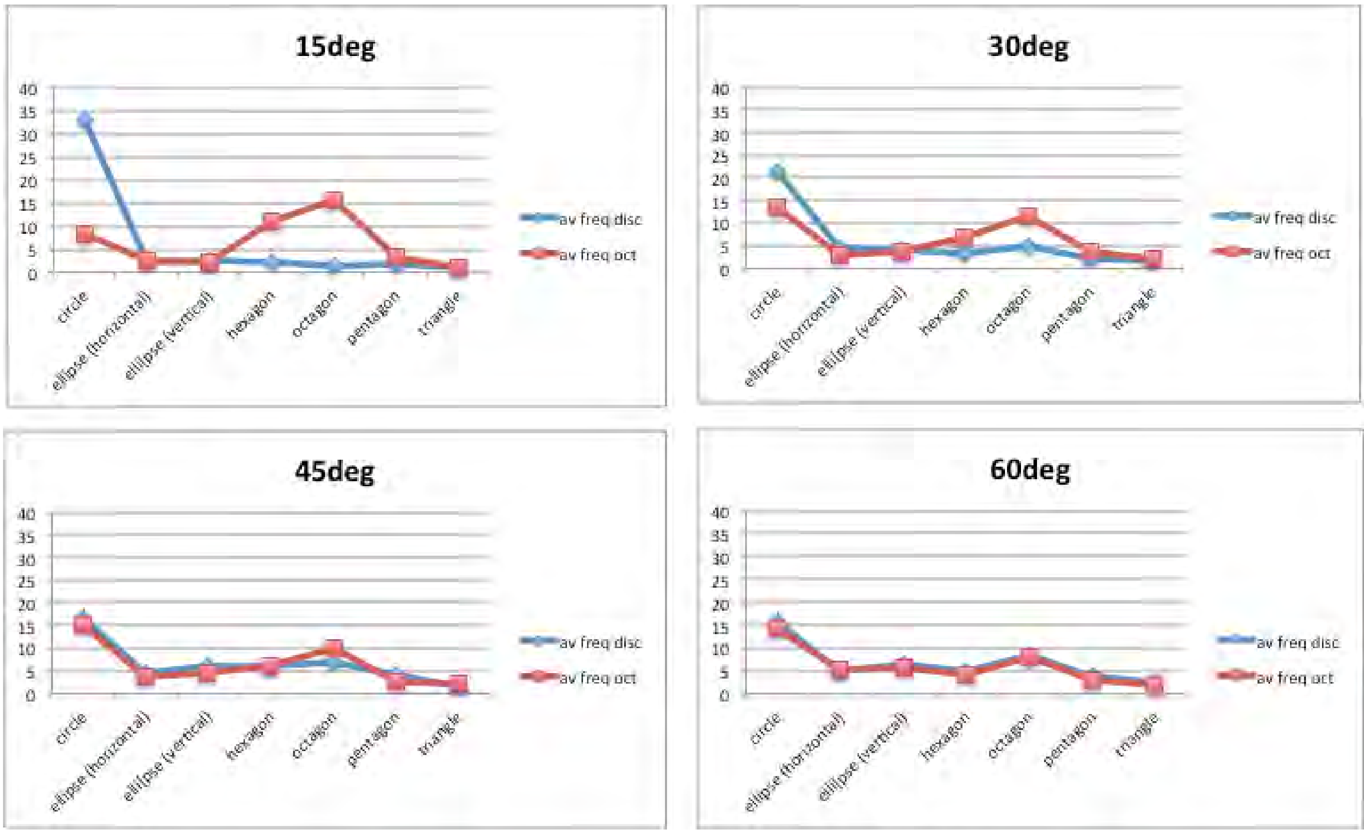

Figure 11. These graphs show the mean frequencies for each shape in the condition in which discs (av freq disc= average choice frequencies for presented discs) and octagons (av freq oct= average choice frequencies for presented octagons) were presented in the periphery at different eccentricities. The blue line shows the results when discs are presented peripherally and the red line shows the results when octagons were presented peripherally.

5 General Discussion

In our first experiment we found that participants reported diminution and compression of objects when viewed in peripheral vision without constraints on fixation or time. These results indicate that under these conditions both size and shape of peripherally perceived objects can change in a way that is consistent with previous scientific studies and artistic observations. This effect occurred in spite of the participants' knowledge about the physical properties of the peripherally viewed objects. These findings could help to explain why artists have often represented visual space using similar principles of peripheral diminution and compression (Pepperell and Haertel, 2014; Mather, 2015). The picture changes somewhat when eye movements are constrained and exposure times are short. Here we still see a diminution in perceived size, at least up to 60 degrees of eccentricity. But we did not find an equivalent shape distortion to that reported in Experiment 1, neither in terms of compression or polygonal conversion. Unlike in the first experiment, participants in Experiments 2 and 3 had no direct knowledge of the size or shape of the peripheral stimuli, and so relied only on what could be gleaned from a brief peripheral exposure. Overall our study suggests that in early stages of perception objects in the periphery are represented smaller than they appear in the central visual field, but shape is perceived quite accurately up to 30 degrees of eccentricity. However, at later stages of perception, modulated by prolonged viewing, objects can appear more compressed and more polygonal than they actually are. This suggests that the appearance of the world across the wider visual field is mediated by a complex interaction between exposure time, adaptation, prior knowledge, attention, and perception.

It is well known that the acuity of vision varies across the visual field, and that this can affect the way objects are perceived depending on their eccentricity (Helmholtz, 1867). Yet due the fact the region of space on which we fixate is seen with the highest acuity we have the impression that all our visual field is uniformly clear and stable (Gibson, 1950). Artists, however, are trained to pay great attention to the way objects appear in visual space as a whole. Poussin, the great French Neoclassical painter, wrote: “There are two ways of looking at things. One is simply looking at them where the other is considering them attentively” (in Protter, 1997, p. 69). Paying greater attention to the contents of visual experience, which requires prolonged looking, is believed to heighten perceptual acuity and so enable greater representational accuracy. One popular training book for artists advises: “The more closely we pay attention to the information transmitted by the eye the more startled we will be” (Seth Jacobs, 2013, p. 29). This may account for the fact that artists have recorded the diminution and compression of peripherally viewed objects, while this phenomenon goes unnoticed by those not subjecting their visual experience to the same prolonged scrutiny. Understanding the strategies used by artists and other experts for widening the attention across the visual field is a promising direction for future research in visual perception (Hubert-Wallander et al., 2011; Hütterman et al., 2014).

Various proposals have been made to account for the differences in size perception of objects seen centrally and peripherally. Newsome (1972) cites the relative impoverishment of acuity in the peripheral field and structural properties of the eye as possible explanations, along with the depth distorting effects of the binocular horopter, but concludes none of these satisfactorily account for his results. Considering the contradictory findings obtained in previous studies, Bedell and Johnson (1984) suggest a number of factors could influence peripherally perceived size, including the relative sensitivity of the retina between the fovea and periphery, the optical quality of the images projected onto the retina, and contrast and luminosity values of the target stimulus. Experiments will yield differing results, they argue, depending on the choice and presentation of stimulus and whether they exceed retinal thresholds. They attribute their own results to the increase in receptive-field diameter with retinal eccentricity, which degrades the precision with which the stimulus is represented resulting in underestimation of its extent. More recent work has attributed size perception to the cortical magnification factor of the foveal region compared to the periphery (Schwarzkopf et al., 2011). As a consequence of the distribution of retinal ganglion cells there is a enlargement effect of foveal vision, such that identically sized objects seen peripherally will appear small relative to those seen centrally (Anstis, 1998).

The apparent compression in peripheral field reported in Experiment 1 may be due in part to the way light is projected onto the retina through the cornea. Drasdo and Fowler (1974) used trigonometric ray tracing to calculate the projection of the retinal image, and showed the surface area onto which a solid degree of light is projected decreases markedly with eccentricity. In the 80-90 degrees region of the retina the area covered is 37% of that in the foveal region. Due to the roughly spherical structure of the eye, this results in a pattern of optical distortion consistent with the observations reported in Experiment 1 in which objects appear increasingly compressed horizontally in the horizontal axis and vertically in the vertical axis with eccentricity. However, on this basis one would expect the same apparent compression occur even with short exposures, and the results of Experiment 3 do not support this. One possible explanation is that optical distortions are overridden by constancy effects, which the visual brain uses to maintain the appearance of a stable world even at early stages of perception (Valsecchi & Gegenfurtner, 2016). These can in turn be overridden by prolonged exposure, where greater awareness of the proximal stimulus modulates the presumed appearance of the distal one. However, it remains unclear why the same constancy effects would not ‘correct’ the perceived size of briefly presented peripheral objects, as in Experiment 2.

The appearance of polygonal shapes in the place of regular discs reported in Experiment 1 may also be due to prolonged exposures. Ito (2012) suggests the appearance of curved lines as polygonal in afterimages perceived peripherally may result from rivalry between visual processes for detecting curves and corners in cortical areas. Adaptation or fatigue of one process may lead the other gaining dominance. In our first experiment, participants were able to peripherally view the discs for long periods, which may have resulted in adaptation or fatigue of the kind Ito describes.

These experiments are a preliminary attempt to measure the apparent size and shape of objects seen in the peripheral visual field. We studied only a narrow range of possible eccentricities (30 degrees along each axis in Experiment 1 and 60 degrees of each hemi-field in Experiments 2 & 3 in steps of 15 degrees) and it remains to be seen whether the apparent distortion we report can be extended to all eccentricities on both axes. Based on our experience of designing apparatus for Experiments 2 & 3, measuring such properties across the entire scope of the visual field will be technically very challenging. It will require a fully hemispheric rear projection dome, probably using multiple projectors, with suitable eye tracking, which may create problems of synchronisation between devices. However, developing such systems will be worthwhile given the relatively limited state of current knowledge about the structure of visual space in the wider peripheral visual field (Wagner, 2006; Yu & Rosa, 2010). The present study and the apparatus developed to carry it out make a contribution to extending our knowledge about perception in the farther reaches of the visual field.

6 Conclusion

This study suggests that prolonged exposure to objects in the visual periphery can make them appear smaller, more compressed, and more polygonal than in central vision, at least in near and middle regions of eccentricity. Objects in the vertical axis appear compressed horizontally and objects in the horizontal axis appear compressed vertically. These findings are consistent with several previous scientific studies and artistic observations. They further suggest that peripheral diminution and compression may be a more general feature of the structure of visual space under certain viewing conditions, but further experimentation across the entire visual field is needed to confirm this. Brief exposures without direct viewing of stimuli also cause objects to appear smaller in the near and middle periphery, but do not alter perceived shape. This may be due to a constancy effect, which the early visual system imposes on stimuli in order to maintain the appearance of a stable world, and would explain why we are generally unaware of variations between the appearance of central and peripheral vision in everyday experience. However, such constancy effects can be overridden when greater attention and longer exposure is given to the contents of the peripheral visual field. In seeking to accurately depict their visual experience, artists may have recorded these size and shape variations in works of art when viewing their subjects for prolonged periods, and this may account for the way those works are composed. These findings may contribute to our understanding of the structure of visual space and the ways in which artists have depicted visual experience.

Conflicts of interest

There are no conflicts of interest

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Joseph Baldwin **trained and practiced as a product designer before teaching Design and Technology, Industrial Technology, and Product Design. He has completed a PhD at Cardiff Metropolitan University on new methods of representing visual experience.**

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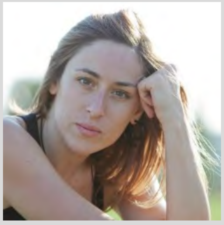

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