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**Primary-school children's  
conceptions of light and their relation  
to the historical progression of optics**

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**A thesis submitted in fulfillment of the requirements  
for the degree of Doctor of Philosophy  
The University of Auckland, 2008**

## Abstract

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The current study assessed children's ideas on light and optics using a cross-sectional design. Given current literature and theory within cognitive psychology, history of science and science education, it was expected that (i) older children would be more likely than younger children to have a modern scientific understanding of light concepts; (ii) for many of the light concepts, there would be a parallel between the pattern of progression and change in children's conceptions of light and scientists' conceptions of light throughout history, and, finally; (iii) employing a historical lens would allow for a better understanding of not only the age-related patterns in children's ideas of light but also children's age specific alternative conceptions of light.

A Light Core Concepts Questionnaire (LCCQ) was administered to participants (N=757) from across a wide age group (6 to 12 years). The participants were representative of ethnic groups attending a range of primary schools situated in a large New Zealand city. None of the participants had received classroom instruction in light and optics. The verbally delivered LCCQ was used to elicit children's responses about prerequisite concepts necessary for a scientific understanding of the physics of light and employed two-choice, multi-choice and open-ended questions. Some questions were specifically designed to compare children's conceptual understanding on light and optics with ideas adopted throughout the history of science.

The results of the current research found that with increasing age (6 to 12 years old) children's modern scientific understanding for many concepts on the physics of light increases. In comparison with other research, a higher proportion of children participating in the current study held correct views at younger ages. On easily observable phenomena, children as young as 7 years could identify common light sources and knew that some objects are reflectors of light. By age 12, the majority of children could correctly identify more abstract concepts such as what causes colours in rainbows.

Results of the present research indicate there is a parallel between the age-related patterns of children's ideas on light and the historical progression of scientific knowledge of the physics of light. With regard to light and vision, both early scientists and children held a similar range of alternative beliefs, that is, extramission, intromission or Eastern Islamic theories. Similar beliefs were shared about other concepts that were accepted as true theories in the history of science. For example, colour is the property of the object and when an object is placed in water it becomes distorted because water is less perfect than air.

The results indicate that the pattern of alternative conceptions held by children as they relate to history provides further understanding of why there are differences in children's beliefs about light and optics across age groups. For more difficult concepts, children and early scientists initially formulate similar theories based on their observations and what appears to be commonsense. As they reconceptualise their ideas, children and scientists formulate similar more abstract theories. In addition to discussing the value of the history of science as a lens to better understand children's conceptions, the implications of these results are discussed as they relate to specific kinds of interventions or instructional approaches to elicit successful conceptual change in the classroom.

## **Dedication**

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I dedicate this thesis to my father Noy George  
who first kindled my interest in science and history  
as we made car journeys together in the Humber Super Snipe.

## Acknowledgements

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I would like to thank the people who have supported me in the preparation of this thesis. Firstly, my sincere thanks to my supervisors Dr Richard Hamilton and the late Dr Lydia Austin. Richard was my supervisor over a long period and I am extremely grateful for his kindness and patience throughout this time. I am also grateful to have benefited from his wide knowledge and intellect, mentoring and feedback. Prior to her retirement, Lydia was also my supervisor during the earlier stages of the thesis. I wish to express my appreciation for her inspiration and sharing of her expertise in science education and the history of science.

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# Table of Contents

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<b>Abstract .....</b>	<b>ii</b>
<b>Dedication .....</b>	<b>iv</b>
<b>Acknowledgements .....</b>	<b>v</b>
<b>Table of Contents .....</b>	<b>vi</b>
<b>List of Tables .....</b>	<b>ix</b>
<b>List of Figures .....</b>	<b>x</b>
<b>CHAPTER 1: INTRODUCTION .....</b>	<b>1</b>
<b>CHAPTER 2: THEORIES OF CHILDREN’S CONCEPTIONS .....</b>	<b>6</b>
2.1 Introduction .....	6
2.2 Cognitive Development Theories .....	7
2.3 Individual Growth .....	12
2.4 The Scientific Revolutions Analogy .....	17
2.5 Theory Theory .....	24
2.6 The History of Science and Children’s Conceptions .....	29
2.7 Science Education and Conceptual Change .....	34
2.8 Conclusion .....	44
<b>CHAPTER 3: THE HISTORY OF LIGHT AND OPTICS .....</b>	<b>50</b>
3.1 Introduction .....	50
3.2 The Nature of Light and Vision .....	51
3.2.1 Early Greek theories .....	52
3.2.2 Eastern Islamic theories .....	58
3.2.3 Western medieval theories .....	65
3.2.4 Theories in the 16 <sup>th</sup> and 17 <sup>th</sup> centuries .....	70
3.3 Light Meeting Matter .....	76
3.4 Light Propagation .....	80
3.5 Colour .....	85
3.6 Conclusion .....	90
<b>CHAPTER 4: CHILDREN’S CONCEPTIONS OF LIGHT .....</b>	<b>96</b>
4.1 Introduction .....	96
4.2 Identifying Children’s Conceptions .....	97
4.3 The Nature of Light – Key Ideas .....	99
4.4 Light Sources .....	102
4.5 Light Propagation .....	104
4.6 Shadows and Darkness .....	105
4.7 The Nature of Light and Vision .....	107
4.8 Colour .....	115
4.9 Interaction of Light with Matter .....	116
4.10 Conclusion .....	118

<b>CHAPTER 5: METHODOLOGY .....</b>	<b>123</b>
5.1 Research Design .....	123
5.2 School Selection/Participants .....	124
5.3 Design of Light Core Concepts Questionnaire .....	126
Question 1: Light sources .....	130
Question 2: Shadows and darkness .....	132
Question 3: Light propagation .....	132
Question 4: Light propagation .....	133
Question 5: Light propagation .....	133
Questions 6, 15 and 22: Shadows and darkness .....	134
Question 7: The nature of light and vision .....	136
Question 8, 9 and 10: The nature of light and vision .....	137
Question 11: Shadows and darkness .....	139
Question 12: Light propagation .....	139
Question 13: Light propagation .....	140
Question 14: Light sources .....	140
Question 16: Interaction of light with matter .....	141
Question 17: Interaction of light with matter .....	141
Question 18: Interaction of light with matter .....	141
Question 19: Light sources .....	143
Question 20: Colour .....	143
Question 21: Colour .....	144
5.4 Data Collection .....	144
5.5 Coding and Scoring .....	146
5.5.1 Independent rater .....	147
5.5.2 Open-ended questions .....	148
<b>CHAPTER 6: RESULTS .....</b>	<b>157</b>
6.1 Introduction .....	157
6.2 Summary of Correct Results .....	158
6.2.1 Overall correct performance .....	158
6.2.2 Gender .....	159
6.2.3 Ethnicity .....	160
6.2.4 Decile .....	162
6.2.5 Comparison of ethnicity, gender and decile .....	163
6.2.6 Comparison of question types .....	164
6.3 Light Sources .....	167
6.3.1 Overall performance for questions on light sources .....	168
6.3.2 Question 1 .....	169
6.3.3 Question 14 .....	173
6.3.4 Question 19 .....	174
6.4 Light Propagation .....	175
6.4.1 Overall performance for questions on light propagation .....	176
6.4.2 Question 3 .....	177
6.4.3 Question 4 .....	177
6.4.4 Question 5 .....	179
6.4.5 Question 12 .....	180
6.4.6 Question 13 .....	181
6.5 Shadows and Darkness .....	183
6.5.1 Overall performance for questions on shadows and darkness .....	183



6.5.2	Questions 2 and 11 .....	185
6.5.3	Questions 6, 15 and 22 .....	187
6.6	Light and Vision .....	192
6.6.1	Overall performance for questions on light and vision.....	193
6.6.2	Question 7.....	196
6.6.3	Question 8.....	197
6.6.4	Question 9.....	199
6.6.5	Question 10.....	203
6.7	Colour.....	209
6.7.1	Overall performance for questions on colour.....	209
6.7.2	Question 20.....	210
6.7.3	Question 21.....	211
6.8	Interaction of Light with Matter .....	212
6.8.1	Overall performance for questions on the interaction of light with matter....	214
6.8.2	Question 16.....	214
6.8.3	Question 17.....	216
6.8.4	Question 18.....	220
<b>CHAPTER 7: DISCUSSION .....</b>		<b>227</b>
7.1	Introduction .....	227
7.2	Overall Correct .....	228
7.3	Children’s Understanding of Light Concepts.....	230
7.3.1	Light sources .....	230
7.3.2	Light propagation.....	232
7.3.3	Shadows and darkness .....	236
7.3.4	The nature of light and vision.....	239
7.3.5	Colour.....	244
7.3.6	Interaction of light with matter.....	247
7.4	Gender, Ethnicity and Decile Effects.....	251
7.5	Conclusion.....	255
7.5.1	Instructional implications.....	258
7.5.2	Future research .....	260
<b>Appendices.....</b>		<b>264</b>
<b>References.....</b>		<b>277</b>

## List of Tables

---

Table 5.1: Ethnicity and decile percentages versus age group.....	125
Table 6.1: Overall correct performance, summary of post hoc Dunnett T Test Multiple comparisons between age groups.....	159
Table 6.2: Light sources concepts and question categories.....	167
Table 6.3: Question 1, children's perceptions of objects that produce light.....	170
Table 6.4: Question 1, children's perceptions of objects that do not produce light.....	171
Table 6.5: Light propagation concepts and question categories.....	175
Table 6.6: Shadows and darkness concepts and question categories.....	183
Table 6.7: Light and vision questions and concept categories.....	192
Table 6.8: Colour concepts and question categories.....	209
Table 6.9: Interaction of light with matter concepts and question categories.....	213

## List of Figures

---

Figure 3.1	Eastern Islamic theories. Version 1 Extramission; Version 2 Combination; Version 3 Intromission. ....	59
Figure 4.1	Key ideas and light concepts covered in the present study.....	102
Figure 5.1	Light concepts covered in the LCCQ .....	127
Figure 5.2	Question 1 .....	131
Figure 5.3	Question 5 .....	133
Figure 5.4	Question 6 .....	134
Figure 5.5	Question 15 .....	135
Figure 5.6	Question 22. ....	135
Figure 5.7	Question 7 .....	136
Figure 5.8	Question 8. ....	137
Figure 5.9	Question 9 .....	138
Figure 5.10	Question 10 .....	138
Figure 5.11	Question 18 .....	142
Figure 5.12	Question 8 correct and alternative conceptions categories .....	149
Figure 5.13	Questions 9 & 10 correct and alternative conceptions categories.....	150
Figure 5.14	Typical correct responses for Questions 18a, 18b, 18c, 18d.....	155
Figure 6.1	Overall correct performance for all questions across age groups.....	158
Figure 6.2	Overall correct performance across age groups for gender. ....	160
Figure 6.3	Overall correct performance across age groups for ethnicity .....	161
Figure 6.4	Overall correct performance across age groups for Māori children.....	161
Figure 6.5	Overall correct performance across age groups for school decile ratings.....	162

Figure 6.6	School decile range versus European/Pākehā and Pacific children for overall correct performance. ....	164
Figure 6.7	Comparison of question types: two-choice, multi-choice and open-ended. ....	166
Figure 6.8	Percentage correct across age groups Questions 1, 14 and 19. ....	168
Figure 6.9	Percentage correct across age groups, Questions 1, 14 and 19 Identification of light sources and non light sources. ....	168
Figure 6.10	Percentage correct across ages groups: Question 1 television. ....	170
Figure 6.11	Percentage correct across age groups Questions 1, 14 and 19. ....	172
Figure 6.12	Percentage correct across age groups: Question 1 bike reflector. ....	173
Figure 6.13	Percentage correct across ages groups: Question 14. ....	174
Figure 6.14	Percentage correct across ages groups: Question 19. ....	174
Figure 6.15	Correct Performance for Questions 3, 4, 5, 12 and 13. ....	176
Figure 6.16	Percentage correct across age groups: Question 3. ....	177
Figure 6.17	Percentage correct across age groups: Question 4. ....	178
Figure 6.18	Alternative conceptions across ages: Question 4. ....	178
Figure 6.19	Percentage correct across age groups: Question 5. ....	179
Figure 6.20	Alternative conceptions across age groups: Question 5. ....	180
Figure 6.21	Percentage correct across age groups: Question 12. ....	180
Figure 6.22	Alternative conceptions across age groups: Question 12. ....	181
Figure 6.23	Percentage correct across age groups: Question 13. ....	182
Figure 6.24	Alternative conceptions across age groups: Question 13. ....	182
Figure 6.25	Percentage correct across age groups: Questions 2 and 11. ....	185
Figure 6.26	Alternative conceptions across age groups: Question 11. ....	186
Figure 6.27	Percentage correct across age groups Questions 6, 15 and 22. ....	187
Figure 6.28	Question 6: correct example by a 10 year old boy drawing a shadow in relation to a person and the sun. ....	188

Figure 6.29 Question 15: correct example by a 6 year old boy drawing a sun in relation to a person and its shadow .....	188
Figure 6.30 Question 22: correct example by a 12 year old boy drawing a person in relation to its shadow and the sun .....	189
Figure 6.31 Alternative conceptions across age groups: Questions 6 and 15.....	190
Figure 6.32 Question 6: example of 8-year old girl's drawing a correct symbol (shadow) but placing it in an incorrect position in relation to the sun and person.....	190
Figure 6.33 Question 15: example of a 6-year old girl's drawing of the correct symbol (sun) but placing it in an incorrect position in relation to the person and its shadow .....	191
Figure 6.34 Question 22: example of 10-year old girl's drawing of the correct symbol (person) but placing it in an incorrect position in relation to the sun and shadow.....	191
Figure 6.35 Percentage correct across age groups Questions 7, 8, 9 and 10.....	194
Figure 6.36 Questions 7 and 8 correct and alternative conceptions categories .....	194
Figure 6.37 Questions 9 and 10 correct and alternative conceptions categories.....	195
Figure 6.38 Percentage correct across age groups: Question 7.....	196
Figure 6.39 Alternative conceptions across age groups: Question 7.....	197
Figure 6.40 Percentage correct across age groups: Question 8.....	197
Figure 6.41 Question 8: example of an 11-year old boy's depiction of the correct view.....	201
Figure 6.42 Alternative conceptions across age groups: Question 8.....	199
Figure 6.43 Question 8: example of a 9-year old boy's depiction of a combination extramission-intromission view.....	199
Figure 6.44 Percentage correct across age groups: Question 9.....	200
Figure 6.45 Question 9: example of an 11-year old girl's depiction of the correct view .....	200
Figure 6.46 Alternative conceptions across age groups: Question 9 .....	201
Figure 6.47 Question 9: example of a 6-year old girl's depiction of an extramission view.....	202

Figure 6.48 Question 9: example of an 8-year old girl's depiction of an Eastern Islamic view (version 1).....	202
Figure 6.49 Question 9: example of a 9-year old boy's depiction of an Eastern Islamic view (version 2).....	203
Figure 6.50 Percentage correct across age groups: Question 10.....	204
Figure 6.51 Alternative conceptions across age groups: Question 10. ....	205
Figure 6.52 Question 10: example of a 6-year old boy's depiction of an intromission view (version 1). ....	205
Figure 6.53 Question 10: example of an 8-year old girl's depiction of an extramission view.....	206
Figure 6.54 Question 10: example of a 6-year old girl's depiction of an Eastern Islamic view (version 1).....	206
Figure 6.55 Question 10: example of a 12-year old boy's depiction of an Eastern Islamic view (version 2).....	207
Figure 6.56 Question 9 (tree) and Question 10 (bear) Extramission responses.....	207
Figure 6.57 Question 9 (tree) and Question 10 (bear) Eastern Islamic responses .....	208
Figure 6.58 Question 9 (tree) and Question 10 (bear) Intromission responses .....	208
Figure 6.59 Percentage correct across age groups Questions 20 and 21.....	210
Figure 6.60 Alternative conceptions across age groups: Question 20.....	211
Figure 6.61 Alternative conceptions across age groups: Question 21.....	212
Figure 6.62 Percentage correct across age groups: Question 16.....	215
Figure 6.63 Alternative conceptions across age groups: Question 16.....	216
Figure 6.64 Percentage correct across age groups: Question 17.....	217
Figure 6.65 Alternative conceptions across age groups: Question 17 mirror. ....	218
Figure 6.66 Alternative conceptions across age groups: Question 17 white t-shirt. ....	219
Figure 6.67 Alternative conceptions across age groups: Question 17 black t-shirt.....	220
Figure 6.68 Percentage correct across age groups: Question 18.....	221

Figure 6.69	Representative correct response for Question 18.....	222
Figure 6.70	Children’s depictions of correct responses for what happens to light when it strikes a mirror, translucent and transparent glass and a piece of white wood.....	223
Figure 6.71	Alternative conceptions across age groups: Question 18 mirror.....	224
Figure 6.72	Alternative conceptions across age groups: Question 18 translucent glass.....	225
Figure 6.73	Alternative conceptions across age groups: Question 18 transparent glass.....	225
Figure 6.74	Alternative conceptions across age groups: Question 18 white wood.....	226