

2021

Light Dance: Beyond the Dichotomy of Light and Vision

Riskin, Seth

<http://hdl.handle.net/10026.1/17787>

<http://dx.doi.org/10.24382/385>

University of Plymouth

All content in PEARL is protected by copyright law. Author manuscripts are made available in accordance with publisher policies. Please cite only the published version using the details provided on the item record or document. In the absence of an open licence (e.g. Creative Commons), permissions for further reuse of content should be sought from the publisher or author.

Copyright Statement

This copy of the thesis has been supplied on condition that anyone who consults it is understood to recognise that its copyright rests with its author and that no quotation from the thesis and no information derived from it may be published without the author's prior consent.



**UNIVERSITY OF
PLYMOUTH**

Light Dance: Beyond the Dichotomy of Light and Vision

by

SETH RISKIN

A thesis submitted to the University of Plymouth
in partial fulfilment for the degree of

DOCTOR OF PHILOSOPHY

School of Art, Design and Architecture

August 2021

Acknowledgements

Dedicated to my parents Annette Green Riskin and Martin Riskin.

Return love to my family Donna, Sofia, Eden (Delphi) and Frida for the love that makes the work matter.

Heartfelt thanks to Professor Roy Ascott whose luminary ideas and works extended my vision.

Thanks to Professors Jane Grant and Mike Philips for their guidance and empathy.

Gratitude to Professor Pawan Sinha and Sarah Schwetmann for the ongoing collaboration that nourishes my ideas.

Thanks to Joel Simundich for perceptive editing support.

Thanks to Allan Doyle for his patient ear, insights and photography throughout.

Author's Declaration

At no time during the registration for the degree of *Doctor of Philosophy* has the author been registered for any other University award without prior agreement of the Doctoral College Quality Sub-Committee.

Work submitted for this research degree at the University of Plymouth has not formed part of any other degree either at the University of Plymouth or at another establishment.

A programme of advanced study was undertaken, which included nine intensive research sessions over the period 2013 through 2017. I presented my work, with intensive critiques by University of Plymouth professors and fellow students in each of the sessions.

Relevant conferences were regularly attended at which work was presented; external institutions were visited for consultation purposes; and papers prepared for publication.

The following external institutions were visited for consultation purposes: Massachusetts Institute of Technology, Cambridge, Massachusetts, USA.

Publications:

Riskin, S. (2020). "Light Dance." *Leonardo Journal, The International Society for the Arts, Sciences and Technology* 53(1), pp. 341-350. doi: https://doi.org/10.1162/leon_a_01636

Riskin, S. (2015). "Undivided Light." *Technoetic Arts: A Journal of Speculative Research: Consciousness Reframed* 13(3), pp. 90-91. doi: https://doi.org/10.1386/tear.13.3.341_1

Presentations at conferences:

Balance/Unbalance: A Sense of Place, University of Plymouth, 21-23 April 2017

Art and Consciousness in the Post-Biological Era Conference, Shanghai Institute of Visual Art, Shanghai, China, 26-27 November 2016

Cairotronica, American University in Cairo, Cairo, Egypt, 3-10 May 2016

The Atemporal Image Conference at the Intersections of Art, Science and Culture, University of Plymouth, 1-3 July 2016

Ionian Center for Arts and Culture, Kefalonia, Greece, 21 April 2015

i-DAT, Plymouth University, UK, 24 April 2015

The Matter of the Immaterial, De Tao Masters Academy, Shanghai, China, 20-22 November 2015

The Undivided Mind: Exploring Boundaries Between Minds and Worlds, University of Plymouth, 16-18 July 2015

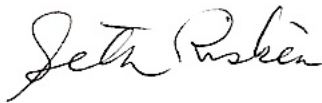
Fourth Computer Arts Conference, Cidade Universitária, Ilha do Fundão, Rio de Janeiro, 1-3
September 2014

Ionian Center for Arts and Culture, Kefalonia, Greece, 4 May 2014

COST Arts & Technologies Workshop, European Science Foundation, Zagreb, Croatia, 25-27
November 2013

Word count of main body of thesis: 50, 774

Signed

A handwritten signature in black ink, appearing to read 'Seth Ruskin'. The signature is fluid and cursive, with the first name 'Seth' and last name 'Ruskin' clearly distinguishable.

Date 11 March 2021

ABSTRACT

Light Dance: Beyond the Dichotomy of Light and Vision

Seth Riskin

This practice-based dissertation focuses on Light Dance, an original artistic practice developed by the author that, in reducing light to its core elements in a setting devoid of other sources of illumination, centers the equivalence of light and vision in experience. Moving with projection instruments attached to his body, the artist articulates geometrically elemental light forms on the boundaries of the room. Through unique artistic technologies and methods, Light Dance creates a visual environment in which light is perceived as a reflexive experience of vision, an inversion of our ordinary visual experience. These Light Dance experiences—shaping as they do primary perceptions of space and time through the manipulation of light—speak to the early visual system of the brain, provoking new concepts. In turn, the author shows how this inverted perspective has implications for the epistemic paradigm under which light and vision currently operate, especially as reflected in the relationship between visual art and vision neuroscience.

To come to a realization of this inverted order, the research undertaken in this study pursues a reflexive process applied to the Light Dance practice, where the artist's writings, illustrations, and photo documentation of past performances are used to generate a series of postulates testing this refined understanding of light and vision. Working closely with this documentation, the author builds upon the postulates to a thesis statement proposing a principle of equivalence between light and vision. The postulates and thesis are subsequently tested through a series of light array experiments designed by the author to photographically document and evidence

details of the unique spatiotemporal perceptual experiences generated by Light Dance performances.

Upon situating this reflexive study in epistemic evidence, the author then traces the genesis of this reflexive practice to forebearers in the Light Art tradition: Thomas Wilfred, László Moholy-Nagy, Otto Piene, and James Turrell. Examining how these artistic forebearers begin to establish a nascent practice of seeing into perception by working with light as a medium, the author then returns to reexamine Light Dance as a process of perceiving perceptual construction. By pursuing artistic practice in situ, Light Dance ultimately presents new knowledge concerning the relationship between light and vision as well as reworks the relationship between artistic practice and vision neuroscience, centering artistic insight not as corroboration of scientific theory, but as companion—and at times, as lead—to discoveries on the nature of perception.

TABLE OF CONTENTS

ACKNOWLEDGEMENT	3
AUTHOR’S DECLARATION	4
ABSTRACT	7
TABLE OF CONTENTS	9
LIST OF FIGURES	13
PREFACE.....	22
INTRODUCTION	31
“I See Light”	31
Opportunity and Aims of the Thesis	33
Argument and Method	39
Background and Origin of Light Dance	44
Light Dance in Practice	49
Two Ways of Seeing: Seeing Concepts and Direct Perception.....	51
Epistemic Inversion	57
Purpose and Research Questions	60
On the Practice-Based Nature of the Thesis	62
Overview of Chapters.....	63
 1. POSTULATES AND THESIS AS DRAWN FROM THE LIGHT DANCE	
EXPERIENCE.....	67
1.1 Light Dance as Reflexive Study of Vision	67
1.2 Postulates	70
1.2.1 Postulate 1: Light in the Light Dance experience is spatially and temporally ambiguous	70
1.2.2 Postulate 2: Movement of the light defines spatiotemporal structures in perception	79
1.2.3 Postulate 3: The spatiotemporal order defined by the light is the inverse of our ordinary visual perspective	85
1.2.4 Postulate 4: Light in Light Dance <i>plays the role of a slice of vision, if it,</i>	

<i>and not the material environment, were visible</i>	95
1.2.5 Thesis Statement: What we call “light” is vision conceptualized and projected as a physical phenomenon; what we call “vision” is pre-conceptualized light.....	100
1.3. Testing the Postulates and Thesis.....	111
2. THE RED LIGHT AND LIGHT LINE EXPERIMENTS	113
2.1 Introduction: Testing the Light Dance Postulates	113
2.1.1 Rearticulation of Thesis.....	113
2.1.2. On the Problem of Multiple Viewpoints: Actors and Manifolds	116
2.1.3. Overview of Chapter	119
2.1.4. On Method and Setup of Experiments	124
2.2 Experiments for Postulate 1: Light in the Light Dance experience is spatially and temporally ambiguous	127
2.2.1 Postulate 1, Experiment 1 (A line of brightness)	127
2.2.2 Postulate 1, Experiment 2 (A line of brightness with low, ambient illumination)	127
2.3 Experiments for Postulate 2: Movement of the line of brightness articulates higher-level spatiotemporal structures in perception.....	128
2.3.1 Postulate 2, Experiment 1 (A line of brightness in translatory movement about one axis).....	129
2.3.2 Postulate 2, Experiment 2 (A line of brightness translates and grows).....	130
2.3.3 Postulate 2, Experiment 3 (A line of brightness in translating about two axes and slowing)	130
2.3.4 Observations on Postulate 2 Experiments	134
2.4 Experiments for Postulate 3: The visual space geometry experienced in Light Dance is the inverse of our ordinary visual perspective.....	135
2.4.1 Postulate 3, Experiment 1 (Comparison of brightness and material geometries: grid).....	136
2.4.2 Postulate 3, Experiment 2 (Comparison of the brightness and material geometries: parallel lines).....	141

2.4.3 Observations on Postulate 3, Experiments 1 and 2	143
2.4.4 Postulate 3, Experiment 3 (Perspectives)	145
2.4.5 Observations on Postulate 3, Experiment 3	150
2.5 Experiments for Postulate 4: The Light Dance elemental unit of brightness— spatiotemporally constricted, originating from the body, moved to acquire information— <i>plays the role of a slice of vision, if it, and not the material environment, were visible.</i>	152
2.5.1 Postulate 4, Experiment 1 (Solid cube)	153
2.5.2 Postulate 4, Experiment 2 (Lattice cube)	154
2.5.3 Postulate 4, Experiment 3 (Plane and line of light)	155
2.5.4 Postulate 4, Experiment 4 (Architectural corner and a line of light)	156
2.5.5 Observations on Postulate 4 Experiments	157
2.6 Conclusion	160
 3. APPROACHING LIGHT AS REFLEXIVE VISION: PRECEDENTS OF THE LIGHT DANCE ART FORM	162
3.1 Introduction: Light Art	162
3.2 Thomas Wilfred: <i>Lumia</i> and the First and Second Fields	168
3.3. László Moholy-Nagy: <i>Light-Space Modulator</i> and “Vision in Motion”	172
3.4. Otto Piene, <i>Light Ballet</i> and “Purity of Light”	178
3.5. James Turrell: Equiluminant Light Fields and “Perceiving Perception”	185
3.6 Perceptual Inversion	192
 4. LIGHT DANCE PARADIGM AND ANALYSIS OF A PERFORMANCE	197
4.1 On the Reflexive Experience of Vision	197
4.1.1 Overview of Chapter	197
4.1.2 From Perceptual Observations Back to Concepts: Rearticulation of Thesis	198
4.2. <i>Circles</i>	201
4.3. Conclusion	217

CONCLUSION	219
Overview of Purpose	219
Research Questions and Summary of Findings.....	220
New Vision: Reimagining the Conversation between Visual Art and Vision Neuroscience	226
Contributions to New Knowledge, Part I: The View from Light Dance on the Inverse Optics Problem	233
Contributions to New Knowledge, Part II: Visual Art, Vision Neuroscience and the Receptive Field	238
“Through Light I See Vision”	247
APPENDIX I: GLOSSARY	251
SELECTED BIBLIOGRAPHY	262

LIST OF FIGURES

Figure 0.1. <i>Light Dance</i> , Seth Riskin, M.I.T. Center for Advanced Visual Studies, 1987. Photo: Ellen Sebring.....	26
Figure 0.2. <i>Light Dance</i> , Seth Riskin, M.I.T. Center for Advanced Visual Studies, 1989. Photo: Noah Riskin.	26
Figure 0.3. <i>Light Dance</i> , Seth Riskin, M.I.T. Center for Advanced Visual Studies, 1987. Photo: Bill Seaman.	27
Figure 0.4. <i>Light Dance</i> , Seth Riskin, M.I.T. Center for Advanced Visual Studies, 1989. Photo: Noah Riskin.	35
Figure 0.5. Early drawing of the Light Dance experience: conjunction of the body and light through movement expressed in radial spacetime. Source: Seth Riskin.	40
Figure 0.6. [top] Original Light Dance concept drawings, Seth Riskin, M.I.T., 1987: A light projector mounted on the back of the performer casts a sheet of light to the boundaries of the room, seen as a light-line circumscription of the space. As the performer swings on the parallel bars, the sheet of light tumbles and turns, effecting sensations of movement within the viewers. Source: Seth Riskin.	44
Figure 0.7. [bottom] Original Light Dance concept drawings, Seth Riskin, M.I.T., 1987: A light projector mounted on the back of the performer casts a sheet of light to the boundaries of the room, seen as a light-line circumscription of the space. As the performer swings on the parallel bars, the sheet of light tumbles and turns, effecting sensations of movement within the viewers. Source: Seth Riskin.	45
Figure 0.8. Original Light Dance concept drawing, Seth Riskin, M.I.T., 1987: Owing to the deprivation of visual information in the Light Dance environment, the viewers experience the ring of light not within space and time, but defining space and time as the performer moves. Using low-dimensional light, body movements are translated in terms of perceptual space and time. Subjective experience of space and time, i.e., vision, is extended into a collective experience. Source: Seth Riskin.	45
Figure 0.9. <i>Light Dance</i> , György Kepes Memorial, M.I.T. 2002; entire performance in single exposure. Photo: Walter Dent.	48
Figure 0.10. Close-up of Light Dance perceptual spacetime structuring. Photo: Allan Doyle.	57
Figure 1.1. [top] The Light Dance performer effects dimensional perceptions through body	

movements. Photo: Allan Doyle.....	69
Figure 1.2. [bottom] The Light Dance performer effects dimensional perceptions through body movements. Photo: Allan Doyle.....	69
Figure 1.3. Light Dance instruments “cut” elemental geometric units from the sphere of light that propagates from a point-source. Source: Seth Riskin.	71
Figure 1.4 [left] Light cones cast from the body to the wall surface are visible as circles. Source for image and photo: Seth Riskin.	71
Figure 1.5 [right]: Light cones cast from the body to the wall surface are visible as circles. Source: Seth Riskin. Photo: Allan Doyle	71
Figure 1.6: The ongoing, perceptual origin of the world in concept: location of the self-experience. Source: Seth Riskin.	73
Figure 1.7: Close attention to the experience of light in context of perception of the physical world reveals that it does not stand as an object but is a point of “collapse” into the subject-experience. Source: Seth Riskin.	74
Figure 1.8: Visual world squeezed down to a sliver, foregrounding a perceptually primitive experience of light before dimensionality of space, time and objects. Photo: Allan Doyle.	75
Figure 1.9 [top]: A line of light is cast from the body. The body pivots counterclockwise, sweeping out a plane in perception. Compound movements of the body effect two-dimensional manifolds in three-dimensional perceptual space. Photo: Allan Doyle.....	81
Figure 1.10 [bottom]: A line of light is cast from the body. The body pivots counterclockwise, sweeping out a plane in perception. Compound movements of the body effect two-dimensional manifolds in three-dimensional perceptual space. Photo: Allan Doyle.....	81
Figure 1.11 [left]: Studies of the visual perspective order of material objects illuminated by ambient light for comparison with Light Dance projections and the inverse perspective order they articulate. Source: Seth Riskin.	86
Figure 1.12 [middle]: Studies of the visual perspective order of material objects illuminated by ambient light for comparison with Light Dance projections and the inverse perspective order they articulate. Source: Seth Riskin.	86
Figure 1.13 [right]: Studies of the visual perspective order of material objects illuminated by ambient light for comparison with Light Dance projections and the inverse perspective order they articulate. Source: Seth Riskin.	86
Figure 1.14: Light-point grids vividly describe the inverse perspective order experienced in Light Dance. Photo: Nicholas Desponds.....	87

Figure 1.15: Studies of the inverse geometries of illuminated material and the visual field, ordinarily invisible for the material objects seen. Source: Seth Riskin.....	89
Figures 1.16 [left]: Studies of the visual perspective order of illuminated material (ordinary visual perspective) and the inverse visual perspective order of projected light made visible by Light Dance techniques. Source: Seth Riskin.....	90
Figure 1.17 [right]: Studies of the visual perspective order of illuminated material (ordinary visual perspective) and the inverse visual perspective order of projected light made visible by Light Dance techniques. Source: Seth Riskin.....	90
Figure 1.18: Figure and ground in early visual perception develop equally and oppositely. Source: Seth Riskin.	91
Figure 1.19: Study of the perspectives of the actors in the Light Dance performance (performer, viewer and light source) on the brightness geometry. Source: Seth Riskin.	92
Figure 1.20 [left]: Figure and ground: study of the inversely proportional perspective orders of illuminated material and light seen by way of material. Source: Seth Riskin.....	94
Figure 1.21 [right]: Figure and ground: study of the inversely proportional perspective orders of illuminated material and light seen by way of material. Source: Seth Riskin.....	94
Figure 1.22 [left]: Study of size and speed correlation in inversely proportional perspective orders of illuminated material and light seen by way of material. Source: Seth Riskin. ..	94
Figure 1.23 [left]: The perceptual objects of the Light Dance experience describe angular directions and radial distances from the source, resulting in curvatures. Source: Seth Riskin.....	96
Figure 1.24 [right]: The perceptual objects of the Light Dance experience describe angular directions and radial distances from the source, resulting in curvatures. Source: Seth Riskin.....	96
Figure 1.25: The geometry of the Light Dance experience is radial, referring to the point-source of light mounted on the body and expanding in size and speed with distance. Source: Seth Riskin.....	97
Figure 1.26: The inverse perspective orders of vision and material seen by vision. Source: Seth Riskin.....	99
Figure 1.27: “Curvature” of advancing knowledge of light and vision: one leads to the other. Source: Seth Riskin.	99
Figure 1.28: From the perspective of the perceiving subject, the continuum of light and vision brings “curvature” to visual experience at all levels, perceptual and conceptual. Source: Seth Riskin.....	102

Figure 1.29: The physical-world experience references the viewer in shape and dynamics, presenting an inverse, counterpart order to that of the physical-world concept. Source: Seth Riskin.....	109
Figure 2.1: Red Line Experiments equipment view: Handheld laser line projector swept right to left over a plaster wall surface marked with a 3” square grid. Photo: Seth Riskin.	125
Figure 2.2: Red Line Experiments equipment view: A laser light source, beam-shaping optics and batteries are mounted on an optics breadboard, fixed on a tripod with a grip-action ball head; beam-shaping optics were changed out for line and cross projections. Photo: Seth Riskin.	125
Figure 2.3: Light Line Experiments equipment view: Motorized system for sweeping a line of light over rotating objects; light from a source at the back of the system (top center) passes through a series of slit apertures before reaching a front-surface mirror (far right); the mirror rotates, sweeping the line of light over the plaster cubes, themselves spinning on adjustable-speed motors. Photo: Allan Doyle.	126
Figure 2.4: A line of brightness. Photo: Seth Riskin.	127
Figure 2.5: A line of brightness with low, ambient illumination. Photo: Seth Riskin.	128
Figure 2.6 [left]: A line of brightness. Photo: Seth Riskin.	129
Figure 2.7 [right]: A line of brightness in translatory movement. Photo: Seth Riskin.....	129
Figure 2.8: A line of brightness translates and grows. Photo: Seth Riskin.	130
Figure 2.9: A line of brightness translates about two axes and slows. Photo: Seth Riskin.	131
Figure 2.10 [left]: Different planar shapes and their brightness-intensity distributions. Photo: Seth Riskin.....	131
Figure 2.11 [second from left]: Different planar shapes and their brightness-intensity distributions. Photo: Seth Riskin.	131
Figure 2.12 [second from right]: Different planar shapes and their brightness-intensity distributions. Photo: Seth Riskin.	131
Figure 2.13 [right]: Different planar shapes and their brightness-intensity distributions. Photo: Seth Riskin.....	131
Figure 2.14: Multi-exposure of plane in motion. Photo: Seth Riskin.....	132
Figure 2.15: A folded plane. Photo: Seth Riskin.	132
Figure 2.16 [left]: Two-dimensional cross. Photo: Seth Riskin.	133
Figure 2.17 [right]: “Extruded cross.” Photo: Seth Riskin.	133

Figure 2.18: Deep cross “extrusion.” Photo: Seth Riskin.....	134
Figures 2.19 [left]: Sequence showing original line projection, perceptual plane and manifold generated from right-to-left sweep. Photo: Seth Riskin.	137
Figure 2.20 [middle]: Sequence showing original line projection, perceptual plane and manifold generated from right-to-left sweep. Photo: Seth Riskin.	137
Figure 2.21 [right]: Sequence showing original line projection, perceptual plane and manifold generated from right-to-left sweep. Photo: Seth Riskin.....	137
Figure 2.22 [left]: Distinct, two-dimensional manifolds defined by shape, size and intensity distributions. Photo: Seth Riskin.	137
Figure 2.23 [right]: Distinct, two-dimensional manifolds defined by shape, size and intensity distributions. Photo: Seth Riskin.	137
Figure 2.24: Ribbon manifold. Photo: Seth Riskin.	138
Figure 2.25: Movement of cross projection. Photo: Seth Riskin.....	139
Figure 2.26: Long-sweep cross figure. Photo: Seth Riskin.	139
Figure 2.27 [left]: Complex movement of two-dimensional cross figure. Photo: Seth Riskin. ...	140
Figure 2.28 [right]: Complex movement of two-dimensional cross figure. Photo: Seth Riskin..	140
Figure 2.29: Detail of a locally two-dimensional manifold seen globally as a three-dimensional brightness form. Photo: Seth Riskin.	141
Figure 2.30: Sweeping vertical line of brightness grows in size and speed with distance. Photo: Seth Riskin.....	142
Figure 2.31: Relative to the sharply converging ruled lines, the sweeping cross exhibits inverse depth space. Photo: Seth Riskin.	143
Figure 2.32 [left]: Sequence of views on a line of light projected into an architectural corner. Photo: Seth Riskin.	147
Figure 2.33 [second from left]: Sequence of views on a line of light projected into an architectural corner. Photo: Seth Riskin.	147
Figure 2.34 [third from left]: Sequence of views on a line of light projected into an architectural corner. Photo: Seth Riskin.	147
Figure 2.35 [third from right]: Sequence of views on a line of light projected into an architectural corner. Photo: Seth Riskin.	147
Figure 2.36 [second from right]: Sequence of views on a line of light projected into an architectural corner. Photo: Seth Riskin.	147
Figure 2.37 [right]: Sequence of views on a line of light projected into an architectural corner. Photo: Seth Riskin.	147

Figure 2.38 [left]: A cross of light projected onto an architectural structure. Photo: Seth Riskin.	147
Figure 2.39 [second from left]: A cross of light projected onto an architectural structure. Photo: Seth Riskin.....	147
Figure 2.40 [second from right]: A cross of light projected onto an architectural structure. Photo: Seth Riskin.....	147
Figure 2.41 [right]: A cross of light projected onto an architectural structure. Photo: Seth Riskin.....	147
Figure 2.42 [left]: A cross folded into a corridor. Photo: Seth Riskin.	148
Figure 2.43 [right]: A cross folded into a corridor. Photo: Seth Riskin.	148
Figure 2.44 [left]: A cross of light projected to a wall, intercepted by a sheet of paper. Photo: Seth Riskin.....	149
Figure 2.45 [second from left]: A cross of light projected to a wall, intercepted by a sheet of paper. Photo: Seth Riskin.	149
Figure 2.46 [second from right]: A cross of light projected to a wall, intercepted by a sheet of paper. Photo: Seth Riskin.	149
Figure 2.47 [right]: A cross of light projected to a wall, intercepted by a sheet of paper. Photo: Seth Riskin.....	149
Figure 2.48 [left]: Fixed cube and line of brightness. Photo: Seth Riskin.	153
Figure 2.49 [right]: Transformed cube resulting from sweep of the line over rotating cube. Photo: Seth Riskin.	153
Figure 2.50 [left]: A fixed lattice cube. Photo: Seth Riskin.	154
Figure 2.51 [right]: A transformed lattice cube. Photo: Seth Riskin.	154
Figure 2.52 [left]: A fixed plane and a line of light. Photo: Seth Riskin.....	155
Figure 2.53 [right]: A transformed plane. Photo: Seth Riskin.....	155
Figure 2.54: A twisted plane. Photo: Seth Riskin.....	155
Figure 2.55 [left]: A fixed wood corner and line. Photo: Seth Riskin.....	156
Figure 2.56 [right]: A transformed corner. Photo: Seth Riskin.	156
Figure 2.57: Comparison between Light Dance visual experience and ordinary visual experience.....	157

Figure 3.1: Wilfred’s illustration of the “first and second fields” in the Lumia experience. The “first field,” the physical, luminous imagery moving within the bounds of the frame generates the “second field,” the perceptual space that extends far beyond the frame.

Source: <i>Lumia: Thomas Wilfred and the Art of Light</i> , Yale University Press.	170
Figure 3.2: <i>The Light-Space Modulator</i> . Source: Harvard Art Museum.....	174
Figure 3.3: Still from <i>Lichtspiel Schwarz-weiss-grau</i> (1930) showing the results of a beam of light cast through a perforated disc: light/shadow interplay.	176
Figure 3.4: Close of <i>Light Ballet</i> filament and reflector. Photo: Allan Doyle, 2018.	179
Figure 3.5: <i>Light Ballet</i> filament projections. Source: Seth Riskin.....	180
Figure 3.6: <i>Flying People</i> , Otto Piene, 1952. Photo: Seth Riskin.	181
Figure 3.7: Early mechanization/electrical programming of <i>Light Ballet</i> , first solo exhibition in Düsseldorf, 1959. Source: Center for Art and Media, Karlsruhe, Germany.....	182
Figure 3.8: Hand-cut grid for early Light Ballet, 1961. Source: ZERO Foundation, Düsseldorf, Germany	183
Figure 3.9: Early Light Ballet projection through grid. Light Ballet was originally a hand- operated performance, later mechanized. Source: ZERO Foundation, Düsseldorf, Germany.	183
Figure 3.10: Developed, mechanized Light Ballet (2000s). The light sources turn on and off in sequenced program. Source: Seth Riskin.	185
Figure 3.11: James Turrell, <i>Afrum I (White)</i> , 1967. Source: Solomon R. Guggenheim Museum.	188
Figure 3.12: James Turrell, <i>Prado (White)</i> , 1967. Source: Solomon R. Guggenheim Museum.	188
Figure 3.13: James Turrell, <i>Perfectly Clear (Ganzfeld)</i> , 1991. Source: The Massachusetts Museum of Contemporary Art.	189
Figure 4.1: In total darkness, light is cast from the performer's body. Source: Seth Riskin.....	203
Figures 4.2 [top] and 4.3 [bottom]: With the slightest movement, the circle expands spatially and temporally, as changes to the shape, size and speed manifest visually. Source: Seth Riskin.....	204
Figure 4.4: With movement, the circle becomes a time-embodied form, unfolding in perception from the moving present and location of the light source. Source: Seth Riskin.	205
Figure 4.5 [top] and 4.6 [bottom]: Linked space, time and form open in perception, clearly of a different order than the space and time of the "host" environment. Source: Seth Riskin.....	206
Figure 4.7 [top] and 4.8 [bottom]: With movement, the original, two-dimensional circle	

expands into a spatiotemporal structure in perception. Perceptually-integrated changes (transformations) articulate higher-order geometries in the minds of the viewers and performer. Source: Seth Riskin.	207
Figure 4.9 [top] and 4.10 [bottom]: Structure and rules of the perceptual spacetime defined by the brightness begin to reveal themselves, e.g., the cylinders grow in size and speed with distance from the body. Source: Seth Riskin.	208
Figure 4.11: Global characteristics of the spatiotemporal brightness-structure in perception: continual unfolding from the moving present and location of the point source on the performer's body; radial geometry, originating from and referring back to the source. Source: Seth Riskin.	209
Figure 4.12: The Light Dance elemental unit of brightness, in this case a circle, plays the role of a concentric, circular slice of the cone of vision, if it, and not the material environment, were visible. Source: Seth Riskin.	210
Figure 4.13: Light Dance geometry shows us the slice of the cone of vision as it is cut by the material architecture. This concept accounts for the transformations. They are cross sections of the slice of the cone of vision, extending and moving from the body and intersecting the material architecture in a sequence of angles and distances. Source: Seth Riskin.	211
Figure 4.14: The circle smears into a curved sheet, a two-dimensional manifold experienced in three-dimensional perceptual space. Source: Seth Riskin.	212
Figure 4.15: The performer sweeps out two-dimensional manifolds with bright points of tight transition—"singularities." Source: Seth Riskin.	213
Figure 4.16: Time-trace of the cone of vision. The circle-slice of the projected receptive field sweeps radially in a visible seeing process that embodies time in its global structure, evidenced by spacetime transformations, such as the shadow of the arm, elongated. Source: Seth Riskin.	214
Figure 4.17: What it is like to see: a process of constant unfolding in the present about a locus of movement. My body is the center of an envelope, the shape of which is constant, the patterns of which change. Patterns flow through the present, located around me, making an envelope of early information. Source: Seth Riskin.	216
Figure 4.18: Light Dance demonstrates a principle of equivalence between vision and light. The projection, here the circle, is equal to a geometrically elemental portion of the projected receptive field, which, in itself, has no spatiotemporal information, rather is the receptive field of changing patterns of visual information. For the viewers and	

performer, the changing bright/dark patterns perceptually construct/are experienced as time-based volumes in visual space. The cone of vision sweeps through the environment in a seeing process made visible. Source: Seth Riskin.....	217
Figure 5.1: A given angle projected on the retina may come from various objects at various angles, of varying lengths, and with varying orientations in space. Source: Purves et al., 2001.	235
Figure 5.2: Responses of a cell in the cat's striate cortex to a 1° spot of light. At left, the field location of the spot and electrical responses; at right, the complete map showing areas of excitation (x) and inhibition (Δ). Source: Hubel and Wiesel, 1959, p. 577.	241
Figure 5.3: a-e: X-axis, time (x, t) plots of bars moving left or right at various speeds. f: Motion is like orientation in (x, t), and a spatiotemporally oriented receptive field can be used to detect it. g: The same oriented receptive field can respond to sampled motion just as it responds to continuous motion. Here, constant velocity plots as a straight line, while accelerated movement would result in a curved line. Source: Adelson and Bergen, 1985, p. 288.	242
Figure 5.4: Geometric interpretation of spacetime. Source: Hand-colored transparency presented by Minkowski in his 1908 Raum und Zeit lecture.	244

PREFACE

Being Here and There at Once

The thesis at the heart of this dissertation stems from the visual experiences afforded by my Light Dance artwork, an original practice that uses light projected from my body to create perceptual environments that act upon the primary functions of our visual faculties. Elemental light forms manipulated by my body in the otherwise totally dark environment stimulate dialogue with the visceral dimensions of perception. The “early” perceptual experiences evoked by the art practice, specifically fundamental structures of space and time, set the focus of the dissertation, with the goal of raising the intrinsic knowledge of the art practice to the level of thesis.

As a preface to the dissertation, I will give a firsthand, personal account of some of the experiences and conditions that contributed to the origination of Light Dance. These impressions and notions, while vague in conception, have been the motivating force behind my art and the guiding compass of its development. The following experiences are therefore important to understanding the thesis origin and, in connection, Light Dance as a method of exploration and discovery at the transition between perception and thought.

Seeing my identical twin has a quality different from that of seeing other people. The view of my twin is like seeing myself from the outside. Though I have learned to interpret the view of my

brother as that of a separate individual, there remains an element of selfsameness that conflicts, as it coexists, with the experience of another, physically distant person.

Seeing my identical twin, I experience a sense of oneness that consists of both me and my brother. Even while experiencing each other as independent individuals, with bodies separated in space and time, we feel connected in a way that transcends the distance. In what follows, I describe this both as “extension” and “collapse”: both descriptors point at the sensation of overcoming the distance between us. My brother is like a wormhole in the spatiotemporal structure of the scene that I see, where the “me-experience” is identical with the “he-experience.”

Feeling this trace “singularity” is both familiar, consistently present, and yet a paradox against the conventional way that we, as human beings, conceive ourselves in the context of the world around us. Reconciling these experiences—twin singularity and the conventional concept of having a physical body localized and separate from other bodies and things in the physical world—has propelled my art and thought.

There is a great learning opportunity in having sight of another person and feeling to be *in* that body—no separation or distance. Here is a sensation of bi-locality. Is this experience mistaken, or does this experience, rooted in an unusual human biological condition, have something to tell us about ourselves and the world?

I believe that having an identical twin through the course of my visual development attuned me to the subjective element inherent in the view of what we learn to interpret as another being, or

physical object in the world. Twin experience primed me to perceive my own perception; it sensitized me to the trace of my own perceptual construction in the “outer world” we experience.

My brother and I walked on our hands before we knew there was a sport of gymnastics. I have often wondered why: what compelled us? I reflect on the excitement we shared in watching each other move, like the visual sensations played within our bodies, inciting physical emulation. Gymnastics provided a framework for a dialogue of movement between twin bodies. The sport emphasized precision that required acute awareness of one’s body in space and time. It was like we were learning to see our bodies from inside and outside, leading to a high degree of control that fueled our progress in the sport.

The experience I shared with my twin, with its euphoric quality of inhabiting distance, fueled the testing of the limits of our bodies through gymnastics and came to apply elsewhere in my relationship to the world. The feeling of being here and there at once that I know from my twinhood, I recognized at a young age in looking at light. The first chapter of this dissertation begins with an introspective account of the experience of seeing light as an element within a visual scene, e.g., the highlight on the shoulder of a bottle. Visual focus on this “piece” of light reveals that it does not situate in space like other objects. This bounded unit of nondescript brightness cannot be located in depth; it is as much a sensation as an object perceived; it locates both “here,” in me, and “out there,” at a distance. In the fabric of my visual world, my twin and light are located both within the scene *and* with me. The profoundness of the experience and the problems it posed concerning visual perception propelled my art as a means of exploration, first

through the vehicle of painting and then through the art form designed for the purpose: Light Dance.

As a student of visual art at Ohio State University, I was not interested in “picture-making,” but painting as a vehicle for shaping the inner state of the viewers. Using large, square canvases, I filled the viewer’s field of view with a language of abstraction, primitive visual elements (points, lines, shapes, color fields) arranged in centralized compositions, designed to capture and steer visual attention prior to cognitive interpretation, at the level of primary perceptual structuring. Applying paint to canvas was a means of manipulating the light reflected to the eye and thereby constructing experiences in the minds of viewers. My paintings were to be “transparent” to inner sensations, closing the distance between the artist and viewer.

In 1987, I began graduate school at the M.I.T. Center for Advanced Visual Studies (C.A.V.S.). C.A.V.S. Director Otto Piene (after reminding the graduate students of the cost of tuition) exhorted “Define your dream project!” In response, I drew the human figure in gymnastics movement extended by a ring of light. Light had properties matching my artistic vision. Working with light, I experienced “extension,” a feeling of “embodying” space and time through the way it connected my hand holding the source and the distant wall surface where the light was seen. Through experiential study, I isolated and pronounced this sensation, and I devised instruments for controlling the light forms with my body. Light enabled me to transpose my body movements to the surfaces of the room, thereby effecting movement experiences within viewers. Through the efficacy of light, my subjective experiences of body movement became collective.

The first projector I created was fit with a harness and cast a sheet of light parallel to my back, seen as a light-line circumscription of the room.



Figures 0.1 and 0.2, top to bottom: *Light Dance*, Seth Riskin, M.I.T. Center for Advanced Visual Studies, 1987. Top photo: Ellen Sebring, bottom photo: Noah Riskin.¹

¹ Photographs, illustrations, and figures related to or captured from *Light Dance* performances or my notes are drawn from the author's personal collection and are property of the author.

C.A.V.S. had a space for experimental installation and performance, a white, windowless, 30' cubic room called "the pit," the site of my original experiments and performances. In the room set in complete darkness, I introduced the sheet of light, and experienced the visual analog of seeing my twin: the light enabled me to "embody" space. It transposed and abstracted my movements into low-dimensional visual information that shaped the viewer's perceptual experiences. I had created an original artistic practice and art form that I called "Light Dance."

Initially, I performed on the parallel bars, tumbling and turning the light plane in space.



Figure 0.3: *Light Dance*, Seth Riskin, M.I.T. Center for Advanced Visual Studies, 1987. Photo: Bill Seaman.

As I continued to refine the equipment and the visual experiences resulting from performance, I began to wonder: "What is the viewer's experience of space and time in Light Dance?" Is it simply that of the "hard" architecture surrounding the performance, or does Light Dance evoke different space and time perceptions? How should we think about Light Dance? Is it appropriate to apply conventional concepts of space, time, light and vision, or does the Light Dance experience prefigure and require a different way of perceiving and therefore thinking?

In my 1989 M.I.T. master's thesis, "Light Dance: Light and the Nature of Body Movement," I set the Light Dance experience in historical and theoretical context. In addition to exploring connections to the work of Oskar Schlemmer, I was drawn to the record of human experience in which so-called "inner light" overcomes perception of one's body. An expression of this experience is the "light-body," the perceived conjunction of the body and light that is a consistent, interdenominational symbol of highest spiritual value. My master's thesis initiated extensive and ongoing research, e.g., in India (Fulbright 1992-93) to study Hindu fire dancing in its philosophical context in relation to Light Dance. A further extension of these investigations, this dissertation seeks to find contemporary, intellectual articulation and contextualization of the Light Dance experience.

As an artist, I use light to "speak" to the eye at the level of its early perceptual processes. The Light Dance instruments reduce and shape light into geometric minima, like "graphemes" of perception. Light Dance allows me to explore the structure and "semantics" of vision in their basic spatial and temporal terms. Cast from my limbs to the surfaces of the unseen room, the elemental light forms become units of perception in the viewer's experience. In other words, Light Dance is a shared seeing experience. Working with light and drawing from its fundamental geometry, I create the conditions in which light does not illuminate the hard room, but lights the early perceptual structuring of space and time. Light Dance taps the being-here-and-there function of light and, in so doing, my bodily seeing process becomes the viewer's.

At the outset of this dissertation, I have taken some time to describe the personal experiences behind the genesis of the Light Dance art form. The feelings I have tried to convey are nonspecific, but powerful and consistent. They have organized and guided my work. They stand outside—even at complete odds with—the prevailing, collective concepts that we use to organize our experience of ourselves in the world and the world itself. Therefore, the feelings challenge, at times defy, conceptualization and verbal communication. These feelings, such as the persistent oneness of my twin experience and the spatiotemporal ambiguity inherent in the experience of light, constellate their own order in perception and thought. There is a tendency to dismiss and reduce such intuited order to prevailing models, to force such feelings into the frameworks of dominant ways of perceiving and thinking. However, if such feelings are given open attention, if they are permitted to constellate meaning, first at the level of sensation and early perception, and then in the form of ideas; if awareness of such meaning is cultivated by generating and refining sensations through the manipulation of perceptual stimuli—these I would suggest are activities of art. I believe that art can be a method of cultivating and communicating meaning at the level of sensation/perception, at the interface of the human sensory system and the physical world.

Against the framework of rational thought, such perceptions as described above may appear inchoate, but they can function as new loci of concept formation and ultimately of articulated knowledge. In this view, art drives toward knowledge, and visual art toward knowledge of vision. The visual artist who works with light has a specific opportunity to isolate and experientially study the intersection of the physical and perceptual. With the artist's perceptual acuity, what can be learned at this juncture? Does the artist's experience simply reduce to existing theory, or can the artist demonstrate and foster new order in thought?

This dissertation documents a process of *ordering thought from how the art itself orders experience*. I believe this will bring us closer to understanding what unique contributions Light Dance makes to how we think about and conceptualize light and visual perception, and, in turn, how we think about art.

INTRODUCTION

“I See Light”

We think we see light.

Common understanding holds that we see light as we do other objects: a beam of sunlight in a wooded area, a glint of light off the shoulder of a wine bottle, a patch of light on the ground.

“I see light.” The statement is considered semantically correct. But what do we mean by it?

Something like “The physical phenomenon ‘light’ stimulates my vision such that I apprehend its presence in the objective physical world.” However, in the case of the perception of *light*, the object cannot be separated from the material it interacts with. For example, looking closely at the beam of sunlight, we discern that it is not light that we see, but particles suspended in the air.

Light undermines its own objectness in experience, leading us to restate James Gibson’s (1986, pp. 54-55) observation that we do not see light but have a “sensation of brightness,”

overstimulation of the photoreceptors. When we say “I see light,” then, we do not actually see an object in the world. We do not see light, but “things lighted,” and when we go to focus on the perception of light itself, we find that we cannot differentiate between the experience and the object.¹ William James (1890, p. 4): “The first time we see *light*, in Condillac's phrase we are it

¹ Percy Williams Bridgman (1927, p. 151) writes: “the most elementary examination of what light means in terms of direct experience shows that we never experience light itself, but our experience deals only with things lighted. This fundamental fact is never modified by the most complicated or refined physical experiments that have ever been devised.” See *The Logic of Modern Physics*.

rather than see it.” We have a sensation that evokes the concept “light,” one that is the product of a long chain of experiences, inferences and thought abstractions *reapplied to perception*.²

If we take from the shoulder of the wine bottle the highlight and remove the visual contextual information from around it by pushing it into darkness, we are left with a small, bounded “piece” of light. Perceptual study of this sliver of light will show that it offers no situation in space or dimensional structure. Light information has collapsed to a small line of brightness within darkness. What we see in this instance is no object or environment, no spatial or temporal structure within which the phenomenon of light operates. We have in the pre-conceptual percept simply fundamental brightness/darkness opponency in one dimension.³

Here, by the elemental simplicity of the darkened setting and the bounded piece of light, we become conscious of the “priors” that attach to it, the formed mental constructs that activate by the slightest cues, imposing objects, distances, depths, and surfaces upon early percepts. What we think and what we see are often two different things, and by the careful artistic control of light we can untangle the unpremeditated visual experience from the complex of higher-level vision and re-present “early seeing,” before conceptual constructs, to the eye. In this world where the abstraction of “light” has been bared, revealing brightness experience, the assumed division between the phenomenon “light” and the biological vision dissolves; we are faced with the possibility of building new logic from fresh perceptual ground.

² See Appendix I: Glossary for the operative definitions of “sensation” and “concept.”

³ See Appendix I: Glossary for entries on “opponency” and “percept.”

Opportunity and Aims of the Thesis

I begin this practice-based thesis with a reflection on the nature of light in perceptual experience to underscore a course of inquiry for the work that follows: light and vision are fundamentally entangled.⁴ The concepts around these are among the most developed in western, rational thought and experimental method, deeply embedded in how we see the world, individually and societally, and so much so that we cannot discern, or at least not without great difficulty, the difference between concepts and percepts. Art has the capacity to bare perceptual facts to the eye by its unique method of progressive dialogue between physical creation and conscious perception that may be aimed at revealing perception to itself. I will argue that this is an established function of art that has long been cultivated and expressed by visual artists but is today scarcely recognized. Especially at the intersection of light and vision where we are faced with enmeshed physical and biological processes, I believe thought deriving from art practice provides a key in a new character of knowledge that my original Light Dance art form is well suited to realize.

The dissertation that follows is rooted in art methods and experience. As a light artist working with original Light Dance tools and techniques, I have become aware that the content and order suggested by the perceptual experiences that I generate differ from the ways we think about light and vision. The art experience has a logic of its own, and in this case one that is detailed and can be experimented upon and intellectually articulated. The dissertation is organized around the goal of drawing thought from perceptually rudimentary Light Dance experiences and building a theoretical framework upon art perception. This approach is not new. There are examples in

⁴ See Appendix I: Glossary for the operative definition of “perceptual experience.”

modern visual art of the artist deriving and ordering thought about vision through practice—Kandinsky, Klee, Albers. There is surrounding evidence that these and other artists demonstrate the possibility of manifesting in artworks structure and functions of vision, producing information consistent with contemporary theories of early visual processing.⁵ Art is often analyzed and reduced to principles and theories of other disciplines; the content and order the artist sees and expresses is missed. Contemporary artwork using light as a medium, Light Art, presents a distinct opportunity to advance the study of vision by the artistic method of putting physical creation and conscious perception in a heuristic loop. Light is the medium by which the artist shows vision to itself. An example comes from the *Light Ballet* of Otto Piene. A perforated sculpture, inverse camera obscura, casts articulated light forms into the surrounding, dark environment.⁶ Changes of size, shape and speed of the light forms define the viewer's perception of space and time; the room expands and curves in a multidimensional experience that supplants the notion of a "hard" architecture.

By precise work with light, interacting with material surfaces in physical space and time, the artist creates a realm *between* physical reality and the mind, one in which elements of vision become environmental, shared experiences.⁷ This intersection, this undivided mental/physical

⁵ Wassily Kandinsky's *Point and Line to Plane* (1947), *The Notebooks* of Paul Klee (1920s), Josef Alber's *Interaction of Color* (1963): each in their own way, these works are expressions of thought originating from and ordered around artistic practice and perceptions. Visual experiences drive a sense of order that seeks conceptual articulation. Contemporary vision neuroscientists detect evidence of early visual processing in 19th and 20th century paintings, e.g., Margaret Livingstone's *Vision and Art: The Biology of Seeing* and Eric Kandel's *Reductionism in Art and Brain Science* (2002); *Bridging the Two Cultures* (2016). These efforts, while productive, view art within an ill-suited body of knowledge. In what follows, I will make the case that the thought-expressions of the artist intimate knowledge of a fundamentally different order, one orthogonal to and completing that of analytical models of vision and light, the fuller articulation and understanding of the artistic model will expand knowledge *between* the art and science of vision/light.

⁶ See Appendix I: Glossary for the operative definition of "light form." See too Appendix I: Glossary for entries on associated terms "light construct," "light figure," "light object," and "light structure."

⁷ See Appendix I: Glossary for the operative definition of "physical space" and "vision structure."

space, generated, explored and communicated in artistic practice, I believe holds potential for fresh insights to contemporary problems of light and vision.

Light Dance works in the manner and tradition of the above-mentioned visual art, specifically Light Art. To this work of building theoretical structure from perceptual ground, Light Dance brings unique instrumentation and techniques. Light Dance is designed for this work, and the purpose of this dissertation is to methodically build a thesis argument out of the elemental visual experiences that Light Dance makes available to perception. (See Figure 0.1.)



Figure 0.4: *Light Dance*, Seth Riskin, M.I.T. Center for Advanced Visual Studies, 1989. Photo: Noah Riskin.

There are internal barriers to arriving at the experiential realm encouraged by visual art that Light Dance seeks to transcend. The notion “I see light” unconsciously carries physical and epistemic theories into the experience of seeing. That I open my eyes and see an object, let alone

one such as light with subtle properties, means that I am continually imposing “high-level” conceptual structures on the direct seeing experience. “Early visual processing” is a phrase typically used to identify visual perception prior to cognitive processing and integration, as implicit in the statement “I see a landscape” that incorporates three-dimensional objects, spatial depth and time, and the perceiving subject, “I.”⁸ The structures and dynamics of early visual processing are “simple, local and opponent” (Livingstone, 2002).

Elemental percepts stimulate, but do not complete, cognitive processing and interpretation. It has been known for centuries that the patterns of light that fall on the retinae are coarse and ambiguous. Extraretinal information is needed to overcome the ambiguity of raw retinal pattern, yielding “unequivocal and behaviorally informative” (Albright, 2012, p. 227) information, but how does the brain achieve this?⁹ In recent decades, progress on this problem has been made on multiple fronts, e.g., the development of scientific instruments and techniques that address single-unit brain cells, structural and functional imaging of the brain, and work integrating results from psychology, artificial intelligence and neurophysiology in early computational vision science, e.g., the original bottom-up theories and algorithmic models of David Marr.¹⁰ Nevertheless, given all the progress, including applications of deep and machine learning approaches to the study of biological vision, how the brain fills the gap between what meets the retinae and what is seen remains an open question.

At least it is clear by now that the eye is not a camera and that the visual world in all its detail is

⁸ See Appendix I: Glossary for the operative definition of “cognitive integration.”

⁹ See Appendix I: Glossary for the operative definition of “ambiguity.”

¹⁰ See Marr’s *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information* (1982).

not passively registered.¹¹ Information on the retinae is scant; the visual brain fills in missing information. Apparently, this “filling in” is based on experience and driving toward accuracy and yield of unequivocal and behaviorally informative percepts, “near instantaneous and without awareness” (Albright, 2012, p. 227). Here, we might return to our example of light on a surface. In otherwise total darkness, a point of light is projected onto a white surface from a distance of two feet. The early vision of this event is merely point-brightness in opponent darkness. This point is a zero-dimensional object of uncertain size and distance. In this example, it must be conceded that there is no “light.”¹² There is an instance of opponency by which a point is distinguished from the surround by what may be called “brightness,” but “light,” the abstract concept, has insufficient information to perform the advanced mental scaffolding, at least in this pre-conceptual assessment of the perceptual facts before us. Equally, in this experience-assessment, there is no “surface,” no “distance,” no “depth.” By comparison, it is usually the case that unpremeditated perception and conceptual abstractions together form “experience,” “physics,” perhaps unconsciously, filling in the gap.

From this raw retinal data, then, is there one right way to perceive light? Vision as a subject of study brings us right to the convergence of the human brain/mind and the physical world. Is there one right quality and application of mind to bring to this, one “real” world? And the learning and filling in teleologically certain?

The visual experience of the artist is conventionally considered to be a subjective take on an

¹¹ See the recent work of Alva Noë, e.g., Chapter 10, “Art and the Limits of Neuroscience,” in *Strange Tools* (2015).

¹² See James Gibson, “Do We Ever See Light as Such?” in *The Ecological Approach to Visual Perception* (1986), pp. 54-55.

objective visual world, but the artist's experience suggests the inverse: what we call the "objective world" is in some part concept, built upon subjective experiences.¹³

The visual artist working with light inverts the common experience of the world. Whereas structures and dynamics of what we ordinarily see cue concepts that occlude early visual processing, the artist changes those structures/dynamics (e.g., by working with light), foregrounding early visual processes.¹⁴ The artist cultivates inverse seeing; concepts reveal as constructions. For the artist, the visual world constructs around oneself from elemental percepts that initially bear no spatial or temporal distance from the viewer. Perceptual space and time construct from the perceiver-center and refer back to it in radial unfolding.¹⁵ The subjective gives rise to the objective. The concept that curved visual space is a distortion to be unlearned is turned upside-down. In the paradigm of the artist's inverse vision, visual space is a foundational fact that qualifies physical space. Optical illusion is optical truth (Goethe, cited in Magnus, 1949, p. 140). Light shows vision to itself, and by the efficacy with which it does, ontologically flips light and vision in the context of knowledge. Here we have the root of "epistemic inversion" as it will be used in what follows. This hints at the potential for knowledge in applying visual art to the reflexive study of vision.

This appears as an utter impossibility, in the context of current, accustomed thought on the nature of sight, but what makes it possible, brings it into the realm of conceivability, flips the epistemic order, is experience, afforded by art, of a causal flip of light and vision. I will build a

¹³ See Appendix I: Glossary for the operative definitions of "objective" and "subjective."

¹⁴ See Appendix I: Glossary for entries on "early vision" and "early visual processing."

¹⁵ See Appendix I: Glossary for the operative definition of "unfolding."

case for this as a goal and experience, traces of which can be found in the history of Light Art, evidence for which can be detailed and documented in the Light Dance art form.

Argument and Method

In what follows, the dissertation demonstrates how we might access this flipped epistemic order through Light Dance, an artistic practice developed and performed by the author that articulates light phenomena through movements of the body, shaping the perception of viewers.¹⁶ If artistic abstraction has the capacity to penetrate into the physical truth of things, it does so at the level of perception. In changing what we see, visual art generally – and Light Dance specifically – holds the potential for alerting the mind to the seeing. I will argue that Light Dance focuses on this particular function of visual art, raising consciousness of vision by what is presented to the eye. Light Dance penetrates vision and in so doing comes to light. This is the path to knowledge I intend to follow guided by the Light Dance practice and art form, and it is where this dissertation begins.

A note on Light Dance terms: Through the course of this dissertation, many terms are used in description of Light Dance, e.g., “Light Dance instruments,” “Light Dance perception.” The reason for this is that, as an artwork, Light Dance is not an object (such as a sculpture) experienced within the system of the visual environment; Light Dance *is* the visual environment in experience, owing to the fundamentality of light as applied in Light Dance to vision. The work

¹⁶ By “flipped epistemic order,” I am referring to the unique visual paradigm established by Light Dance. Elsewhere, the process through which Light Dance establishes this flipped epistemic order will be referred to as “epistemic inversion.” This paradigm will be elaborated in Chapters 1 and 2. See too Appendix I: Glossary for entries on “epistemic paradigm” and “epistemic inversion.”

of Light Dance includes everything from its technologies, to the viewer's perception of space and time that the artist shapes in performance. Originating as a natural consequence of the practice, it is therefore appropriate to speak of the "Light Dance method," "Light Dance perceptual environment," and related terms.

The concept behind Light Dance emerged first as an image in mind and then on paper, a drawing associated with a bodily experience, or more closely, bodily "vision": visual experience effecting from and affecting the entire body, "seeing" from the whole body, transcending the locality and limits of the body, evoking an experience of "being" space. The drawing showed a figure circumscribed by a ring of light. The light was an extension of the figure and the figure, the source of the light. (See Figure 0.2.)



Figure 0.5: Early drawing of the Light Dance experience: conjunction of the body and light through movement expressed in radial spacetime. Source: Seth Riskin.

Taking place in a darkened environment in which the senses have been deprived of common

points of reference and through an application of light, the body becomes extended and, through its movements, sweeps out arced spaces in the perception of viewers.

Light Dance challenges common experience by revealing how cognitive functions and abstract concepts such as “light,” and “three-dimensional architectural environment,” influence, perhaps unconsciously, what we see of the art. In the case of Light Dance, we might describe it as follows: “Light forms, projected from the body over spatial distance and time, land on material surfaces and change shape and size, as the body moves relative to the architecture.” Yet breaking these terms down further reveals how our preconceptions shape the experience of the artwork. Let us take the beginning of the sentence: “Light forms projected from the body.” It appears to be a description of observational fact, something we simply see. However, “light” and “projecting” are highly abstract concepts derived by reasoning, inductions from a long chain of observations. In the context of the Light Dance performance, we don’t see “light”, and clearly don’t see it projecting. “Light”, in the context of the Light Dance performance and in the first instance, is a line of brightness. The space has yet to unfold in experience. But the same is true of ordinary experience: these concepts, “light” and “projecting,” stand on a stack of inductive premises. A common experience of Light Dance, and certainly a common assessment of visual art more broadly, is through this lens of cognitive abstraction.

There is another experience of the art more closely attached to its origin and purpose: the early, visual experience prior to concepts, or preconceptual. It is this experience that I seek to illuminate in Light Dance and in this thesis. The following description offers an account closer to the preconceptual visual experience I wish to convey: “Vision extends from my body, and as I

move, I shape the collective experience of space and time.” Within this statement, one detects traces of a different structure of knowledge, one that resists the trappings of our visual episteme: to think of light as vision “extending” the body, or of “shaping” space around viewers, is already to invert our conventional understanding of the relationships amongst these forces. Nevertheless, we are still stuck in verbal consciousness, attempting to describe something that apparently precedes it. The Light Dance experience holds its own perceptions and thoughts and should not be considered within a knowledge structure ill-according with—even oppositional to—its fundamental order and significance. By pursuing a practice-based thesis, I intend to stay close to the percepts embodied in the practice. In doing so, the visual experience it affords can be articulated in conceptual structure with fidelity to the original perceptual order.

There is an additional aim to pursuing a practice-based thesis, which is to demonstrate how Light Dance builds upon a strand within the Light Art tradition—that which approaches work with light as reflexive study of vision—and disentangles, extricates it from the dominant mindset within and about the genre which treats light as a plastic medium to be manipulated for effects. Light Dance does something different and specific with light. It uses light not to illuminate material, but to coax the interaction of material and light to illuminate, or reveal, light itself. Throughout this thesis, light will not be approached as a physical phenomenon, but as a *function of seeing*. In this way, Light Dance reorders and recontextualizes the Light Art genre as it does not treat light as a physical medium, rather *approaches light as seeing*, and takes decisive artistic steps to realize that experience for viewers. Working precisely with light in relation to a constrained architectural setting, Light Dance sets up a perceptual environment that enables the viewer to cognize seeing, specifically concerning its spatiotemporal construction, or

“scaffolding.”¹⁷

This use of light to show seeing to itself reveals a fundamental connection between seeing and light, one that in turn raises a host of problems pertaining to the prevailing epistemic paradigm of vision and light. Vision and light represent arguably the most information-rich and consequential interface between the human being and the physical world. Both forefronts of knowledge, vision and light, are among the first of the western scientific and philosophical traditions and, relevant to a range of disciplines, they have been extensively explored. Yet there exists, in contemporary rational thought, no theoretical model for relating the “subjective” realm of vision to the “objective” realm of light beyond functional interaction. When applied to physical phenomena, objectivity is an either/or affair, and a phenomenon such as light is never treated with a notion of nuanced objectivity.¹⁸ Similarly, in this line of thinking, vision can only reconstruct what objectively exists. No matter the perceptual construction powers of the visual brain, it is merely filling in from the paucity of information received through the retinae.¹⁹ *Put another way, there is no place for the subjective mind in the objective, physical world.* Is there no other approach to the problem of the divide between light and vision? Is there only one mind to bring to this problem?

In a later section, I will return to this problem to draw out a series of research questions that will guide the thesis. In the following section, I begin by elaborating on the origin and details of this practice as a means of introducing the perceptual ground laid by Light Dance for a reassessment

¹⁷ See Appendix I: Glossary for the operative definition of “spatiotemporal construction.”

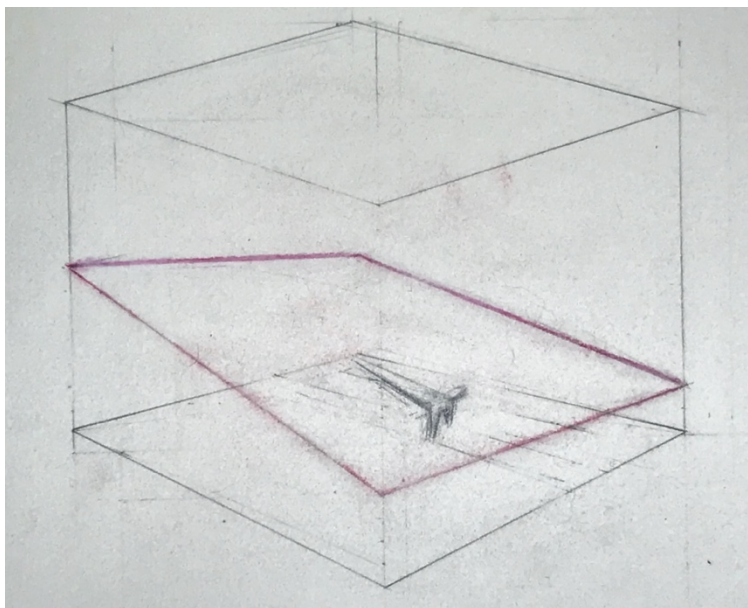
¹⁸ See Thomas Nagel (1974, 1986, 2012)

¹⁹ See Appendix I: Glossary for the operative definition of “perceptual construction.”

of light as a function of vision.

Background and Origin of Light Dance

The thesis that follows is based on the practice of the Light Dance artwork, an original art form created and performed by the author beginning in 1987. As a graduate student at the Massachusetts Institute of Technology Center for Advanced Visual Studies, I began experimenting with the projection of light from my body in otherwise totally dark spaces and in silence. My purpose was to “extend” my body and “move” space around viewers, inverting and projecting my subjective experience of body movement. I created an instrument for mounting on my back that cast a sheet of light parallel to my standing figure, visible as a light-line circumscription of the room. This projection was experienced as a slice of perceptual space, extending from my body. My movements generated arced planes and volumes in perception; viewers found themselves within the “dance.” (See Figures 0.6, 0.7, and 0.8.)



Figures 0.6 and 0.7, top to bottom (next page): Original Light Dance concept drawings, Seth Riskin, M.I.T., 1987: A light projector mounted on the back of the performer casts a sheet of light to the boundaries of the room, seen as a light-line circumscription of the space. As the performer swings on the parallel bars, the sheet of light tumbles and turns, effecting sensations of movement within the viewers. Source: Seth Riskin.

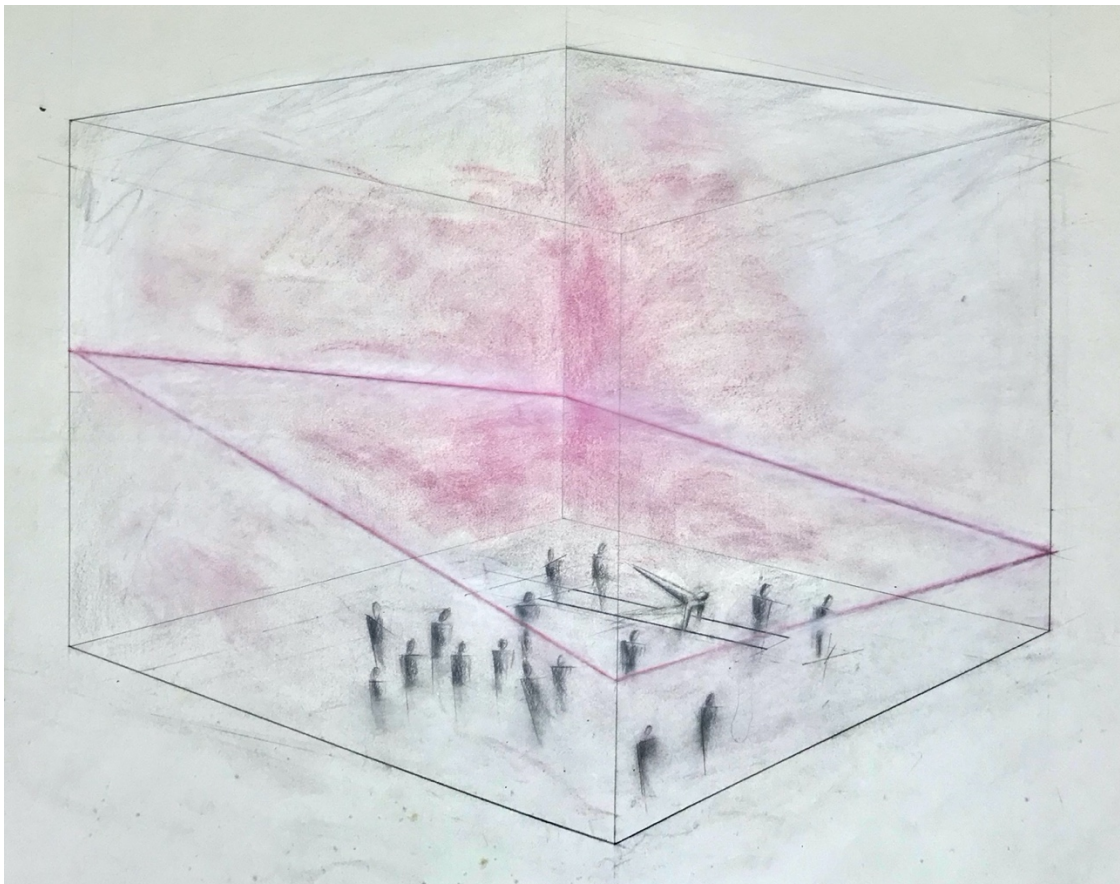
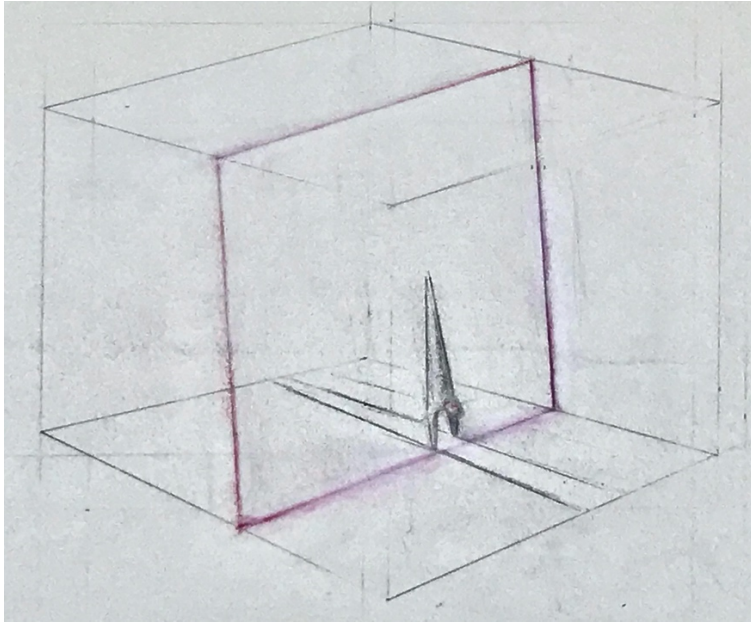


Figure 0.8: Original Light Dance concept drawing, Seth Riskin, M.I.T., 1987: Owing to the deprivation of visual information in the Light Dance environment, the viewers experience the ring of light not within space and time, but defining space and time as the performer moves. Using low-dimensional light, body movements are translated in terms of perceptual space and time. Subjective experience of space and time, i.e., vision, is extended into a collective experience. Source: Seth Riskin.

This work posed many questions and artistic opportunities. I expanded the art form's scope with a range of original techniques, varied light sources and optics. In context of the art form, I explored the meaning of movement and choreography, first on the parallel bars and then without the apparatus. My gymnastics ability served me. Light propagating from my body magnified my movements, requiring fine control. I was dancing not the body, but perceptual space and time, the geometry of which implicated the body in all that was seen. In these performances, I "became" light. I felt the light as my body—its direction, scale and geometry—and moved accordingly. It became clear that the performances worked for me and for viewers when the light, body and architecture cohered in movement, dissolving the habitually perceived boundaries between these elements. This was the goal and message of the work: the experience of light *as* vision, revealing the perceptual basis of the world in concept, by which the nature of "light" itself is revealed. I had established fresh perceptual ground in collective experience through an inversion of light's illuminating function.

Over the course of my work as an artist, I have developed and expanded the Light Dance practice with a range of technologies and techniques, in chosen and built environments. Silence has been an important element, foregrounding nuances of the perceptual spaces and dimensional shifts that are, for purposes of the work, best studied as isolated sensory experiences. In 1991-1992 at Carnegie Mellon University, I developed optical costumes, the first made of large, mirrored cones, one enwrapping each section of each limb. Lit by high-intensity beams, the costume filled the theater with reflected arcs of light, changing in diameter in response to my movements. A suit of mirrors cast countless rays from all parts of my body, moving like arms through large indoor and outdoor spaces. At the Academy of Media Arts in Cologne, Germany, 1997-1998 I

originated a method of freeing holographic effects from the “window” of the conventional hologram and constellating them around my body, responsive to my movements. Through transparent, wall-sized sheets of holographic film, viewers looked upon my body outlined with long, linear-filament light sources to see three-dimensional holographic forms and spaces, manipulated at architectural scale through my movements. I also developed a series of diode laser instruments, e.g., casting light-point grids. The grids shone vividly on surfaces without illuminating the otherwise dark spaces, such as the cavernous ice-storage room of the old Linden Brauerei in Unna, Germany on the occasion of the Connected Cities exhibition, celebrating the cultural network of the Ruhr area, North Rhine-Westfalia, 1999. The large patterns that reached from my body to the boundaries of the room expanded and warped with my movements, like layers of spatial fabric in the minds of viewers. During that time, Otto Piene and I collaborated on a series of Sky Art/Light Dance events. With light suits and optical costumes developed for the occasions, I was lifted upon helium-filled, polyethelene tubes into the night sky where I performed for viewers holding the tethers. In 1998, in response to Piene’s *Light Ballet*, I developed a series of “aperture rooms” set within larger spaces. Like Piene’s sculptures, the surfaces of the aperture rooms were perforated, each room with a different aperture: holes, slits, rings and squares. I performed inside these rooms with linear-filament bulbs on each section of each limb. Camera obscuras operating in reverse, the aperture rooms imaged the three-dimensional spatial dynamics of the incandescent lines on the surfaces of the outer room. The holes imaged lines; the slits, sheets of light; the rings, cylinders, and the squares, cubes of light. The luminous body within the aperture room was multiply imaged on the surfaces of the surrounding space, where the myriad aperture “views” could be seen in the inverted, moving-body images that encompassed the viewers. In 2002, I was asked to develop a Light Dance

performance by the family of György Kepes for his memorial service at M.I.T. Based on the concept of an altar, I built an architectural setting to be assembled and disassembled on stage during the service at the Kresge Auditorium. An “architectural optic,” the structure was designed to shape light around my body as I moved up and into it. When the stage lights went dark and the structure was in place, I stood before it wearing an instrument that cast a sheet of single-wavelength blue light from my torso. Caught by the outer-most edge of the structure, the plane of light shone as a golden-section rectangle contour, beginning the performance. I ascended the ramped floor of the structure, positioned on stage like a square pyramid on its side, and the blue light delineated a sequence of “spaces” around my body, from a rectangle, to a square, to fluttering, iris-like images, before concentrating, collecting, ultimately “extinguishing into” my body. The medium of light, its color and geometric shapes, as well as the geometry of the “architecture-optic,” referenced Kepes’s artworks, teaching and thought.



Figure 0.9: *Light Dance*, Seth Riskin, György Kepes Memorial, M.I.T., 2002; entire performance in single exposure. Photo: Walter Dent.

Light Dance in Practice

Light Dance concerns the reduction of light to geometric minima in space and time, e.g., a plane of light.²⁰ Projected from the body and seen on the surfaces of the room, the plane of light appears as a line. Light so constricted does not illuminate the material it interacts with but *becomes visible by it*. In total darkness, these light forms have no visual context. Light is reduced to a geometric element of its spherical propagation, here a diametrical slice. By using light in a manner that does not illuminate the environment, circumventing cues to concepts, the art speaks to the early visual system of the brain, e.g., the light line grows, sweeps perpendicular to its orientation, exhibits speed changes along its length, articulating rudimentary space and time in perception.²¹ This light alone becomes *an object, rather than means, of perception*. The light, initially experienced as a one-dimensional sensation of brightness, moves and transforms to generate bright/dark patterns that evoke, in the minds of the viewers and the performer, low-dimensional structures in foundational terms of space and time, each slightly different owing to the different vantage points.²²

By this method, Light Dance taps into the language of early visual processing, making perception its medium. This practice of light penetrates vision by outer means, lifting perceptual processes into collective awareness. The instruments, methods and, importantly, the experience of the work concern the fundamental, or “early,” visual percepts that, with movement, articulate relative spatial and temporal magnitudes. A point moves, defining the rudimentary space of one dimension and change-speed, i.e., time; a line sweeps, expanding from one dimension into two.

²⁰ See Appendix I: Glossary for the operative definition of “light line.”

²¹ See Appendix I: Glossary for the operative definition of “speed differential.”

²² See Appendix I: Glossary for entries on “object of perception” and “one-dimensional brightness.”

In this way, the perceived brightness effects of Light Dance embody space *and* time, they are spatiotemporal. The thesis originates from and refers back to these germinal spacetime percepts, and from this ground, thought is built.²³

The spatial and temporal structures articulated in the Light Dance experience is not the familiar visual perspective of the room.²⁴ The inverse perspective is seen. The light forms grow larger and cover a greater swath of space in a given period of time, with distance from the body. In these respects, the Light Dance artwork is not to be looked at but seen *through*. The articulated light thereby becomes “transparent” to spatiotemporally primitive visual experiences, e.g., one-dimensional figures that grow in complexity in perception, through movement and transformations, persistence of vision and memory.²⁵ Light is used in such a way as to recast its relation to vision and thereby its function of illumination and the associated interpretation of visual perspective of illuminated material. Under conditions of the Light Dance practice, light is vision-like, presenting early visual processes to the eye *from without*.

Study of this fundamental inversion of light and vision led to the core insight around which the thesis is organized: a principle of equivalence of light and vision and the resulting possibility of the conversion of one into the other.²⁶ In contrast to common understanding that holds light as an entirely physical phenomenon, wholly separate from the perceiving observer, Light Dance proposes an inverted world in which “light” is in some degree a conceptual abstraction deriving from visual perception. The following section will disambiguate these paradigms into two

²³ See Appendix I: Glossary for the operative definition of “spacetime.”

²⁴ See Appendix I: Glossary for the operative definition of “visual perspective.”

²⁵ See Appendix I: Glossary for the operative definitions of “transparency” and “transformations.”

²⁶ See Appendix I: Glossary for the operative definition of “equivalence.”

separate orders or ways of seeing: seeing through mental models, or concepts, that I will call “seeing concepts” and seeing percepts relatively free of concepts. This I will call “direct perception.”²⁷

Two Ways of Seeing: Seeing Concepts and Direct Perception

Given that I will show how Light Dance engages visual perception to posit an inverted epistemic order, in this section, it is necessary to first address how the conventional, “seeing-concepts,” account of visual perception treats vision and, from there, how direct perception is approached. The story of what we know about visual processing is a complex one and it sets within a broader narrative about how the world functions, the theoretical framework of which is so extensively rooted that we generally do not see it. Rather, we take this framework as ground truth and starting point of any inquiry into how the visual brain can possibly make such consistently accurate sense of the world from coarse and ambiguous retinal information.²⁸

According to this epistemic order, sensory receptors receive physical-world stimuli, beginning the perception process that advances through selection, organization, and interpretation of sensations into higher-order models. As Clarke et al. (2013, p. 187) remark, “[i]dentifying an object requires some degree of stimulus-based visual processing before the emerging representation becomes increasingly abstract and semantic over time.” The visual pathways refer

²⁷ See Appendix I: Glossary for the operative definition of “direct perception.”

²⁸ This angle of attack on the problem of human vision is summed up in the inverse optics problem that is at once the overarching, guiding question of current research and, after decades of intensive work, has no satisfactory answer. I will engage with the inverse optics problem in the Conclusion. See Appendix I: Glossary for the operative definition of “inverse optics problem.”

to structures (e.g., eye, optic nerves, lateral geniculate nucleus, striate cortex) and functions of receiving, relaying, and processing visual information. Visual processing, defined as “converting light energy into a meaningful image” is organized hierarchically from low-level, e.g., determining different types of contrast, to high-level, cognitive processes that, from multiple sources in the brain, integrate the information “that is represented in one’s consciousness.” Early percepts, “bottom-up” information, and higher-level mental constructs, “top-down” information, flow in both directions and are mutually-informing. Within this epistemic order, vision continually (often unconsciously) converts early perceptions into higher-level perceptions/concepts that are *established as physical facts*, i.e., not questioned, not investigated, resting on the paradigm of one-way seeing process: “reading” physical facts from incoming light information. For example, while an ellipse pattern may fall on the retina, the direct percept of it is supplanted by “foreshortened-circle,” so completely that it, and not the ellipse, is taken for the direct perception.²⁹

In this larger narrative, artists can practice “reduction” whereby they produce artworks that reflect early visual processing. This derives from an established idea that traces to the “beholder’s involvement” in a work of art (Alois Riegl), the psychological contribution of the viewer, activated by ambiguity in the artwork. Riegl’s work was advanced by Ernst Kris, Ernst Gombrich and others (“Beholder’s Share”), increasingly drawing from science to explain art, leading to current neuroscience approaches, e.g., Semir Zeki’s “neuroesthetics” and Eric Kandel’s “reductionism” common to artistic abstraction and scientific analysis.³⁰ In this

²⁹ The distinction between the two ways of seeing and the pursuit of art as means and manifestation of early perception and its nuances owes in part to the work and teaching of Josef Albers.

³⁰ See Eric Kandel’s *Reductionism in Art and Brain Science: Bridging the Two Cultures* (2016) and the PBS *Closer To Truth* interview series “Neuroesthetics: How the Brain Explains Art.”

narrative, artists naively, if consistently, cover the same ground as science. The artist's work, coarsely and for the most part unwittingly, images facets of visual processing that corroborate scientific models. If evidence afforded by art should be found unaccounted for by the scientific model, it may indicate directions for theoretical advance. This is the current, common account of the visual art/vision neuroscience "conversation".

The "seeing concepts" view of Light Dance may go something like this: in otherwise total darkness, instruments mounted on the body cast sheets of light perpendicular to the white walls of the thirty-foot cubic space. The sheets are seen by viewers as lines on the surfaces of the room, projecting from the central, performing body. The lines map to the confines of the room, grow and change as the performer manipulates the spatial relationship between his body and the architecture. Light forms grow in size and speed with distance from the body; the movements draw upon the artist's ability as a gymnast as he temporally controls the sequence of slice-illuminations of the architectural surround.

This is one way to "see" Light Dance. Here I would ask, what do we mean by "projection of light"? The start of an explanation goes something like "There exists 'light' that propagates by certain laws in space and time, the local measure of which is expressed by "thirty-foot cubic room." It should be clear even from this brief example that described is what we *think* we see, not what meets the eye. Under conditions set by the Light Dance art, what meets the eye in the first instance is a line of brightness relative to the surrounding darkness. Does the spatiotemporal structure that unfolds in the mind of the viewers simply "add up" to the cubic space? With movement, the line changes in length, orientation, speed and brightness. Closer examination

reveals that the changes are many along the length of the line, and that they temporally, perceptually constitute in perception a radial geometry referring to the source. Light Dance experience reveals that the line of brightness perceptually articulates spatiotemporal structures of a different—in fact, inverse—order than that of the cubic space seen in ordinary visual perspective.³¹ In the “seeing concepts” perception of Light Dance, this inverse order is simply occluded by mutually reinforcing perceptual habits supporting the “hard” cubic architecture.

Visual art is often set within a common framework of knowledge about how the world is, colored by the “modern scientific worldview,” and, often unconsciously, “experienced” and evaluated within that framework of preconceived ideas.³² Visual art is thereby relegated to metaphor-making, cultural criticism, or “aesthetic experience”—engaging light and vision, but considered as not fundamentally contributing to knowledge in these areas, except perhaps by accident, whereby the work of generating knowledge is then taken up by others from other disciplines. For example, Monet said that he wanted to see the world as a blind man just regaining his sight, “a pattern of unidentified color patches” (cited in Lippard, 1967). Relatedly, Marius von Senden, (1960, p. 130) in his foundational study of the perception of space and shape in the congenitally blind before and after surgery, uses “pure sensation” to describe the experience of a congenitally blind person who has just gained sight through surgery:

The girl went through the experience that we all go through and forget, the moment we are born. She saw, but it did not mean anything but a lot of different kinds of brightness. She wasn't even positive that these strange new sensations were coming through her eyes until she proved it by closing the lids and finding that this stopped the sensations...

While it was once supposed that vision was a one-way “reading” process, “converting light

³¹ See Appendix I: Glossary for the operative definition of “ordinary visual perspective.”

³² See Thomas Nagel, *Mind and Cosmos* (2012) on the necessity for theorizing a unitary mind and cosmos.

energy into meaningful information,” it is now understood as two-way, pre-attentive, “bottom-up” processing interacting with “top-down,” cognitive processing. Visual processing advances in abstractions of increasing scope and synthesis, folding back into early vision. Where lies the edge of physical truth and the mental model?

In contrast to the prevailing paradigm of “seeing concepts,” the Light Dance thesis suggests that the model advanced by the artist is of such different order as to be unrecognized by, or largely invisible to, the analytical perspective and, once recognized, lights a paradigmatically new way to see the same evidence.

In my view, based on years of artistic practice with light, art drives after knowledge of a certain kind. The quality of mind art cultivates, the knowledge that can be derived from it, is in specific ways *distinctly opposite in character from that of the objective method and model of vision*.

Artistic method originates from and refers back to a fundamental experience in conscious perception: the unity of the mind and the physical world. Art goes after the visual explication of their unity in experience by working at their juncture, peeling away contrary and patterned thought, stripping bare perceptions, such that the mind may be seen as an element in the physical world, and the physical world, as the physical world, may be seen as an element in the mind.

This underscores the unique advantage of the artistic method in addressing questions at the mind/world juncture; unlike philosophy, art “thinks” through physical manipulations that stimulate and steer perceptions that may constellate in thoughts. Unlike other disciplines, art takes as a first principle the *experiential indistinguishability* of the subject and object and works toward knowledge that this experience, mental posture and associated methods might elucidate.

This kind of art works with materials and physical phenomena not as objects of representation, but as mirrors reflecting human subjective experience. The working of material or phenomenon through art is a “polishing,” such that the subject encountering the work self-perceives. This process creates self-reflexivity in experience, a perception of the subject in the object that co-exists with, but limits, their ordinarily assumed duality. In our ordinary experience of our separate self in an autonomous, physical world, this art, to the extent we are open to it, is a “collapse”, a touchpoint between the subject and physical object that relativizes the prevailing functional absolutism between self and world.

Some artists are motivated by this experience and go after it, to know and communicate it. They work to make it “real”—shape, hone, transform materials to counteract their objectness in experience, admitting an element of the subjective: “To be an artist is not a matter of making paintings or objects at all. What we are really dealing with is our state of consciousness and the shape of our perception” (Irwin, 1999).

The Light Dance experience indicates that the art and science of vision represent intersecting, orders of knowledge, the relation of which must be filled out and comprehended to cohere a whole (Nagel, 1980).

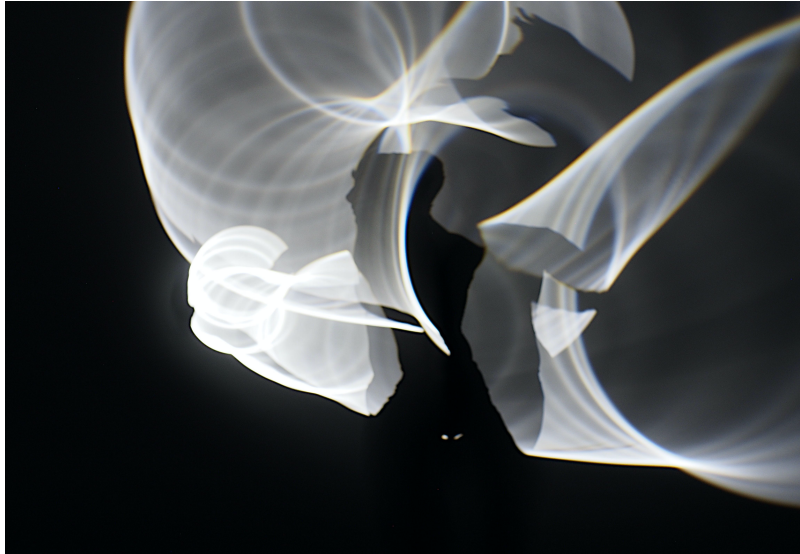


Figure 0.10: Close-up of Light Dance perceptual spacetime structuring. Photo: Allan Doyle.

Epistemic Inversion

The potential for a different order of knowledge suggested by the Light Dance experience has a specific connection to what the historian of science Peter Galison calls “concrete abstraction.” In what follows, I want to bring out that artistic method has the potential to penetrate deeply into physical truths and to form valid concepts that overarch and order how we understand the world. Galison’s notion of “concrete abstraction” and the “double vision” it requires is especially pertinent to art, the ability to look innocently, yet with an order-seeking intelligence that draws from direct experience embracive abstractions. Galison has approached the emergence of the modern distinction—and potential for productive relationship—between the arts and the sciences as a question about the function of abstraction in both disciplines. Abstraction can be understood as moving away from or, inversely, deeper into “concrete” reality. The difference correlates with that of how art and science are understood. In his essay “Concrete Abstraction” toward the end of the Museum of Modern Art exhibition catalogue *Inventing Abstraction*, Galison (2013) says that

there is another way of looking at the history of the arts and the sciences at the turn of the twentieth century, “not as abstraction breaking free of materiality, but instead as a kind of abstraction intensified not against concreteness but through it” (p. 350). As his case study, Galison (2013, p. 351) discusses the way Albert Einstein’s abstractions were about high physics and also the most concrete things. “He began his papers with the most tangible of machines and procedures, an electrical generator, say, looked at from two perspectives. He then went on to ask questions that, as he once put it, were ones only a child would ask: what do we mean by ‘The train arrives at the station at 7 o’clock’? We mean we imagine standing in a station, noting the position of the small hand on the seven as the train pulls in opposite us.” By such procedure, guided by principles established by Einstein, (e.g., principle of relativity) he “came to the ‘peculiar consequence’ ... that every moving frame of reference has its own time” (Galison, 2013, p. 351). The new conception of simultaneity implicated here, based on the constancy of light speed, set the foundation of the special relativity theory.

Counterintuitively, firmly held abstractions, presumed to be physical truths, can take us away from physical truth, while abstractions produced by the artist, seemingly distortions, can penetrate into concrete things. Galison sees Einstein’s approach as a way of grounding thinking in clear-minded experience, thus “distilling” out ungrounded beliefs from fundamental percepts, extended by consonant principles of thought. Galison describes concrete abstraction as “double vision”, closer to the concrete yet farther from experience—at least as we think it is. For it is just the unwitting mix of concepts into what we see that leads us to believe we experience things as they are, when, in truth, we are looking through the distorting lenses of ideas. Artistic abstraction can be seen as distortion against the notion of correct representation, when in truth, the

abstraction is more “real” than the concepts that form the basis of “correct representation.”

I see this approach—connecting experiential acumen with principles of abstraction for penetrating truth—as a conceptual correlate of visual art abstraction in general and Light Dance in particular. Galison suggests that artistic and scientific abstraction can be fundamentally the same in function and objective, while reflecting different methods and first principles. What looks like artists stumbling upon the same early-visual processing discoveries as scientists, *actually* turns out, shown in Light Dance, to be artists advancing an *inverse epistemic paradigm of light and vision*. In Light Dance, “light phenomena” are introduced only in minima and only from the location in space and time of the body so as to avoid the cascade of concepts that flood in with full-field illumination. The abstraction of “light” is supplanted with the direct perception of brightness. The accustomed hierarchical mental model of light and eye flips and, with it, the epistemic order of the world as we experience it.

Inversion is a theme that I will consistently use through this work, as it represents not only a shift in perspective on the art but also what Light Dance reveals concerning the light/vision connection.³³ “Light” is a construct of the mind. Abstraction—scientific or artistic—can lead into or away from reality. In the case of light, physical theory has advanced to the point of obscuring a more holistic, integrative view that must, in the end, take into account a perceiver. Art provides a counterpart way of approach, one that begins and develops with the perceiver at the center. From this perspective, ‘light’ in objective-world order *is* vision. By developing these interdependent models in relational counterpart, we can advance on a more complete knowledge

³³ See Appendix I: Glossary for the operative definitions of “inversion” and “inverse visual perspective.”

of light and vision. The thesis that follows endeavors to lay groundwork for that knowledge.

Purpose and Research Questions

My purpose in this thesis is to develop and communicate the knowledge embodied in the Light Dance art. Squeezing down light to a single dimension to the point where its function of illumination inverts—light itself visible by way of the material with which it interacts—reveals visual perception as the underpinning of light concept.

Light Dance may be thought of as an experiment that flips the functions of vision and light. What world is experienced as a result? What “objects” are seen? What structures of space and time are perceptually constructed? How does this inversion inform the current understanding of light and vision? My initial questions proceed from those that have attended thought about art probably since the beginning of such, asked still by, e.g., Alva Noë (2015, p. xii) in his recent book *Strange Tools: Art and Human Nature*: “What might be the character of the knowledge at which art aims be?” I will elaborate more on the practice-based nature of the thesis as well as the structure of the thesis below, but first, I will clarify the research questions addressed and answered in this thesis. The research questions are as follows.

1. Does art focused on visual perception work within the same knowledge paradigm as vision science, or can a case be made for experiential research in the manner of visual art leading to fundamentally new discoveries?

2. Visual art that takes optical light as a medium represents an area of inquiry where subjective method and objective phenomenon intersect. Is there anything to be learned from the history of Light Art? Does it evidence the prevailing distinction between subjective vision and objective light, and/or may evidence be found for an integrative approach?

3. What does Light Dance offer to this line of inquiry? Can Light Dance and elements of history of the light art genre mutually inform experiential research of vision/light? Can Light Dance techniques be used to generate specific evidence for an integrated vision/light model?

I answer the first research question in the concluding section of Chapter 2. The second set of research questions are answered in the concluding section of Chapter 3. Finally, the third set of research questions are answered in the Conclusion to thesis, where I additionally present new knowledge on the relationship between light and vision.

As Noë (2015, p. xii) says “...art provides us an opportunity to catch ourselves in the act of achieving our conscious lives, of bringing the world into focus for perceptual (and other forms of) consciousness.” Noë is alluding to knowledge of the unique method and communicative function of art in showing our perceptual consciousness to ourselves by way of the physical world. Such consciousness is largely absent from the landscape of current knowledge. It’s not that thinkers and practitioners haven’t identified it, or marked the space around it, but that rarely have artists built perceptual knowledge into conceptual knowledge with fidelity, for multiple

reasons, including the distorting factor of prevailing paradigms. I believe Light Dance presents a current opportunity to do so, positioned as it is at the convergence of light and vision and advancing a practice-based approach.

On the Practice-Based Nature of the Thesis

My first purpose is to use the practice of the art as a means of concept formulation. The work begins with the perceptions Light Dance generates. These are primary experiences that hold germinal order that I intend to develop into principles that guide the thesis argument. Light Dance, in its form, tools and especially the perceptual experiences it generates, prefigures concepts of a character wholly different from those of conventional knowledge of light and vision.

To get at this ground of the Light Dance experience, I will rely on documentation of the perceptions and early thoughts originating from the art experiences extending over the course of development of the art. These documented thoughts, consisting of text descriptions and associated drawings, are presented in the next chapter as “notebook entries.” This material will function as a *proto-thesis*: select notebook entries will be ordered and related toward articulating the basic structure and dynamics of the early Light Dance experience. These entries lead to core postulates concerning the inverse epistemic order that Light Dance affords.³⁴ Testing and further detailing the postulates drives the set of experiments in Chapter 2, the results of which define a

³⁴ I have chosen “postulate” in its meaning of assuming the truth of something as a basis for further reasoning. I’ve not raised the term to “hypothesis,” as I believe the subsequent experiments are not so much proving but building the context of the argument for more precise, directed testing.

line of inquiry into Light Art that both situates Light Dance and informs the genre.

The following section will provide an overview of the chapters as they are ordered in the thesis.

Overview of Chapters

The chapters that follow seek to document and detail, contextualize and theorize upon the Light Dance experiences. As stated above, in contrast to a theory-driven approach, the thesis is structured from the “inside out.” First order is to give account to the specific experiences that the Light Dance art generates, and I will thus treat Light Dance as a form of experimental, experiential research in the first half of the thesis as ground for knowledge generation in the later chapters.

Chapter 1 presents the materials from my notebooks, writings/drawings, grouped around core postulates that have emerged from my practice. The four key postulates and thesis that form a progression of thought are unanswerable within the conventional way of thinking and require further engagement.

Chapter 2 presents a series of experiments conducted to test the inverse epistemic order yielded by the Light Dance work. These experiments follow and demonstrate the four core postulates. In the initial and primary series of experiments titled “The Red Light Experiments,” I isolate and refine the original Light Dance procedure by working with a thin sheet of light in otherwise total darkness. In the second series of experiments titled “The Light Line Experiments,” I then examine and illustrate the complex perceptual structures that emerge when the Light Dance and

ordinary, conceptual, visual cues merge, e.g., the line of light sweeping over a moving cube, a manifest “bottom-up/top-down” experiment. Taken together, the experiments serve as a means of testing the postulates and thesis, yet they also result in a question for the tradition of light art out of which Light Dance first emerged: is Light Art driven by and positing new knowledge concerning the equivalence of vision and light?

In Chapter 3, I approach the historical tradition of light art from this new vantage point.

Art tends to be subjugated to an analytical approach, or, equally, the original logic and content of thought deriving from art is inchoate and ill-suited to cohering with adjacent, analytical theory.

Within the genre of light art, these two tendencies are evident. Works of the light art genre tend to reflect this situation, on the one hand deriving from and directing attention to the medium and the showcasing of physical properties of light—“light effects.” Artwork that treats light as a plastic medium for effects embodies conventional assumptions regarding light that are characteristically modern-scientific. On the other hand, the artist may “see through” light to the perception it shapes. In this case, the physical medium is not looked upon, but through, to experience. An experiential, as opposed to a conceptual, approach to light makes light perceptually disappear for the sake of the visual experiences it engenders. I will touch on four specific examples that reveal light art as part of a tradition of mutually informing thought and practice using light as an instrument for the generation of knowledge of vision: Thomas Wilfred’s Lumia will provide an early and clear example of the bifurcation (“seeing concepts” of light and direct perception of light) in the Light Art genre. From this basis, I will explore the environmental light art works of László Moholy-Nagy, Otto Piene, and James Turrell with focus on the momentum they represent within the genre for practice and conception of light as

reflexive vision. I will argue that the works and the surrounding thinking reflect an impulse to knowledge, in visual art generally and light art specifically, that seeks to penetrate vision by application of light.

Chapter 4 brings the Light Dance artwork back to the fore. I use a sequence of images from a single performance and, through them, illustrate the claims of the thesis argument. In Light Dance, artistic technologies and techniques of light are applied to generating the perception of light as vision, i.e., making light transparent to structure and dynamics of vision. Creating a perceptual environment within which awareness of the equivalence of light and vision dawns is the primary function of the Light Dance artwork. By making the thesis claims through Light Dance imagery, Chapter 4 strengthens the thesis argument by reestablishing connection with its visual source.

The Conclusion begins by reasserting the primary premise and objective of the dissertation: to contribute to theoretical knowledge by methodically and faithfully developing thought out of the practice of the Light Dance art form, based on the premise that Light Dance, foremost the perceptual experiences it affords, contains new knowledge. A summary of methods, key findings of the chapters, and an overview of the contributions of the work follows. The dissertation closes by investigating applications of the Light Dance thesis. Connections between visual art and vision neuroscience, nascent to this point, are explored further historically and contemporaneously and as they may be reimagined through the lens of the Light Dance thesis. A key example is drawn connecting the Light Dance experience and knowledge of receptive fields in the visual system. A final claim is asserted summing up the thesis and directing future work:

Art shows us a world epistemically inverted about light/vision, seeing through the inverse optics problem to light phenomena as vestiges of visual process. Light Dance thereby gives us a way to think about and investigate vision in terms of what we know about light.

CHAPTER 1: Postulates and Thesis as Drawn from the Light Dance Experience

1.1 Light Dance as Reflexive Study of Vision

The purpose of this chapter is 1. to provide an account of the ideas that constellate around perceptual experiences in the course of the Light Dance practice and 2. to organize and build the nascent concepts into postulates that frame the thesis. This chapter will therefore serve as a document of conceptual transition from work with light to reflexive study of vision. I will draw upon performance images and notebook entries, my written reflections, diagrams, and drawings generated in the course of practice as I work through a progression of ideas in forming the thesis concept. The writing in this chapter is helical, a spiraling progression of concepts core to the Light Dance perceptions.

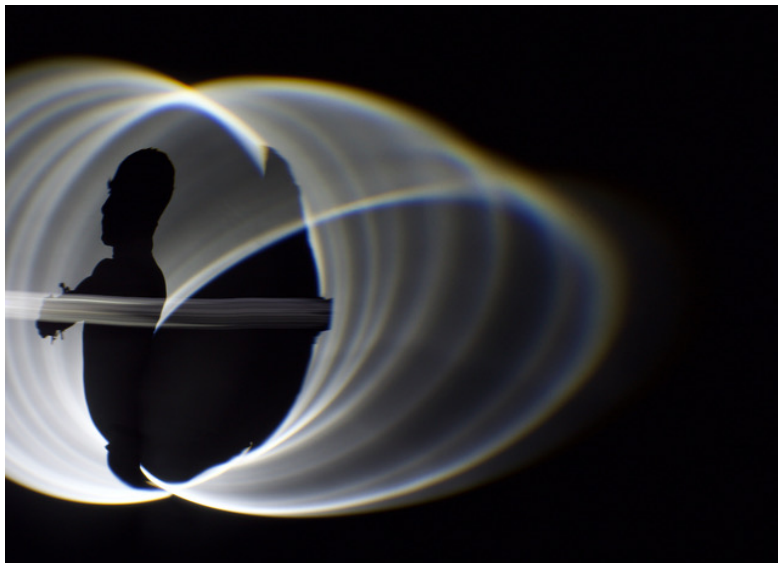
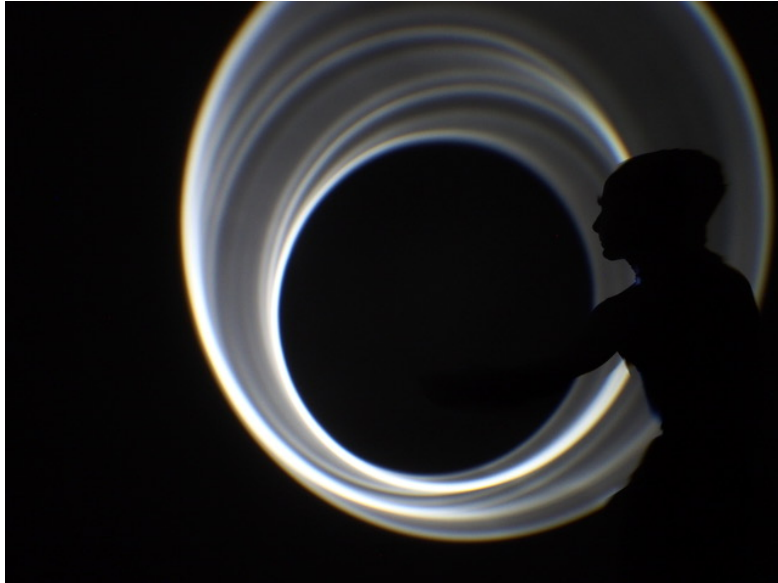
In Light Dance, geometrically elemental units of light are cast from the performer's body to the surfaces of an otherwise dark room. As the performer moves, the low-dimensional units of light transform to effect primary spatial and temporal perceptions. These experiences—shaping as they do our primary perceptions of space and time through the manipulation of light—provoke new concepts. In the context of the Light Dance experience, even the notion of “light” has no place. “Light” is already a conceptual abstraction that, carried into the experience of the work of art, imposes preconceptions about how the world works upon perceptions that intimate a different order. In the perceptually primitive environment of Light Dance, “light” stripped of cues to higher-order concepts (e.g., color, luminance gradient) is simply brightness., e.g., a line,

sensation in one dimension.¹ From here, the performance starts. By laying fresh perceptual ground, Light Dance primes the mind to reassess accustomed concepts of the relationship of light and vision. Through the fundamental inversions of its method, Light Dance allows us to *see vision*; whereas we ordinarily look through vision to experience a “hard,” physical reality, Light Dance prepares the environmental conditions and inverts the light/material illumination to foreground vision in perception.

An example of the way vision comes to the fore in the Light Dance experience is the dimensional expansion of the light in perception. As the Light Dance performer moves, the line (or circle) of brightness shifts in position, orientation, size relative to the viewer. Perception coheres these changes into higher-dimensional planes, volumes, tunnels. (See Figures 1.1 and 1.2.) A multi-dimensional visual world opens around the performer, responsive to his movements and enveloping the viewers. Body movements sweep out lucent volumes poised between memory and physicality; stillness halts the changes, collapsing the dimensionality of the light-structures to the original one- or two-dimensional unit of light. Such experiences evoke compelling questions: is it not a contradiction that light is both an object of perception *and* its cause? What does it mean that light both generates, and is experienced as functioning within, perceptual spacetime?² Is distinction between the mental and the physical to be maintained in this environment, or does the experience call for a new model?

¹ At this point, “light” will be replaced with “brightness” in describing the Light Dance experience as progression of the thesis argument has determined that the conceptual abstraction “light” has no place.

² See Appendix I: Glossary for the operative definition of “perceptual spacetime.”



Figures 1.1 and 1.2, top to bottom: The Light Dance performer effects dimensional perceptions through body movements. Photos: Allan Doyle.

Addressing such questions, in what follows, I will closely examine the Light Dance experiences for their intrinsic order. My intention is to work from bare accounts of the Light Dance experience to concepts rooted in the perceptions. Four postulates and a thesis statement provide the chapter framework. Led with a guiding concept, each section connects ideas and images that, in turn, illuminate the concept. These conceptual formulations build, one upon the other, to the

thesis statement that guides the chapters that follow. The thesis statement provides a way of getting beyond the habit of seeing light as a strictly physical phenomenon and into the Light Dance frame of mind where perception holds primacy and the perceptual construction of space and time out of sensations of moving brightness can be studied.

This conceptual framework original to the Light Dance experience will be tested and further developed in Chapter 2 and applied to a targeted investigation of Light Art and precedents of the Light Dance art form in Chapter 3. From the original conceptual order built out of Light Dance experiences, insights into Light Art emerge, revealing a twofold—at times dichotomic—approach: seeing and working light as a physical medium versus seeing through light to perception itself, i.e., a reflexive study of vision, the fuller understanding of which promises new knowledge that I believe Light Dance is uniquely equipped to advance.

1.2 Postulates

1.2.1 Postulate 1: Light in the Light Dance experience is spatially and temporally ambiguous

In ordinary illumination, light from a point source propagates spherically until it meets material surfaces. Distributed throughout a room, the light will illuminate: colors, texture, shadows, shapes, and their changes. This light information activates established cognitive interpretations, it coheres and compounds into a world that is detail-rich, spatially deep, and dynamic in experience. In this case, we look through light to have a world experience.

Light Dance illumination takes an opposite approach. The same point-source of light is at the

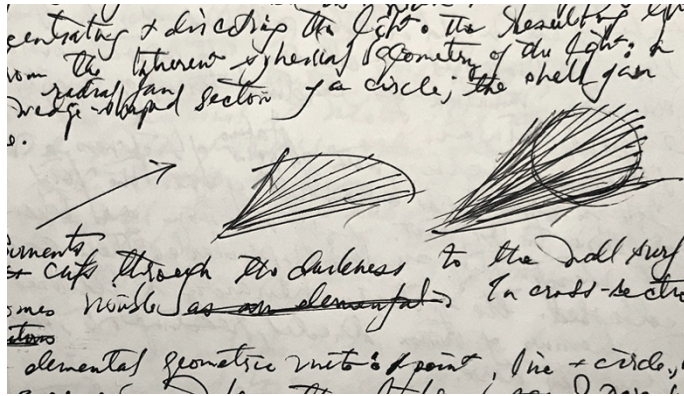


Figure 1.3: Light Dance instruments “cut” elemental geometric units from the sphere of light that propagates from a point-source. Source: Seth Riskin.

heart of an optical system that contains, shapes, and directs the light into a

geometric element, a unit of uniform

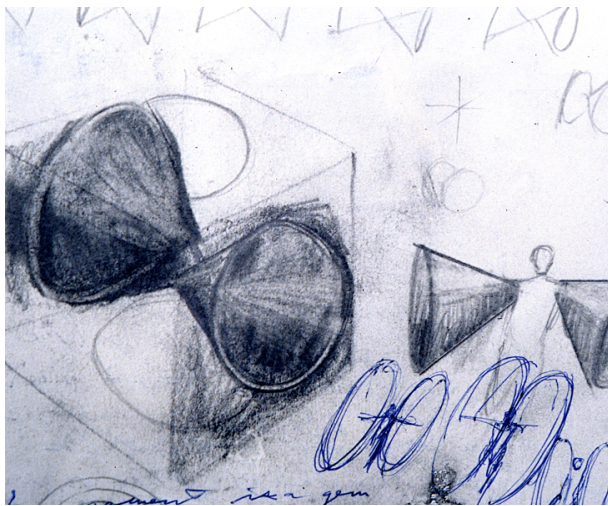
brightness, such as line or circle. The

Light Dance light units of brightness

derive from the inherent spherical

geometry of the propagating light itself: a

radial line; the radial section of a circle; the shell of a radial cone. (See Figure 1.3).



Figures 1.4 and 1.5, left to right: Light cones cast from the body to the wall surface are visible as circles. Source for image: Seth Riskin. Photo: Allan Doyle.

Cast by the instruments, this light cuts through darkness to a wall surface where it becomes

visible in cross section as an elemental geometric unit: a point, line, or circle. (See Figures 1.4

and 1.5). Light so presented does not illuminate material, rather is itself illuminated, revealed, by

interaction with the material surface. Light becomes the object of visual perception. What is the

experience of this perceived object? How does it behave? What spatial and temporal structures does it articulate in perception?

Notebook Entry, 28 Jan 17:

If we focus on our perception of light in itself, we must admit that we cannot define or place it.

To define it as “light” and to place it in physical context, we must put framework around it,

framework of otherness relative to perception. In human experience, knowledge of the world and

the world are ultimately inseparable and co-originate, not in time but of time. The two-state

condition goes all the way down and through. The present doesn’t sit on a timeline. The origin of

time is not in the past; the origin of the past and future is in the present.

These are thoughts that arise in Light Dance, in perception of the visually de-contextualized units of brightness. Extracted from the fabric of light information of the ordinary visual environment, what visual order does the moving, geometrically elemental unit of brightness convey to the eye?³

Notebook Entry, 17 Apr 20:

Not only a world within which I find myself, but my self within which there is a world; “delicate

empiricism” [Goethe] so as to not break the totality. Time past is not distant and foreign, but

traces to me.

³ See Appendix I: Glossary for entries on “elemental unit of brightness” and “geometrically elemental.”

Notebook Entry, 7 Aug 16:

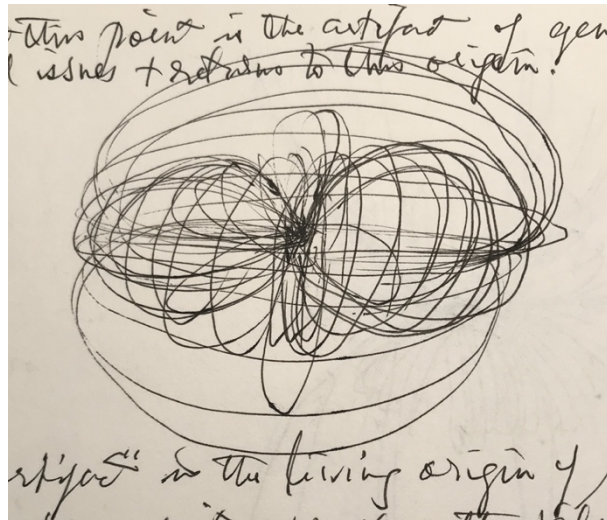


Figure 1.6: The ongoing, perceptual origin of the world in concept: location of the self-experience. Source: Seth Riskin.

It is forgotten that all percepts of the physical world are located at me, where my sense of self is located. All the light before me—the glint off the distant teapot, the tonal arc of its lid, the shape of the silhouetted stool—are located at me in continual origin. Perceptual delineations of shape, the extension of form; the depth of space and duration of time, as well as the partial perceptions of myself, originate at, and extend

from, a common origin, and the world-experience issues from and returns to this origin. (See Figure 1.6).

If the experience of light as a physical phenomenon rests upon cognitive structures such as physical space and time, then Light Dance attempts to dislocate light from its visual context in order to disclose the spatial and temporal ambiguity of light in direct perception, uninfluenced by cognitive interpretations. The sense of spatial and temporal ambiguity achieved in Light Dance can be described in different terms by recounting a simple demonstration. In total darkness, a pinpoint of light is seen. Memory of the room and equipment setup fades. It can be readily seen in the surrounding total darkness that the experience of the pin-point brightness *in and of itself* could be the result of a distant star, or a source near to the eye, or even from within the eye

(Gibson, 1978, pp. 54-55). In this perceptual environment, the brightness is spatially and temporally ambiguous; the conceptual separation between the vision and the object of vision cannot be maintained.⁴

The experience of light itself in *Light Dance* – isolated and delimited brightness relative to surrounding by darkness – is spatially and temporally ambiguous and cannot otherwise be separated from the experience of vision. The light in *Light Dance* is spatially and temporally coincident with the vision experience.

Notebook Entry, 22 Feb 20:

In looking closely at light, we become aware that it is like a hole in the world, a spatiotemporal point of collapse. In itself, light does not stand as an object; it falls into me and me into it. The

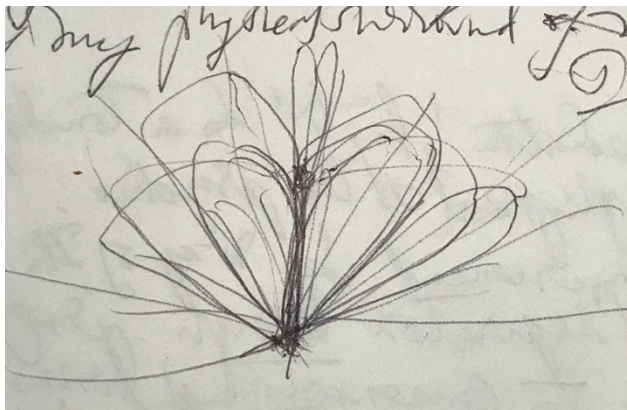


Figure 1.7: Close attention to the experience of light in context of perception of the physical world reveals that it does not stand as an object but is a point of “collapse” into the subject-experience. Source: Seth Riskin.

subject and the object of perceptual experience collapse into one, even as the objects around the light remain as such, along with their according spatial and temporal distance from me.⁵ I am counterpart—a center is “punctured.” (See

Figure 1.7). The point of light that is in and part of the world is in and part of me. The

geometry distorts and draws to me. At that point of light, it is wholly collapsed, even as the world

⁴ See Appendix I: Glossary for the operative definition of “spatially and temporally ambiguous.”

⁵ See Appendix I: Glossary for the operative definition of “perceptual collapse.”

*remains around that point. This curvature draws a circle of consciousness: the ends meet as one.*⁶

In the context of the spatiotemporal structure of our ordinary visual experience of the world, light is a “hole,” a point of collapse and coincidence with vision experience.

It may be asked “What makes light different from other objects of visual experience?” It is not. Any object the visual information of which is reduced to uniformity disappears.

Take, for example, the differences in brightness across the surface of a stone. Equalize these and the form vanishes; what is left is an equiluminant field, a ganzfeld, conveying no form, no depth, no object.⁷ Where light is different from other objects of visual perception is not in experience, but in *concept*: light is not illuminated but illuminates, and therefore is conceived as an object of vision that is the source of vision. When we examine the illuminant, lose it as the object of perception, we are left with vision. Looking into light we see vision.

The concept of “light” is constructed upon the world of depth objects. The space and time connected in mind that originate and develop in mind, is the spacetime that supports the movement and speed that *are* light. This mental construction objectivized is “light.”

⁶ See Appendix I: Glossary for the operative definition of “curvature.”

⁷ See Appendix I: Glossary for the operative definition of “equiluminant.” I discuss the ganzfeld in the context of the work of James Turrell in Chapter 4.

In Light Dance, light, as we ordinarily experience it is flipped around in function. In contrast to ambient, incoming light of ordinary experience, the light is cast from the body in spatiotemporal minima. Here, the Light Dance experience begins with a motionless line of light, one-dimensional brightness within darkness. “One-dimensional” because the higher-dimensional architecture has no place in this perceptual environment; “brightness” because light, as a conceptual abstraction, has no place in this perceptual environment. Light and vision are taken



Figure 1.8: Visual world squeezed down to a sliver, foregrounding a perceptually primitive experience of light before dimensionality of space, time and objects. Photo: Allan Doyle.

back to indistinguishability, their causal relationship collapsed. The epistemic hierarchy is flattened. Here, light is used in the manner of vision, delimited, directed, reaching out in rudimentary patterns of bright/dark opposition that change and thereby spatiotemporally develop in the mind. Through the Light Dance method, the ordinary visual experience of the physical world is “squeezed down” to a sliver. (See

Figure 1.8). Depth, breadth, form and attendant time collapse to a single dimension. This is the condition of vision before change begins higher-order, mental constructions: integration of patterns, inferences, concept formation, all of which are ordinarily invisible, *must be seen through*, for the perceived solidity of the physical world.

Notebook Entry, 12 Aug 16:

We forget that the origin of the world is at “me.” Visual and spatial instance are extended and preserved as a function of mind. The physical world is so hard, clear and extensive, but the origin is ever here at the spatial and temporal locus of conscious experience. All “experience is only half experience,” [Goethe] so the origin-at-me and the extensive world exist in counterpart.

What does this experience tell us? *All* light information is inherently ambiguous. In any given instance, we might experience the world as solid and extensive around us, but this solidity is perceptually constructed. We do not see depth or form. Rather, we mentally *construct* depth and form out of changing visual patterns.

Notebook Entry, 26 Apr 20:

Light is the immediacy of vision. It is the pure experience of vision before difference. Light is an experience on the edge of such. It is a state of non-difference that enters consciousness by relative difference. Brightness can be known only relative to darkness. The experience of light holds this horizon within it: in completeness, or totality, of the experience of light there is no percept to hold onto, no object by which to maintain subject. This is the subtlety of light. It does not stand on its own, maintain distance from the subject-experience in terms of space or time. It is like a hole in the experience of the world where the edges are the last difference. Light has its objectness, its physical characteristics and phenomena relative to what it is not. This amounts to the breaking of unity and the perceptual creation of an “edge,” a difference, that separates the absolute brightness, inherently unknowable, from the other, the shadow or slightest brightness attenuation, by which the brightness becomes something perceived and the structure of spacetime begins to grow in the image of the archetype of difference.

Because we must see through light in order to see, we can also use light to see seeing. The constriction of light in quality and spatial extent that occurs in Light Dance subverts the perceptual habit of converting light information to material objects and surfaces. Through an *external* illumination inversion, revealing light by material, Light Dance brings visual experience back to perceptual ground, a state in which brightness is neither “material” nor “light,” but sensation, inseparable from the seeing itself.

In how it constricts light, Light Dance relates to other methods of structuring light for visual effects, e.g., high-speed flash illumination (strobe) and the ganzfeld (full-visual-field equiluminance).⁸ In the case of high-speed flash illumination, the temporal aspect of light is cut up. In the ganzfeld effect, visual information is flattened to single, uniform, full-visual-field brightness. Both have been used to study the interface of perception and physical light, space and time. Advancing on such work, Light Dance takes a different approach. Relative to strobe, Light Dance slices space; relative to the ganzfeld, Light Dance presents a minimum light field. The philosophical starting point and paradigm is different. Light Dance does not seek to modify or manipulate light illumination within a conventional physical worldview, but approaches light *as* vision and develops technologies for visually inquiring about the *continuity of light and vision*.

Notebook Entry, 20 June 18:

Concept formation generates “light,” as the pursuit of knowledge of light leads concept-formation to encounter itself.

⁸ See Appendix I: Glossary for the operative definition of “ganzfeld.”

Notebook Entry, 26 Jul 19:

Matter can be seen by way of light; light can be seen by way of matter. The spacetime geometries of these are inversely related. When light is used to project and manifest the structure of vision, the inverse geometry (compared to ordinary visual perspective of the material environment) indicates an epistemic inversion: we are not situated in and receiving information from an existing world, rather we experience being the source, generating information, of a world that unfolds from us. Light gives vision (in the ordinary sense), and vision also gives light: vision is constructive all the way to the concept of “light.” What we take as one-hundred-percent objective “light” contains an element of perceptual construction. This is the “collapsibility” of light in perception, the inescapable condition of “light” in concept that, no matter its measurability and far-reaching physicality, retains a trace of perceptual construction that is ultimately, in the pursuit knowledge, exposed.

1.2.2 Postulate 2: Movement of the light defines spatiotemporal structures in perception

Based on the initial experience of Light Dance, the spatial and temporal ambiguity of the unit of brightness, we now look at what spatial and temporal order unfolds in experience with movement.

In the earliest condition of Light Dance, the experience of the line is simply one-dimensional brightness: a static object of perception; it evokes no texture, or shadow gradient evidencing the interaction of light and material. One-dimensional brightness functions as a “unit” of vision, an instance of fundamental bright/dark opponency. Yet with movement, the brightness takes on

higher dimensions of form, space, and implicit time: the line grows smaller, larger, faster, slower, in changing orientations and luminance values.

Notebook Entry, 14 Mar 19:

The use of the line of light clears conceptual structures from direct visual perception. It is a method of restoring spatial and temporal early vision by controlling what comes to the eye. The art has its force and function in foregrounding direct perception and backgrounding concepts. In Light Dance experience, a world opens by perceptual construction, therefore originating spatially and temporally at the observer. The geometry of the experiential spacetime structure of brightness issues from and folds around the performer. In the Light Dance experience, the light line that reaches out from the body is not a contour of the objective world, but a linear datum of experience from which a world perceptually constructs.

The Light Dance light form defines spatial and temporal structures in perception. Directed by the body, the vertical line of brightness moves left to right. The displacement is perceived as one dimension developing into two. A plane is experienced. (See Figure 1.9.) Changes in the line's speed, orientation and direction will affect the geometry of the plane in the viewer's perception. (See Figure 1.10.)



Figures 1.9 and 1.10, top to bottom: A line of light is cast from the body. The body pivots counterclockwise, sweeping out a plane in perception. Compound movements of the body effect two-dimensional manifolds in three-dimensional perceptual space. Photos: Allan Doyle.

Light Dance inverts the functions of light and vision—casting light from the body in geometric minima that require movement to unfold perceptual space and time. Here it may be presumed that the Light Dance unfolding of space and time in perception is simply a sequential revealing of the material environment seen under ordinary lighting conditions.⁹ Careful attention to the transformations of the line reveals, however, that a distinct, perceptual spacetime structure emerges, one that is *the inverse of visual perspective*. We can consider this claim through a thought experiment: opposite the viewer is a vertical line of brightness. The line moves from left to right, and, as it does, the line grows in length, tracing out a trapezoid. Now, if a material plane is substituted for the plane of brightness, it will be seen that the material plane is *also* a trapezoid (due to foreshortening with distance from the eye) yet the lateral *inverse*.

In this example, we re-emphasize the conditions of the directly perceived environment. In total darkness, a thin, vertical line of brightness is seen. It conveys no size or distance in space. It could be large and far away, or near and small. Yet as the line of brightness moves, percepts change. What are the changes and what spatiotemporal structures do they articulate in the mind? From the viewer's perspective opposite the line, the line sweeps to the right and grows larger. Then, while sweeping, the line tips to the right and, progressively along the line from the top down, it picks up speed and lengthens, as if elastic. Resulting from such changes, what spatiotemporal geometry unfolds in the mind of the viewer?

⁹ See Appendix I: Glossary for the operative definition of “material environment.”

Notebook Entry, 9 Jul 18:

The artwork presents a method of using light to think about vision, which, in turn, informs light. By carefully applying light in the manner of vision, i.e., constricted, projecting out from the observer, and moved by the body to build information, the conventional interpretation of illumination, object and vision, “seeing concepts,” is undone and an experience of perceptual construction, radial and referring back to the perceiver, is generated. Visual perspective, in ordinary perception, is inverted, and the border between the consciousness experience and physical world is breeched.

One-dimensional brightness articulates in the mind two- and three-dimensional structures that, by their perceptual construction out of movement, embody time. Careful study shows that the rules the line follows in its changes of size, shape, and speed are the inverse of visual perspective relative to the point of projection.

Notebook Entry, 17 Jul 18:

Light Dance method applied to conceptual thought: thread the concept of light through the subject’s “seeing” process.

The “inversion”: physical light is located at the viewer, reaches out, articulates space, time and form as driven by the body’s “seeing” process. The causal order and therefore spatiotemporal structure of the world/viewer experience is inverted. The performer is at the spatial and temporal origin of a transforming world directed by the body.

When the eye occupies the same position in space as the source, the perspective transformations that would have been effected upon the light by the distances and angles of the material environment are completely cancelled out, resulting in an unchanging light line – therefore, one that is spatially and temporally ambiguous, the same as viewing a material object fixed in the field of view *as if attached to the viewer's head*. In terms of projective geometry: the projective space can't distinguish between points that fall on the same line that goes through the origin. In depth, these points all line up from the perspective of the origin and are therefore coincident.

This fixity of the Light Dance unit of brightness from perspective of the source suggests that the light in Light Dance plays the role of the visual field. As an illustrative parallel, take the visual experience of a floater in the eye (a clump of fibers in the vitreous that casts a shadow on the retina). Within the experienced visual field, the floater will maintain its position, even as patterns on the retina change. Put once more in the context of Light Dance, the light line projected from the point source is equivalent to a receptive field made visible. In its transformations, it will behave as a slice of inverse visual perspective cut by the material architecture. *The Light Dance experience indicates an equivalence between light and the projected receptive field.*

The eye, the material environment, light: all of the usual elements of vision are in place, but reordered, in the Light Dance event. Instead of the ambient illumination of the material environment with the eye at the receiving apex of a cone of information, in Light Dance, an elemental slice of the spherical geometry of propagating light, a circle section, is projected out from the body, visible through its interaction with material surfaces as a line.¹⁰ Driven by

¹⁰ See Appendix I: Glossary for the operative definition of “ambient illumination.”

movements of the body, this line of brightness dimensionally unfolds in perceptual construction, based upon perspectival transformations in size, speed and shape, which will be different for the viewer and performer. The higher-dimensional brightness geometries in perception will reveal a radial order relating to the point of origin. The higher-dimensional brightness geometries perceived by the viewer and performer are equivalent to *perspectives on the view from the light source*, the light playing the role of the projected receptive field relative to the point source.

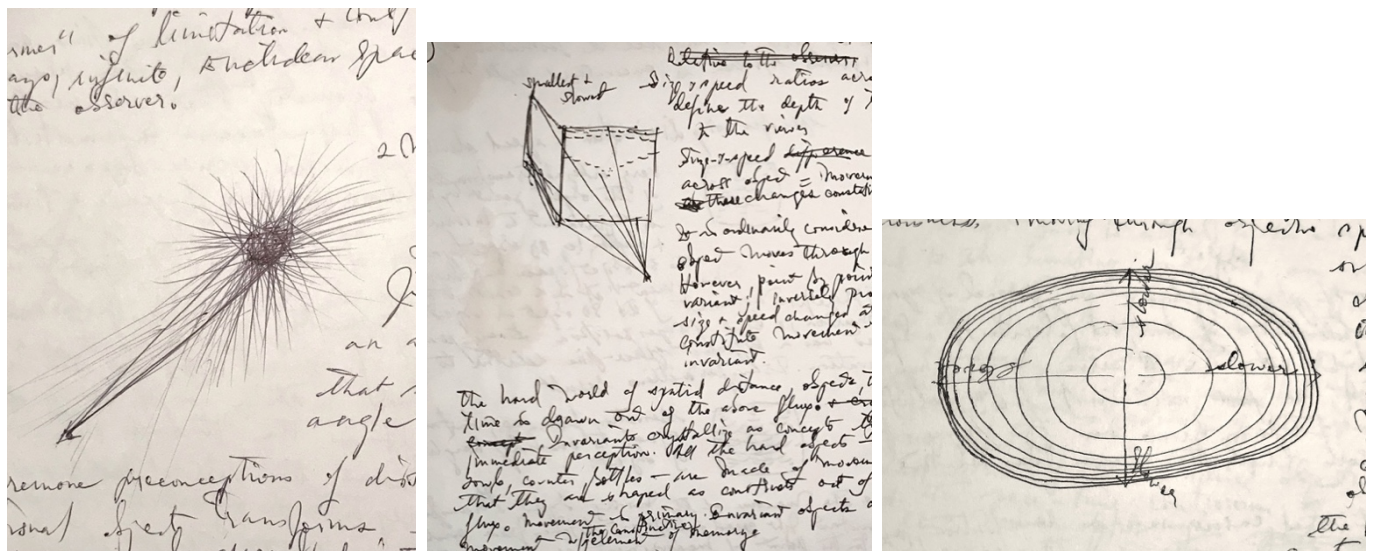
In sum, we witness in the Light Dance performance the construction of spacetime dimensions from an original, single dimension of brightness. The radial geometry resulting from performance refers to the point-source of its origin. The viewer, the performer and the light source will see perspectives on this geometry. The degree of transformations of the line and therefore the dimensionality incorporated in the geometry will be seen to diminish to zero as the angle of view approaches that of the point source.

1.2.3 Postulate 3: The spatiotemporal order defined by the light is the inverse of our ordinary visual perspective

Concerning light and vision, are we dealing with two independent systems causally, functionally connected, or is there an acausal connection, an element of equivalence between light and vision?

Consider the following: a material line, e.g., a rod, is placed in vertical position on a flat wall opposite the viewer. With no prior knowledge and no contextual visual information, the size of the rod appears ambiguous to the viewer. Holding this vertical position, the rod translates along the wall surface to the right as the viewer remains stationary. The rod will appear to decrease in

size due to the laws of propagation of light and the decreasing angle that the image subtends on the retina. Now, put the point source of a light-line projection at the location in space occupied by the eye of the viewer. The line projected from the source lands on the wall in place of the rod at identical length. As did the rod, the light line moves to the right. Due to the laws of propagation of light and the growing distance to the wall, the light line grows in size by the same amount and at the same rate as the material rod diminished. It will be seen that the spatiotemporal structures articulated by the light line (and other light shapes and forms) are the *inverse* of the structures articulated by its material substitute, collectively known as “*visual perspective*.” (See Figures 1.11, 1.12, and 1.13).



Figures 1.11, 1.12 and 1.13, left to right: Studies of the visual perspective order of material objects illuminated by ambient light for comparison with Light Dance projections and the inverse perspective order they articulate. Source: Seth Riskin.

The above conceptual experiment is a specific example of what Light Dance makes perceptually and multiply apparent: the brightness geometry that unfolds in the Light Dance experience and the ordinary visual perspective of material surfaces seen under ambient illumination are inversely

proportional.¹¹ As compared with ordinary visual perspective, the inverse visual perspective of the Light Dance experience features shapes and forms of light that grow larger and move faster with distance from the source; foreshortening inverts to elongation and, accordingly, curvatures are opposite. (See Figure 1.14).



Figure 1.14: Light-point grids vividly describe the inverse perspective order experienced in Light Dance. Photo: Nicolas Desponds.

Notebook Entry, 28 Jan 17:

Light can be more fully understood only as the “vanishing point” at the center of this mind-world structure, coincident in space and time with the observer. It thereby introduces curvature into all we know of the physical world.

In Light Dance, world does not exist apart from me and within which I receive a view of it, rather the view I experience begins the world. It has existence not outside, but inside of me. The present moment of perception is brought to the fore where it remains as a constant beginning.

¹¹ See Appendix I: Glossary for the operative definition of “ordinary visual perspective.”

Relative to ordinary visual perspective, spatiotemporal order is inverted. The size, speed, shape of objects are the inverse of those of visual perspective; the origin of the existence and extensivity of the perceived world flips from “there” to “here,” the perceiver, whereby the global brightness geometry curves with reference to the source.

Light Dance makes light the object of perception. A world of inverse order opens up in perception. The vanishing point of this inverse perspective is not a horizon without, but within, and with it, the origin of time; the continual present of the viewer, is experienced as the origin of perceptual space and time.

Notebook Entry, 25 Feb 20:

I see the spatiotemporal structure of the visual field itself for the spatiotemporal structure defined by the material objects. It is a matter of visual attention. The spacetime of the ordinary visual perspective (visual space) and the inverse spacetime of the projected receptive field as revealed in Light Dance exhibit perceptual bistability, or figure/ground reversibility. They don't exist independently, rather are two interpretations of the same information. (See Figure 1.15).

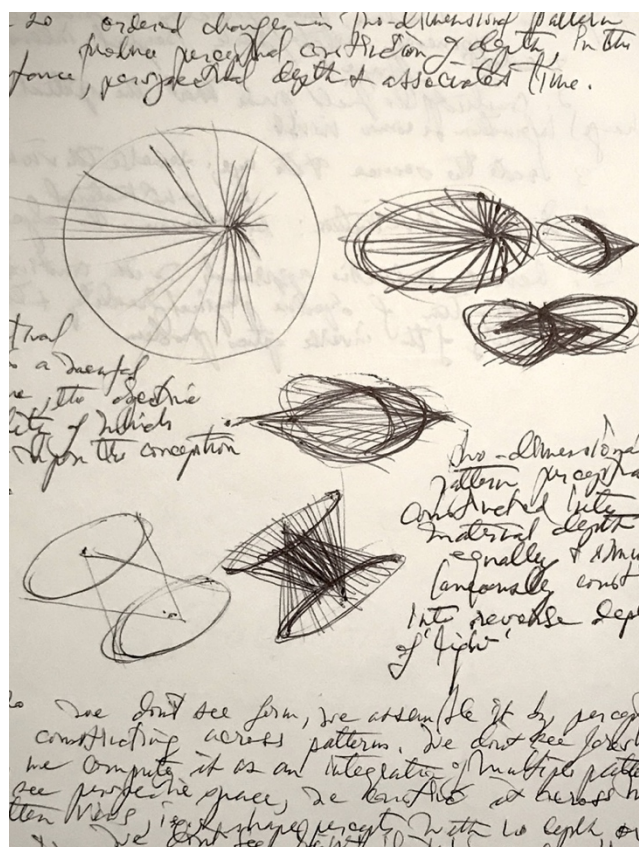


Figure 1.15, left: Studies of the inverse geometries of illuminated material and the projected receptive field, ordinarily invisible for the material objects seen. Source: Seth Riskin.

from the point in space occupied by the eye. The divergence angle of the light line projection is the same as the visual angle of the drawn line, the angle it subtends at the eye. In its original position, the eye, now projecting the line of light onto the table surface, sees the light line as the same length as the foreshortened drawn line. From another angle, e. g., from the side, the light

As an example of figure/ground reversibility of receptive field and material orders, a material object under ordinary illumination is seen to diminish in size with distance from the eye as the object's angular size diminishes. On the other hand, light projection from the body, e.g., a line, will be seen to grow in the opposite amount. Further, this holds across multiple aspects of perspective order. For example, a line is drawn the length of a five-foot-long table.

The table is viewed lengthwise such that the line appears foreshortened to two feet. Now, a vertically oriented line of light is projected

The curvature of the rectangle due to the eye, with reference to the distance (of observation) & size of the corner of the line independent of this transformation

of the same nature as the field of observation of the rectangle and the shape of the surface (bent) away from the eye in oblique view

The rectangle appears, if the original is preserved in space of the eye, to be distorted to distance change

1. rectangle drawn
2. projected rectangle or real surface
3. rectangle drawn in perspective from the eye

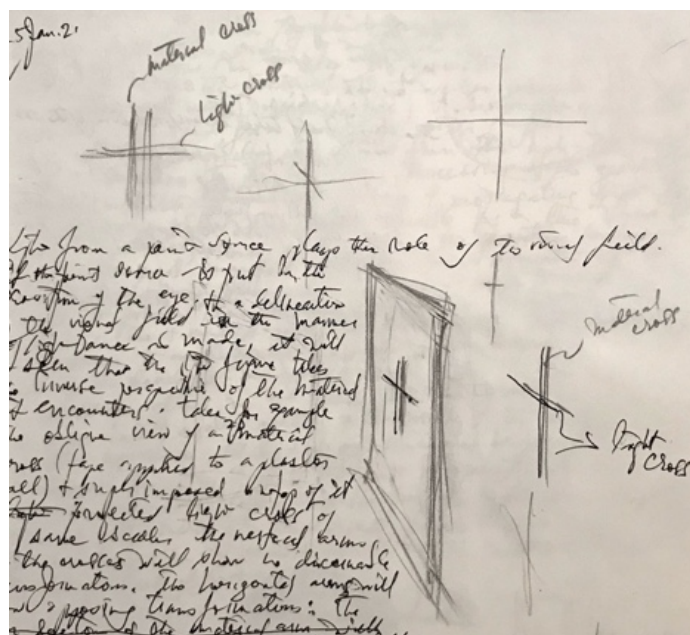
the curvature due to the corner of line drawing 1. independent of the distance of the plane looked away from the eye?

1. view of line drawing, eye opposite center of rectangle, field of vision nearly perpendicular to surface

2. projected rectangle, eye opposite center of rectangle, field of vision nearly perpendicular to surface

3. rectangle drawn in perspective from the eye

result: rectangle is not changed



In the Light Dance experience, light plays the role of *visible vision* or *lighted vision*, showing us, relative to ordinary visual perspective order, *inverse visual perspective*. This suggests that the “lighted vision” of the Light Dance experience is equivalent to what is typically called the “receptive field” that is, in experience, invisible. The projected receptive field structure counterparts the visual perspective structure of illuminated material.

Notebook Entry, 26 Mar 20:

Before visual information is interpreted as physical objects, it is ambiguous; figure and ground are equal; the object or the “negative space” around it may be the focus of attention. (See Figure 1.18). The receptive field and the perceived objects within it develop in counterpart spatiotemporal structures, perspective and inverse perspective orders.

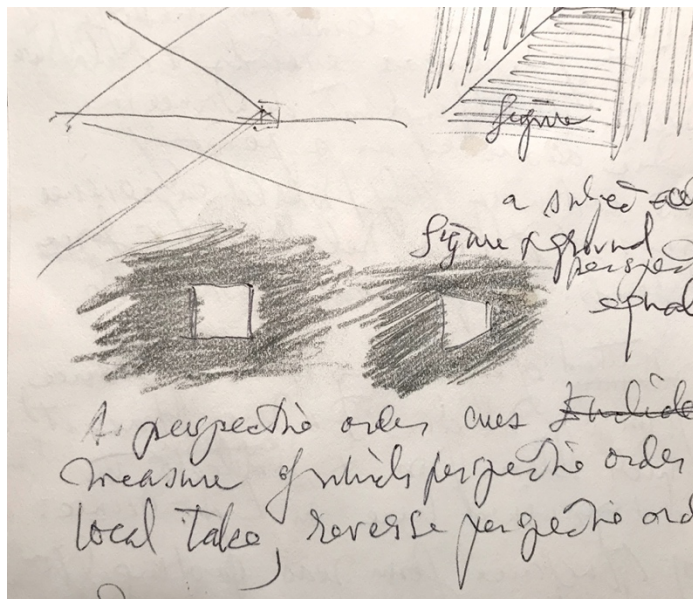


Figure 1.18: Figure and ground in early visual perception develop equally and oppositely. Source: Seth Riskin.

In other terms: through a small spatial and temporal window, Light Dance shows us the structure of vision that invisibly counterparts the material-world structure we ordinarily see. When the source of a bright line of light is located at the point in space occupied by the eye, and the bright line projects into the material environment, the transformations of the line, e.g., stretching along its major axis, spreading in its short axis, subtly curving, will be in just the way and amount *inverse* to the visual perspective transformations we would see of an equal, material line undergoing the same position and orientation changes relative the eye.

The viewpoints of the multiple actors in the Light Dance event, the viewer, performer and light source, afford *perspectives on the perspective of light*. (See Figure 1.19). From perspective of the light source, the original line will appear unchanged no matter how many surfaces of different angles and distances it lands on, as an orthogonal view of the same line and events will see it broken, displaced, stretched in multiple ways.¹²

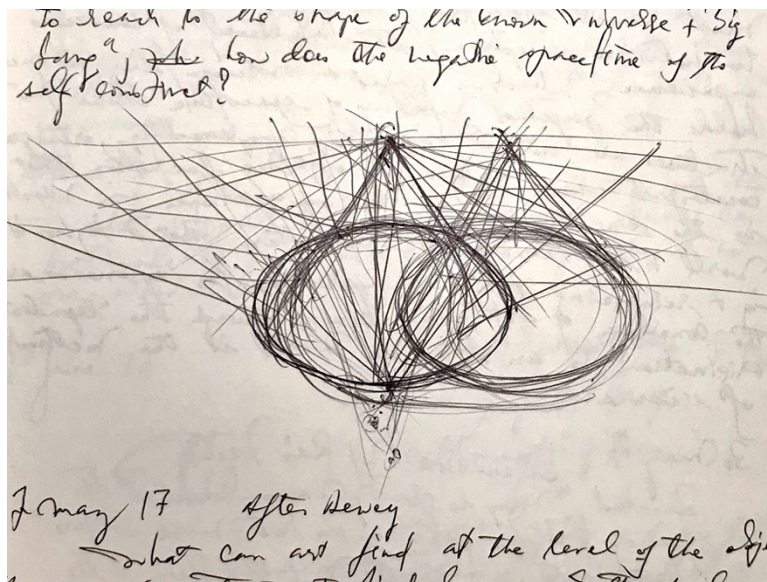


Figure 1.19: Study of the perspectives of the actors in the Light Dance performance (performer, viewer and light source) on the brightness geometry. Source: Seth Riskin

Notebook Entry, 23 June 20:

Through Light Dance, we can decouple from the “point of view” (the light source), move the “point of view”, and see different angles on “seeing” (the geometric brightness structures). This decoupling and shifting of perspective on the point of view corresponds to the spatiotemporal process of our ordinary seeing, e.g., looking at an object such as a cube from multiple angles to build conception of a three-dimensional object existing in time. The Light Dance method lets us

¹² This particular experiment is documented in Chapter 2.

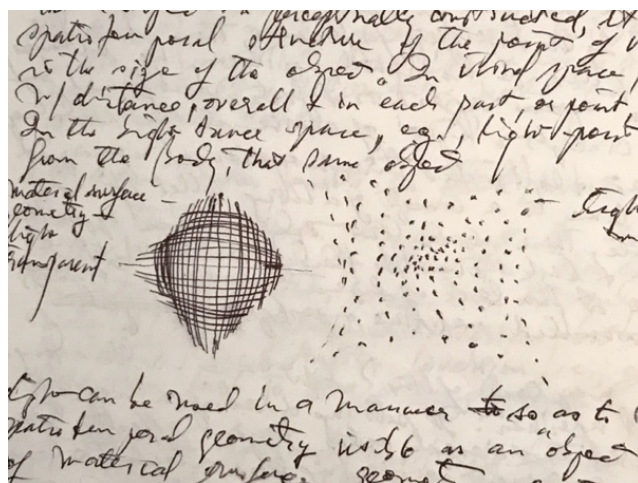
see the process once removed, thereby revealing to the eye the temporal construction process constitutive of our ordinary visual experience. A camera may be a proxy for the eye in certain ways and therefore instructive, but it represents an epistemically lateral step, presenting the full field and full range of light-information/perceptual cues as if they exist on their own. This relates to, as well as distinguishes between, Light Dance and still and moving-image photographic methods, including high-speed photography and video. Relative to these technologies/methods, Light Dance takes an orthogonal approach to light information, not capturing “what is,” but how it comes to be, and thereby does not image within the same paradigm (freezing a moving object or capturing a view from above), but orthogonally penetrates through perceptual constructions whereby the convergence of “light” and “vision” becomes apparent.

We are now in a position to see that Light Dance shows us early geometric structures and the dynamics of vision through precise handling of light. In the Light Dance performance, the body-mounted light instrument is a source of inverse vision, projecting out a “unit” of perceptual spacetime.

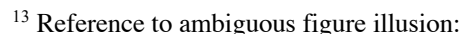
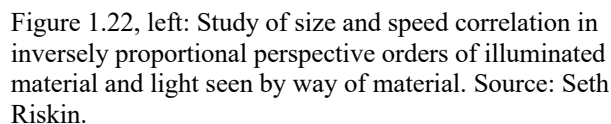
Notebook Entry, 23 Apr 2013:

The mainspring of vision is difference. Figure and ground are always relative and individually ambiguous, like brightness/darkness. Visual attention may attend to one or the other. Differences multiply, but ambiguity remains at the core. The relational structure that emerges is twofold: visual perspective of the “figures” and the inverse visual perspective of the “ground.” (See

*other, has its order by the perceptual transparency of the other, like the rabbit and the duck.*¹³



Figures 1.20 and 1.21, from left to right: Figure and ground: study of the inversely proportional perspective orders of illuminated material and light seen by way of material. Source: Seth Riskin.



Accustomed seeing is *looking through light* to experience material texture, form, size, and associated spatiotemporal structure. Light Dance reflexively reveals to visual perception that the spatiotemporal structure of the material environment—visual perspective—is always counterpoised by an equal, inverse and transparent, projected receptive field, or “structure of vision” that has the metric of inverse visual perspective. Light Dance shows us that ordinary seeing is *as if we were projecting light from the eye*.

Notebook Entry, 13 Apr 2013:

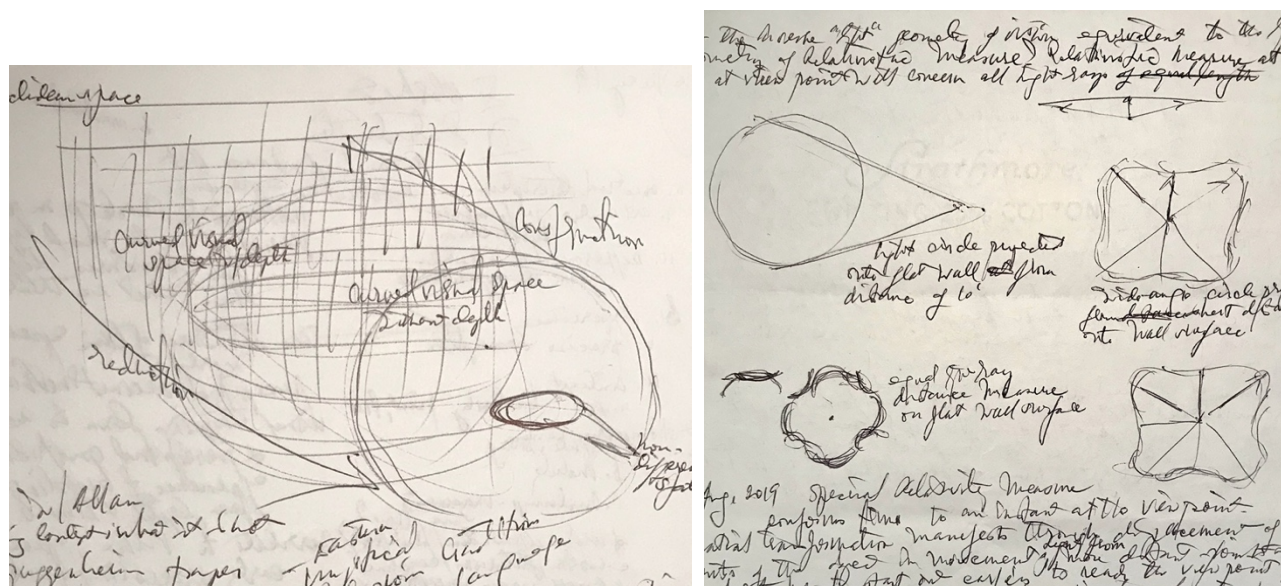
A visual scene is flat against me until another scene is cognitively connected. They are then seen as one; cognitive and perceptual seeing merge seamlessly in experience. Mind makes distance. In visual space, i.e., seeing that is spatially and temporally local, prior to its cognitive extension beyond what the eye can see, the mind takes the place of light.

1.2.4 Postulate 4: Light in Light Dance *plays the role of a slice of vision, if it, and not the material environment, were visible*

We anchor the following considerations in Postulate 1: free of cognitive interpretations, the perception of a line of light in otherwise darkness can only be described as one-dimensional, a visually primitive experience of bright/dark opposition. In this experience, there exists no “light,” no “wall surface,” no “spatial depth.” These are conceptual abstractions that incorporate countless experiences, cognitively integrated into multidimensional constructs. The line of brightness, with its single spatial dimension and implicit temporal immediacy, is the perceptual ground of the Light Dance experience. From this ground, through a process of changes in the line as seen by the viewers, higher-level brightness geometries are constructed in perception. With

movement, the changes in the line's size, position, orientation, and speed integrate into higher-level brightness geometries in perception: the one-dimensional line extends laterally into a rectilinear plane; the rectilinear plane asymmetrically expands into a trapezoid describing depth. The extreme reduction of visual information in Light Dance foregrounds the function of memory and cognitive integration in the experience of higher-level spatiotemporal structures.

The brightness lines, sheets, planes, higher-dimensional structures of the Light Dance experience describe a metric around the locus of their source on the performer's body. Expanding in size and speed with distance from the source, the perceptual objects of the Light Dance experience describe a radial geometry with characteristic curvatures and angular arcs. (See Figures 1.23, 1.24 and 1.25.)



Figures 1.23 and 1.24, from left to right: The perceptual objects of the Light Dance experience describe angular directions and radial distances from the source, resulting in curvatures. Source: Seth Riskin.



Figure 1.25: The geometry of the Light Dance experience is radial, referring to the point-source of light mounted on the body and expanding in size and speed with distance. Source: Seth Riskin.

The Light Dance geometry in direct perception describes a curved geometry referenced to a point in space, as opposed to the rectilinear geometry of the “seeing concepts” view on the material environment. Unlike a material object, the Light Dance shapes and forms of brightness do not persist in perception. They are evanescent, only visible *in movement*. In ordinary perception, it is vision that moves, transient and transparent, as the perceived material objects and according spatiotemporal structure appear invariant, persistent, and multidimensional. These and other, aforementioned inversions of the Light Dance experience (the light source located at the body, projecting out in geometrically constricted units that do not illuminate, but are themselves revealed by interaction with material surfaces) connect to the Light Dance experience of brightness as opposed to light, revealing it as *an inversion of sensation and concept*. The

spatially simple and temporally early Light Dance ground of experience inverts the ordinary seeing of percepts embedded in cognitive interpretations, to the seeing of percepts *as they construct into higher-level percepts and concepts*.

We are now in a position to realize that we cannot hold the Light Dance unit of brightness apart from mental function. “Brightness” means sensation, and therefore we are not speaking of the distal, but proximal, stimulus, the pattern of energy on the retina that is equally a pattern of early visual processing. Though our considerations of Light Dance began with physical light, space and time, we can now see that the Light Dance method systematically subverts these high-level concepts by removing the perceptual cues by which they activate and occlude early visual processing. The Light Dance geometry is a brightness geometry; in Light Dance, we experience vision about its early structuring principles of bright/dark opponency and rudimentary space and time.

The Light Dance line of light is equally a sensation of linear brightness. The conceptual construct that holds these apart and in hierarchical relationship has been circumvented by the Light Dance reduction of light information *in accordance with* the geometric order of vision, letting us see the vision for the light. The Light Dance instrumentation and methods of inversion are precise to the use of light for the reflexive study of vision; the light line projection is equivalent to a radial slice of the “cone of vision,” the projected receptive field: Postulate 4.¹⁴

¹⁴ See Appendix I: Glossary for the operative definition of “cone of vision.”

Having come to the equivalence of light and brightness (vision) in the Light Dance experience, we can now see why the spatiotemporal structure and dynamics of brightness are the inverse of those of material illuminated by light in visual perspective. Light Dance makes visible the “cone of vision,” the total receptive field projected into a volume of space, interacting with the surfaces of a material environment, *ordinarily transparent for the seen material*.¹⁵ (See Figure 1.26.)

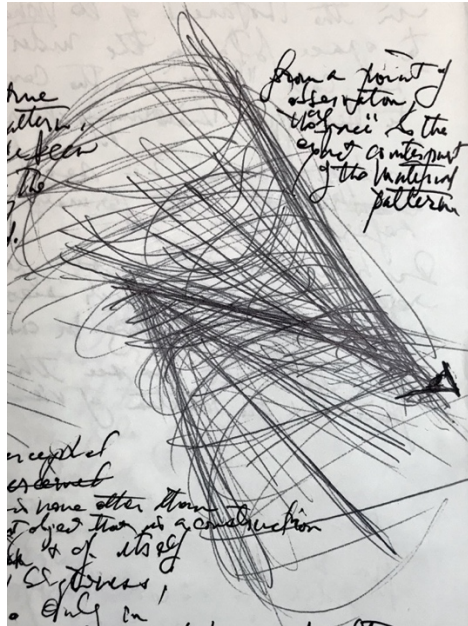
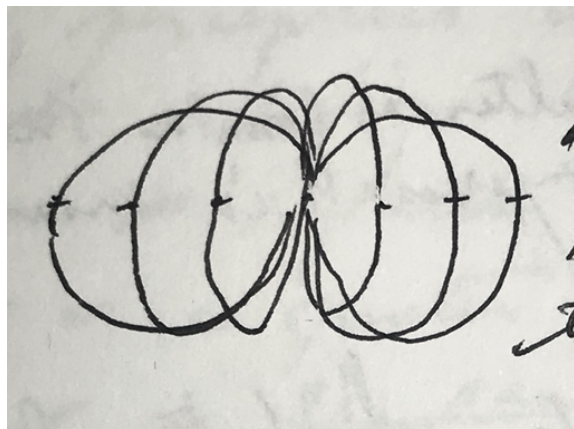


Figure 1.26: The inverse perspective orders of vision and material seen by vision. Source: Seth Riskin.

Notebook Entry, 23 June 20:



“Vision” is the experience of light wherein light cannot exist as an object of experience, must disappear to give the experience, and, complementarily, “light” is vision conceptualized,

Figure 1.27, left: “Curvature” of advancing knowledge of light and vision: one leads to the other. Source: Seth Riskin.

¹⁵ See Appendix I: Glossary for the operative definition of “receptive field.”

an object of thought constructed out of visual experiences, stripped of subjective content and projected as a physical phenomenon.

Notebook Entry, 25 Feb 20:

I see the spacetime of the projected receptive field itself by way of the material objects. It is a matter of the placement of visual attention. The spacetime of the common visual perspective (visual space) and the inverse spacetime of the receptive field itself are perceptually bistable and demonstrate figure/ground reversibility. They don't exist independently, rather are two interpretations of the same information.

1.2.5 Thesis Statement: What we call “light” is vision conceptualized and projected as a physical phenomenon; what we call “vision” is pre-conceptualized light

Light Dance represents the totality of light and vision, i.e., one does not reduce to the other but converts into the other.¹⁶ As what we call “light” contains an element of “vision,” and what we call “vision” contains an element of “light,” we are not dealing with irreducible dichotomies of physical and biological, objective and subjective. We are dealing with a continuum that includes the knowing of the system, introducing a horizon to what can be known and therefore “curvature” to what is known.

Notebook Entry, 12 June 18:

Curvature: The subject influences the known universe like a gravitational center and field, like a reference frame and relative measure of space and time. The mind-free universe appears strange

¹⁶ See Appendix I: Glossary for the operative definition of “interconvertibility.”

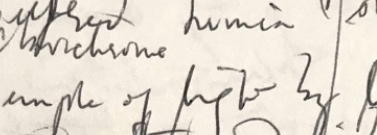
for its horizons: the constant and limited speed of light; quantum uncertainty; the persistence of the problem of accounting for consciousness in the model of the physical universe.

These features of light concept are maps of the world about a consciousness center. The purpose is to identify the role of the mind in the physical world. This will not be achieved by following a path of disciplinary thought. It will not be discovered under a leaf, or in the form of a newly known subatomic particle. It should be obvious by now, by the absence of mind in the model of the physical universe, that any path attending to that model will fail. Rather, a complementary approach is needed, and for this, the manner of thought itself should be expanded to include perception—perception that is the ground of thought and therefore perhaps the goal of thought, in the sense that thought about an object must ultimately discover itself in that object.

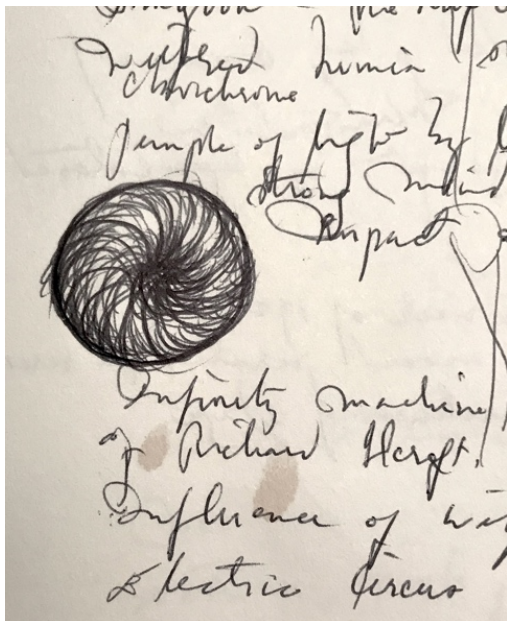
Light Dance operates at this juncture where both sides of “seeing concepts” and “direct perception” can be seen.

The Light Dance experience makes conceivable the common origin and co-emergence of the concepts of vision and light. Light Dance shows the symmetry of the situation: how light can be used for the reflexive study of vision, revealing inverse proportionalities that direct the mind to the continuity of light/vision concepts. In Light Dance, the eye steps away from the “eye” (the point source of light) in a manner equivalent to sequential views in the ordinary process of vision. The world is not discovered but constructed: in Light Dance, vision gives rise to light on the far end of the process of perceptual construction.

In degrees, the body disappears in experience. Locality and totality are experienced at once. Movement is at once discrete and revealing unity of space and time that gives rise to, and transcends, all movement. When the construct of spacetime and individual objects falls away; when the experience of the self exceeds the body; when the path of movement loses linear direction in space and time, there is left “light” to describe consciousness. The last locality, a center and limitless surround, the minimum and the most of being-experience is described as “light.”



loses its center and ultimately returns to it. The whole is organized about the center; the center has its meaning by the whole. (See Figure 1.28). Knowledge will always take this shape. Knowledge always has a subject, and no physical universe is fully known without incorporating of the subjective element into the physical-universe model.



102

Light does not begin vision but *completes* it, a conceptual closing of the circle back to the originating eye. In this respect, light must be conceived not as an ontologically independent phenomenon delivering information to the eye, but *as the completion of a perceptual-construction process that relates the world back to the eye*. The experience of vision is light pre-conceived; light is vision conceptualized. The physical model of light holds, but it is relativized within the condition of knowledge.

Notebook Entry, 8 May 17:

It appears that the world in space-time extension is constructed in concept upon the unknowing of light, and the greater the knowing of light as an object in that world, the more that knowing undermines the space-time extension and the distance between the observer and the object that is essential to the objectivity of the world.

The mind is conceived not apart from the world, but at the origin of a spatiotemporally-extensive manifestation of the condition of knowledge, the final conception of which is “light.”

The Light Dance experience is one of visual spacetime structure issuing from and developing around local, simple, and temporally immediate direct perceptions, into more expansive and complex conceptual, spatial and temporal structure.¹⁷ In method and cultivated practice, Light Dance penetrates into the nexus of illumination revealing the symmetry of light and vision.

¹⁷ See Appendix I: Glossary for the operative definition of “visual spacetime.”

The Light Dance reduction of light information to base units of its propagation geometry allows us to see the spatial and temporal structure of light *as an exponent of vision*, ordinarily invisible because it is sacrificed for material percepts.

Notebook Entry, 13 Aug 16:

Light is the original distance between myself and the object. I see no light; I learn distance, perceptually drawing the invariant out of the flux. The object becomes separate, objective and deterministically bound. The “brightness” inherent in “there-it-is,” the object I am conscious of and therefore “am I,” is light in its fundamental nature, the original unity of mind and physical world.

The material world that we see is counterpoised and substantiated by an inverse order of vision that we don't see, that we *look through*, or “inhabit.” By working with light in the manner of vision, then, the ordinary hierarchy of light and vision is inverted and, with it, the structure of space and time.

Notebook Entry, 11 Feb 20:

The conceptual geometry of physical light and causal sequence to vision is the inverse of the perceptual geometry of vision and time sequence to light. Perceptual construction to “light” is the inverse of light information feeding vision. The symmetry points out “epistemic curvature”: building knowledge toward “light” can progress from direct perception to the physical world, or from the physical world to direct perception. These progressions complete each other in “light.”

The epistemic eventuality “light” is both mental and physical. Avoiding this leads to contradictions.

Notebook Entry, 19 Feb 20:

The spatially and temporally extensive physical-world-in-concept, within which is located the viewer, is counterpoised by the inversely local and curved world of direct perception. Physical light is prefigured in the visual construction of the world-in-mind. I am not in the world localized in space and time and discovering it; I am the world by which I conceive its self-existence, extensivity, and my place in it.

This inversion alerts the mind to a principle of equivalence of light and vision and a fundamental limitation of knowledge of either one in isolation for the overarching condition of unity within which conscious knowing is a divisive function.

Notebook Entry, 20 Feb 20:

Light accounts for vision and vision can account for light. Vision accounting for light: in light we discover an element of ourselves, like a genetic trace we follow back as an epistemic thread.

There is in light-experience an element of “collapse”; the phenomenon—its physical speed, scale of space and time—flattens to the perceiver when knowledge of the origin of light is realized.

The collapse is not only of spatial depth, but time, to the immediacy, or present, of perception, the point of reference. It is as if the physical world, in its extensivity in space and time, ever holds a trace of knowing that locates with the subject-observer, the spatial and temporal locus of self-

experience. “Light” is that through-hole, that illogical, while experientially ineluctable, identity of the physical light and the “light” of consciousness.

We thus arrive at revised understanding of “vision” and “light.” The experience of vision is pre-conceived “light.” What we call “light” is concept-vestige of vision, psychologically projected. The two meet in experience in the light/brightness that equally exists in the world and in the head.

It becomes clear that Light Dance presents a seeing process with *projection* instead of *reception*, and that its point-source geometry works both ways.

Notebook Entry, 2 Apr 20:

The projection of light from the body tells us not about “physical light” but the root of the figure/ground of visual perception. Perception of light itself is anti-perception: the more light is the object of seeing, the less a visual world is seen, leading to the point of non-differentiation, collapse of the subject/object differentiation required for conscious perception. Light is an object only in context of the spatiotemporal realm it generates.

In itself, light is perception and object equally. It is the state of non-differentiation, or unity, itself, perceptible only relative to the differentiated construct it originates. This is the fundamental paradox.

Shaping and concentrating light and casting it from the body allows us to see the perceptual structure ahead of the material structure it underpins. In doing so, the artistic act circumvents the causal construct that forms the hierarchy of physical light and vision.

The severe reduction of light information to a unit of opponency, and the necessity of movement in building dimensional complexity of what is seen, correlates with the function of the receptive field of vision.

Light Dance thereby presents a learning process that begins with minimum information and movement, and builds variation and *experience*. All participants in the Light Dance performance are seers with different vantage points on the early process. This is the essence and efficacy of the Light Dance art: it *externalizes* elements of early seeing structure and process by which it becomes multiply experienced. Under conditions set by the Light Dance tools and methods, the experiential difference between “light” and “vision” is erased. We find ourselves in a perceptually primal world of bright/dark interplay and spatiotemporal genesis.

Notebook Entry, 15 Mar 20:

We must learn to think beyond the divide of light and vision, see continuity. Vision is light in experience; there is no experience of light: that experience is vision. We are dealing with a continuum that, when known, i.e., divided, expresses inverse proportionality and functions.

Notebook Entry, 3 July 19:

Light Dance is a reversal of light/vision order and a reduction of light information so that vision, in what it sees, remembers itself. Light reaches out from the body. The ordinary perspectival geometry inverts: a light line, now the object of vision, grows as it defines distance and curves oppositely. Rather than experiencing the spatiotemporally separated object and viewer linked by light, light becomes the object of vision, closing the separation, i.e., using light-vision to show its invertibility to itself, thereby visually indicating origins, “epistemic reversal”, implicating the subject in the object.

In the Light Dance event, there is effectively a single “eye,” the light source, seeing and multiple perspectives on that early information. All the perspectives and transformations relate to an order organized around this “eye,” while the view from the “eye” shows no transformations. The Light Dance perception plays the role of the receptive field constricted to a slice. Obviously, in ordinary vision, the structure of the receptive field does not change as the eye moves; rather, the receptive field sees stimulations out of which a world is constructed. Light Dance lets us step out of the receptive field and see its projected structure and dynamics relative to material surfaces. Light in the physical world, and the projected receptive field in the perceptual world, are superimposed in the Light Dance experience, revealing to the eye that they *play the same role, a single entity experienced at perceptual and conceptual levels.*

Notebook Entry, 22 July 19:

It thereby becomes conscious that “light” is, in some degree, a creative function of the perceiver and remains so, whereby the entire, extensive structure of the known physical universe is

recollected, inverting the extensivity to implicate the viewer. This I have called the collapsibility of the world in perception that is known in the depthless potentiality of the equiluminant light experience.

This “recognition of self” in the light lies in every percept. It is implicit order that underlies the overt order of the physical world in experience. It is the experienced “invertibility” of the world that, while turning on perception, must pass through the viewer like a focal point (See Figure 1.29). All knowledge of the physical is thereby relativized, like subtle geometry counterpoised against the physical spacetime, implicated increasingly as that exteriority is pursued in knowledge. The increasing implication of the viewer in the structure of objective knowledge—this I call “curvature.” This might be revealed globally—knowledge laid out so as to reveal epistemic pattern across physical entities. Light is most transparent to this pattern and may be used to reveal it.



Figure 1.29: The physical-world experience references the viewer in shape and dynamics, presenting an inverse, counterpart order to that of the physical-world concept. Source: Seth Riskin.

We can flip the geometric relationship of light and material around to produce sensations that add up to visual perceptions of an inverse-perspective world. This suggests continuity between vision and light. We only know one by the other and can foreground one or the other. In the Light Dance experience, physical light and brightness sensation are collapsed to one, and we can see the role vision plays, ordinarily transparent, relative to the ordinary experience of the illuminated material environment.

Notebook Entry, 21 Dec 17:

The Light Dance experience embraces both thought and perception of light and reveals their relationship. Light Dance spans these modes of knowing, showing the transformations that relate

them within an overarching principle of equivalence between the subjective side of light, vision, and the objective side of vision, the physical phenomenon of light.

In the final analysis of the experience of the material environment, it is perceptual. At this level, the level at which Light Dance operates, we experience the inherent perceptual ambiguity of the stimuli: an edge has two sides. Which is foregrounded determines whether a cube will be seen for itself or whether we will see the “negative space” around it. This “negative space” *is vision*, that must be looked through for us to have a “hard” world in experience.

1.3. Testing the Postulates and Thesis

This chapter draws from the Light Dance experiences, a progression of thought that frames the thesis. The practice and experiences of Light Dance are visual; the art works with light and optics, material surfaces and movement to generate fundamental percepts of bright/dark opponency and opponency patterns that form rudimentary space and time in perception. The early percepts of Light Dance express their own logic. Shaping the physical in reflection of perceptual insights that they may be foregrounded in experience is the motivation and method of the art. Light Dance creates the conditions, instruments and sensory experiences that engender original thought. Through a series of “inversions,” approaches to light as a means of reflexive study of vision, Light Dance aims to lay fresh sensory ground for thinking about light and vision. The knowledge within Light Dance is embodied in the practice, and it is the purpose of this dissertation to lift that knowledge into the conceptual realm with fidelity.

The foregoing has used notebook entries, depictive expressions and primary verbal castings that stem from the Light Dance experiences, to generate the thesis concept. The work arrived at four postulates and a thesis statement. Now that we have the framework, it should be possible—and critical to further theoretical development—to test the ideas visually. As the ideas derive from the visual, Light Dance equipment and methods may be used to visually isolate and detail the ideas toward strengthening the thesis argument. Chapter 2 features a series of experiments that visually expand the postulates as a basis for experiencing the equivalence of light and vision perceptually and conceptually.

CHAPTER 2: The Red Light and Light Line Experiments

2.1. Introduction: Testing the Light Dance Postulates

2.1.1. Rearticulation of Thesis

The previous chapter presented a thought process conceiving Light Dance as a reflexive study of vision, working from notebook drawings and text to produce theoretical principles from practice. By reasoning from experiences afforded by the Light Dance practice and developing a progression of postulates, we came to the thesis concept: a principle of equivalence between light and vision. What we call “light” does not exist in visual experience; the two—light and visual experience—do not exist simultaneously. Rather, in visual experience, “light” is “brightness” that has no spatial or temporal measure of its own, but is so defined only with reference to surrounding visual context. With this context removed, as in the Light Dance artwork, brightness is experienced to “float” in distal/proximal ambiguity (Postulate 1). From the Light Dance elemental unit of brightness, e.g., a line, perceptual dimensions can be generated through movement. By changes in length, orientation, direction, speed, and intensity of the brightness, spatiotemporal structures are formed in the mind of the viewer (Postulate 2). Through the Light Dance experience, these structures are seen to articulate a geometric order that refers back to the point source. The brightness structures that experientially unfold in Light Dance are geometrically defined by angular directions and radial distances, referring back to the point-origin located at the performer’s body.¹ As such, the forms, volumes, sizes, speeds, etc. embodied in the brightness structures of Light Dance reveal a perspectival order that is the inverse of ordinary visual perspective (Postulate 3). It thus becomes clear that the Light Dance

¹ See Appendix I: Glossary for the operative definition of “brightness structure.”

elemental unit of brightness—spatially constricted, originating from the body, moved to acquire information—*plays the role of a slice of vision, if it, and not the material environment, were visible* (Postulate 4). This leads to the insight behind the thesis concept: what we call “light” in the context of visual experience is equally the sensation of “brightness,” a primary perceptual function of vision that conceptually builds to the concept of “light.” “Light” and “vision” are two expressions of one phenomenon (in the sense of *phainomenon* “what shows itself, the self-showing, the manifest,” clear and obvious to the eye or mind, neutral with regard to the physical/mental) (Heidegger, 1927, p. 51).

These postulates challenge our traditional ways of understanding the relationship between vision and light. There is a long history in western thought of entangled concepts of vision and light (Ronchi, 1970; Lindberg, 1976). Complete theoretical distinction between biological vision and physical light occurred late, arguably not until the 17th century (Smith, 2015). Today there exists no theoretical model for relating subjective and objective realms of vision beyond purely functional interactions. To put it another way, there is no place for the mind in the model of the physical world.

Yet from the postulates and thesis that have emerged, we have a new way of conceiving of the relationship between vision and light. “Light” submits to two interpretations: 1. the accustomed, physical phenomenon that delivers visual information to the eye, and 2. *conceptualized and projected vision*, which has physical characteristics, including situation in space and time, *only* with reference to contextual information perceptually constructed, a primary instance of which is the cardinal sensation/distinction brightness/darkness. Here we see an element of equivalence

between light and vision. On this basis, we can consider Light Dance as a twofold experience, as a light event, or a brightness event. These two perspectives imply different epistemic orders, the light event signaling the accustomed, causal order of the light “physics” and receiving eye, and the brightness event signaling a perceptual construction experience: we witness space and time constructed as a mental event out of the movement of the elemental unit of brightness. I believe the two perspectives on the Light Dance event represent lower- and higher-level models, similar to perceiving an ellipse as a two-dimensional shape and as a foreshortened circle in three-dimensional space.

“Light” and “brightness” can apply to the same experience and perception can shift like that on the above ellipse/circle, indicating different orders. Though “light” and “brightness” intersect in the above sense, their implications and the conceptual models they give rise to are massively different. It seems that we are dealing with orthogonal perceptual/conceptual structures that intersect at the primary experience “light/brightness.” Light Dance endeavors to show the eye spatiotemporal order that unfolds from an elemental, geometric unit of brightness. Here it is helpful to think of the elemental unit of brightness as a bisecting slice of the volume of the total receptive field space, where “the receptive field of a single photoreceptor is a cone-shaped volume comprising all the visual directions in which light will alter the firing of that cell” (Das, 2015, p. 342).²

The Light Dance elemental unit of brightness doesn’t light material, but becomes visible by it, and thereby shows us the geometric development of the vision we ordinarily look through to a

² Below, phrases such as “slice of vision,” or “slice of the cone of vision” refer to the slice of the volume of the total receptive field space. See Appendix I: Glossary for respective entries.

material scene. Again: *Light Dance shows a slice of vision, if it, and not the material environment, were visible.* This experience primes apprehension of the identity of light and vision, how the two—the physical phenomenon of light and the seeing of it, the vision—are not categorically, fundamentally irreducible (i.e., physical and biological) but congruous and indicating continuity of knowledge, one leading to the other.

2.1.2. On the Problem of Multiple Viewpoints: Actors and Manifolds

A complication emerges in delineating these concepts: the role of multiple viewpoints on the Light Dance event. The Light Dance event includes three actors: the light source, the performer, and the viewer. Each will see the line of brightness and its higher-level constructions from a different angle. It will be noticed that as the viewpoint, e.g., of the performer, moves closer to that of the source, the perspectival changes of the line will diminish in magnitude until, at the point in space occupied by the source, no changes will be seen. Thus, a relational “map” across the viewpoints can be documented showing “collapse” of the spatiotemporal structures at the location of the source or “eye.” This source correlates with receptive field of a photoreceptor in vision. Change is required for even the most rudimentary sensation; perceptual construction and order are born out of change. If the relationship of the distal stimulus and eye is fixed, perception will fade (Pritchard, 1961).

The crucial step in Light Dance is the use of light to illuminate the perceiver’s perspective and to prime a conceptual inversion of light/vision. What is intended in the Light Dance artwork is not a representation of the subjective view within the accustomed, or standard, paradigm, but an

experiential inversion of light foregrounding subjective experience in vision and thereby alerting the mind to the functional symmetry of light and vision.

It is typical to think of Light Dance instruments and effects as equivalent to a flashlight beam lighting a portion of the physical environment. While the mechanics of this analogy are correct, the mechanics and their associated thought-paradigm should not be applied to the perceptual experience; it has its own order or paradigm. Turning upon the artistic handling of light, the Light Dance art form drives toward perceptual and conceptual inversion of light and vision. Light is a pivot point and a portal in this work. The postulates mark passage through the portal, key perceptions/early conceptions that prefigure the thesis concept.

We can thus reapproach the postulates with the problem of multiple perspectives in mind. The Light Dance work begins by squeezing down light to a single dimension, leaving the surround in darkness, thereby removing visual context from around the line. What is the experience of this uniform, one-dimensional brightness? With regard to the habitual divide between human interior and physical exterior realms, it is neutral (as evidenced in Postulate 1). With movement, the line of brightness spatially/dimensionally elaborates (demonstrated by Postulate 2). Postulate 3 then reveals the global spatiotemporal structure of this unfolding brightness and indicates polar coordinates, i.e., that it refers to a point in space, or a perceiver.³ Finally, Postulate 4 states that the spatiotemporal brightness-structures of Light Dance imply an inverse perspective order relative to ordinary visual perspective. This leads to the thesis concept of equivalence between the structures and dynamics we see in Light Dance and vision itself, which in turn raises the

³ See Appendix I: Glossary for the operative definition of “global spatiotemporal structure.”

possibility that an element of what we call “light” *is* vision in conceptualized and psychologically projected form. It should now be clear from the foregoing discussion that, in the context of the Light Dance experience, the point source of light is an “eye” and the line projection, a geometric reduction—a slice—of the projected receptive field. In the spatiotemporally inverse world of the Light Dance experience (the light squeezed down to a spatiotemporally low-level unit), the simplified geometry of the line allows us to experience early spatiotemporal constructions, e.g., two-dimensional “manifolds” that generate from the initial one-dimensional brightness with movement.⁴ Light Dance allows us to step outside of the viewpoint and to see varied angles—other perspectives—on the spatiotemporal elaboration of a slice of the “cone of vision.”

In these respects, the spatiotemporal unfolding in Light Dance allows us to study the relations between the perspectives of the actors. For example, if the light line from the source mounted on the performer’s wrist is projected perpendicular to the corner where the floor meets a wall, three delineations will be seen by the three actors: the viewer with a side view of the scene will see a line at a ninety-degree angle; the performer, whose eye is close to the light source, will see the line at an obtuse angle approaching 180°, and, from the point of view of the light source, the line *will show no angle*.

We can consider Light Dance a visible “seeing event” in which the light source is the eye and the projected light line is vision (the receptive field space), spatially and temporally reduced to one dimension. We can now experience perceptual construction and corresponding spatiotemporal

⁴ See Appendix I: Glossary for the operative definition of “manifolds.”

development of the line, e.g., into a curved plane. As studied in one of the experiments to follow, each of the three actors has a different perspective on this seeing process, with the view from the light source expressing geometrical properties of a projective nature. From this perspective, that of the light source, the light line shows no transformations whatsoever, no matter the movements of the line or the surfaces it lands on. From perspective of the light source, the line remains spatially and temporally ambiguous *until other perspectives are taken on it*. This suggests a correlation between the light projection in Light Dance and the receptive field of ordinary vision that requires change of input for perception and the development of perceptual constructions, such as a three-dimensional form that incorporates multiple perspectives into a single, higher-level percept.

2.1.3. Overview of Chapter

In this chapter, I develop a schematic description of the nested problems embodied in the Light Dance experience. The scheme will serve to order a series of experiments that will follow the progression of the postulates, isolating and demonstrating the key features of the Light Dance experience toward strengthening the thesis argument. From these postulates and the thesis, a set of questions emerges: how do we examine and think about the Light Dance experience as a two-level model, denoted by light and brightness? How to we study and understand the brightness event on its own terms and then in relation to the light event? How do we understand the relationship of the perspectives of the performer, viewer and light source in relation to the above two-level model?

To engage with the nested problems identified above, in what follows, I will test the four postulates and demonstrate the thesis through a set of experiments. The experiments proceed by way of controlling the environment, eliminating ambient light and perceptual cues, and from there, using instruments to project and manipulate a geometric “unit” of light. Each postulate will be tested by an experiment or series of experiments.

The “Red Line Experiments” documented below follow the progression of the first three postulates, describing them in primary visual terms of the Light Dance experience. In these experiments, a red laser light source is used for the control and clarity of the effects that it offers. Line and cross projections are used for the relation of their spatial/temporal effects. In many cases, the photographs show the Light Dance phenomena in context of ambient illumination, allowing the viewer to see both the “hard” space, as ordinarily seen, and the superimposed space of the Light Dance phenomena. This has the function of contradistinguishing the commonly perceived spatiotemporal order and the Light Dance spatiotemporal structures, signaling their inverse relationship. The Red Line Experiments, ordered and annotated according to the postulates, work toward the visual elucidation of the postulates and that of the thesis concept.

Following the Red Line Experiments are the “Light Line Experiments,” which trace the progression of claims in the fourth and final postulate, leading into the thesis statement. The Light Line Experiments apply the Light Dance method to familiar objects or spaces, such as a cube or inward corner, to see what information about vision and the Light Dance method may be revealed through transformations of these known quantities. The experiments show combinatory perceptual effects of the Light Dance method applied to moving objects that epitomize Euclidean

measure (principally a cube), activating perceptual “priors,” previously formed concepts and expectations. In these experiments, the Light Dance line of brightness, as a slice of the “cone of vision”, scans the rotating, material object. Through the Light Dance illumination inversion—seeing the illuminant and not the material—the resulting object transformations reveal dynamics of how we see the world. The eye is in constant, compound motion: microsaccades, macrosaccades, movements of the head, neck, body, as well as movements of physical objects. From this flux, “hard” objects, spatiotemporal structure and location of the observer are “conserved,” perceptually drawn out as invariants. The Light Dance method allows visualization of perceptual transformations that may inform future research.

To clarify the steps taken in each experiment and how they map onto the postulates, I will outline them here. The experiments conducted for Postulate 1 test the distal/proximal ambiguity of the brightness unit. The experiments show the geometrically elemental unit of brightness, a line, with no other visual information. It is impossible to determine the scale of the line. Ambient illumination is introduced whereby the line takes on a specific measure as judged by the contextual information of the room. The contextual information is once again removed, allowing us to see that the line, perceived in and of itself, is spatially ambiguous, setting up the Postulate 2 experiments.

The experiments for Postulate 2 demonstrate spatiotemporal structures unfolding from the brightness unit. On the wall of the dimly lit room, the line of brightness is established as a one-dimensional figure. It shows no breadth or depth. We then see, in a single photograph, change in

the position of the line and the resulting expansion from one dimension to two in perception.

Ambiguity gives way to spatiotemporal construction in perception.

Postulate 3 is tested by a series of experiments that reveal the inverse perspectival order of the brightness unit elaborated in perception. Through these experiments that unfold the brightness geometry, relative to that of the dimly lit room, the rudimentary features of an inverse perspective order are documented. As the distance between the Light Dance instrument and the wall increases, the unit of brightness grows larger (the inverse of accustomed visual perspective where, with distance, objects diminish in size). The increase in size of the unit of brightness is accompanied by a proportional increase in speed, i.e., covers more area of the visual field in a period of sweep. The size and speed changes apply progressively across the shape of the brightness unit, in this case, a cross. The resulting transformations of the shape convey to the eye further details of the perspectival space articulated by the moving unit of brightness, e.g., elongation as opposed to foreshortening effects, announcing the inverse perspective order.

After identifying key characteristics of the Light Dance perceptual phenomena through these experiments, we can then ask: What global order do they demonstrate? Postulate 4 pursues this question by engaging with the brightness unit as a slice of vision. The perceptual spacetime phenomena experienced in Light Dance lead to postulation that the light line projection plays the role of a bisecting slice of the “cone of vision.” This reveals the line and its permutations as cross sections of the slice of the “cone of vision” made visible by intersecting the material surfaces of the room. As the slice of the projected receptive field meets material surfaces, the Light Dance actors see multiple perspectives on the unfolding geometry. The Light Line Experiments inquire

into Postulate 4 by “making perceptual solids” out of a series of perspective views. A white plaster cube is rotated about its vertical axis. In otherwise total darkness, a Light Dance instrument sweeps a line of light across the cube at 15 or more cycles per second. The eye looking upon the scene sees continuous illumination. Sweeping over the cube, the line undergoes changes in orientation, shape, speed and brightness that form a composite in perception. The perceptual results are cube transformations. The type and speed of the cube’s movement and the orientation, direction and speed of the line factor into transformation variants of the cube that appear as still objects due to the sweeps per second and syncing of the light and cube rotations.

Taken together, these experiments ultimately illustrate the claim from the Introduction that we typically abide by two coextensive ways of seeing light: 1) a conventional manner (“seeing concepts”), a projection of light in a material environment which proceeds by revealing material objects, illuminating spaces and informing the eye; and 2) an experiential manner (“direct perception”), whereby physical light is brightness, i.e., a sensation within the subject. The experiments encourage us to revisit the relationship of light concept and visual experience beyond the prevalent hierarchical/dualistic model. By depriving the subject of spatial awareness and typical visual cues in the highly controlled spaces of these experiments and, by extension, in Light Dance, we cognize that these ways of seeing intersect, they are inversely related and continuous. The perceived geometry of brightness from a point-source in space is shown to be the inverse equivalent of our ordinary visual perspective based on illuminated material and transparent light – i. e, the geometry of light is equal to the geometry of vision from a point in space. This inversion cues us to see that the visual perspective geometry of illuminated material and the inverse geometry of "illuminated vision" are *counterpart geometries*. Light and vision

are always working in counterpart, expressing inverse geometries. It may be phrased that physical light and “light” of the mind are complementary in their geometries forming a whole.

A dualistic approach to light and vision can only be taken so far. If there exists an element of wholeness between them, it will not resolve within the dualistic model, but be a point of contradiction or paradox. For knowledge to advance, a different model is required, one that can negotiate, translate between dualistic and holistic paradigms. Visual art can be a method of investigation and expression from the experience of light/vision holism. Light Dance begins here, manifesting the experience, making it perceptible, and then building perceptual order into conceptual structures, experience to knowledge.

2.1.4 On Method, Equipment and Setup of Experiments

The following experiments aim to reveal elements of the structure and dynamics of the Light Dance experience. I will therefore analyze and describe the images in experiential terms of brightness structures, etc., being as faithful as possible to the percepts behind the photographic images. The camera is a useful tool for resolving point-perspective views and exposure periods on the Light Dance phenomena, bringing out specifically spatial and temporal aspects of what is experienced in Light Dance. The exposure time of the photographic recording functions as an analogue to persistence of vision and/or memory in the experiments.

The experiments use simplified versions of Light Dance equipment to produce a line projection, reminiscent of the original Light Dance and the basis for the following studies, and a cross

projection that augments the spatial/temporal articulations of the line. The projectors are tripod mounted, as shown in Figure 2.2, or handheld (Figure 2.1) for movement studies. In the case of the Postulate 4 experiments, the light-line projector incorporates a motor that sweeps the line periodically over a target (Figure 2.3).

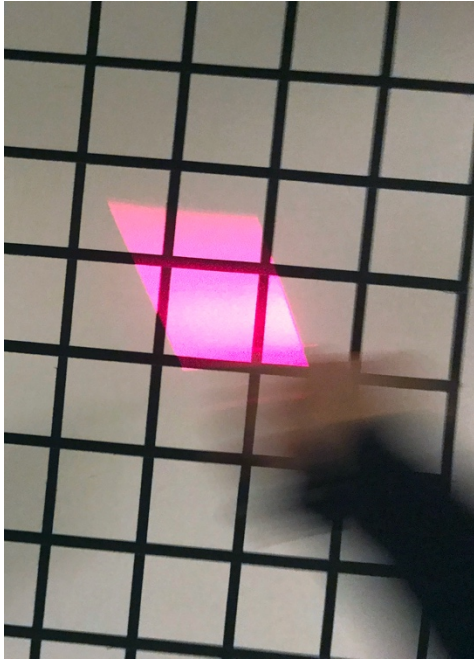


Figure 2.1: Red Line Experiments equipment view: Handheld laser line projector swept right to left over a plaster wall surface marked with a 3" square grid. Photo: Seth Riskin.

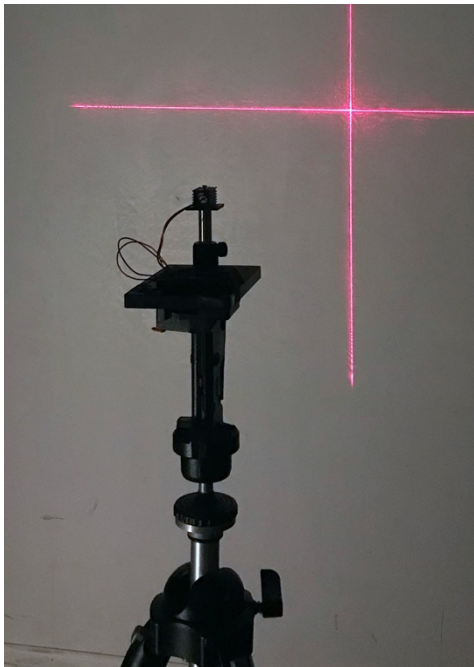


Figure 2.2: Red Line Experiments equipment view: A laser light source, beam-shaping optics and batteries are mounted on an optics breadboard, fixed on a tripod with a grip-action ball head; beam-shaping optics were changed out for line and cross projections. Photo: Seth Riskin.

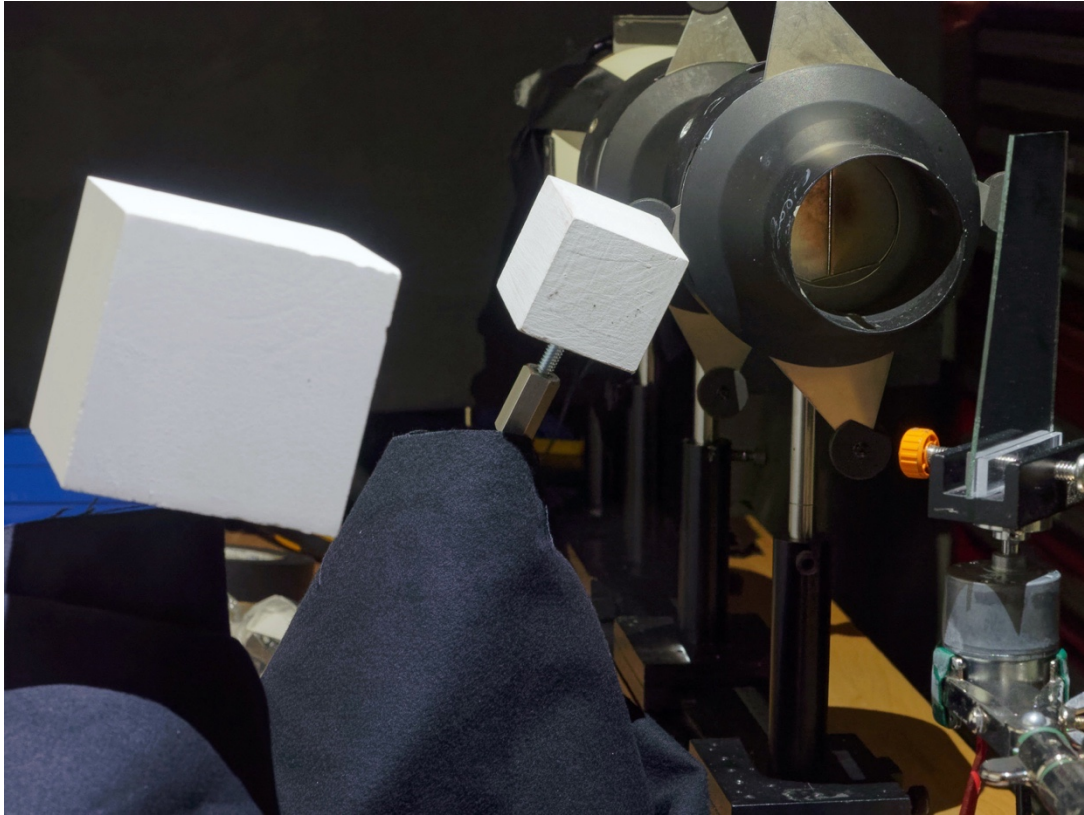


Figure 2.3: Light Line Experiments equipment view: Motorized system for sweeping a line of light over rotating objects; light from a source at the back of the system (top center) passes through a series of slit apertures before reaching a front-surface mirror (far right); the mirror rotates, sweeping the line of light over the plaster cubes, themselves spinning on adjustable-speed motors. Photo: Allan Doyle.

The sequence of experiments, and multiple images within a single experiment, represent progressions. For example, Postulate 1, Experiment 1 focuses on one-dimensional brightness and otherwise ambiguity of the experience. It is followed in Postulate 1, Experiment 2, by a comparative study of the line in low ambient illumination, which allows the viewer to experience the difference between the isolated line and the line contextualized with visual cues to the environment that impose spatiotemporal measure upon the line. Another progression concerns comparison of perspectives (the viewer performer and the light source) on the Light Dance brightness geometry. Together, the experiments endeavor to bring out key features of the brightness event, its unfolding in space and time and its global structure as seen from multiple

perspectives, toward visually elucidating the postulates and, in particular, the thesis argument, advanced in the chapters to follow.

2.2. Experiments for Postulate 1: Light in the Light Dance experience is spatially and temporally ambiguous

2.2.1. Postulate 1, Experiment 1 (A line of brightness):

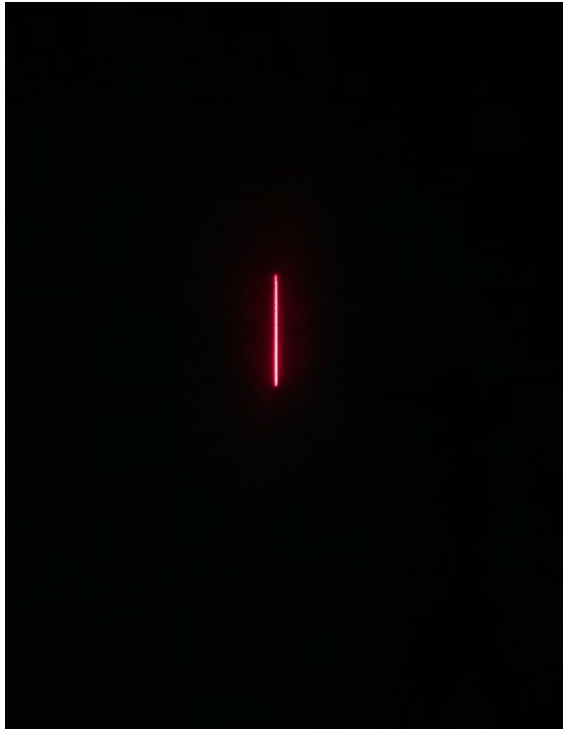


Figure 2.4: A line of brightness. Photo: Seth Riskin.

In early perception, i.e., without cognitive interpretation, this line (Figure 2.4) can be perceived as distant and large, or near and small. It is a one-dimensional figure in perception and therefore ambiguous in size and depth. High-level concepts have no place in this percept, therefore “light,” “wall,” “projection,” etc., do not enter into the perception. “Light” becomes “brightness.”

2.2.2. Postulate 1, Experiment 2 (A line of brightness with low, ambient illumination):



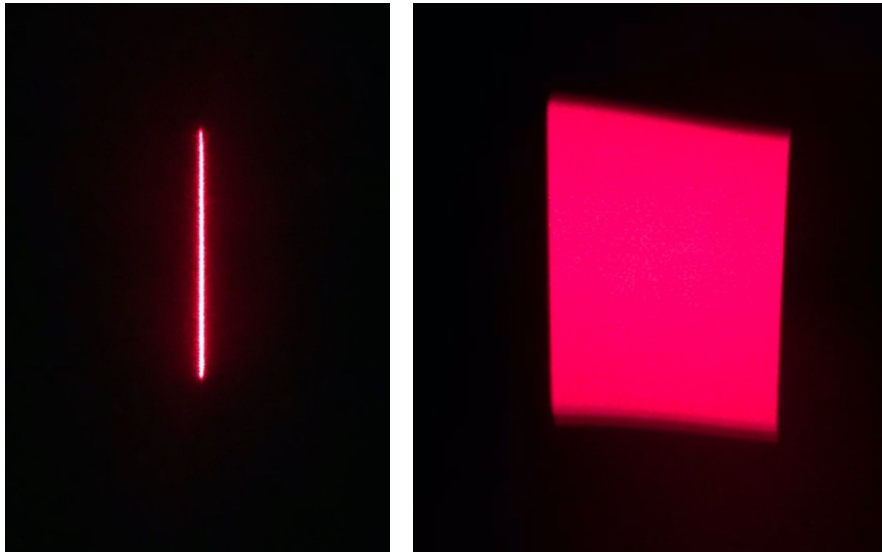
Figure 2.5: A line of brightness with low, ambient illumination. Photo: Seth Riskin.

With minimal contextual information, the “scene” (Figure 2.5) becomes perceptually apparent and the line takes on size and depth in space. Visual cues such as the halo around the line, and the silhouetted tripod trigger interpretive “scene-construction,” whereby the concepts “light source,” “projection,” “distance,” etc. influence, build out the percept. The direct-perception, one-dimensional brightness is set within a conceptual structure whereby it becomes “light projected onto a wall” with implicit spatiotemporal and causal orders.

Light Dance instrumentation and methods allow us to experience early visual processing first by flipping the physical light/material surface illumination function. By carefully controlling the interaction whereby the light, and not the material, is visible, we access an ordinarily occluded realm of perception that obviously intersects with the accustomed “reading” of material properties through (transparent) light.

2.3 Experiments for Postulate 2: Movement of the line of brightness articulates higher-level spatiotemporal structures in perception

2.3.1 Postulate 2, Experiment 1 (A line of brightness in translatory movement about one axis):



Figures 2.6 and 2.7, left to right: A line of brightness; a line of brightness in translatory movement. Photos: Seth Riskin.

The line of brightness moves right to left perpendicular to the viewer's line of sight. (See Figures 2.6 and 2.7). One dimension expands into two, in perception. This is true whether movement of the figure or the viewer takes place, and whether the movement is fast or slow; whether seen by persistence of vision as a sheet of light, or by memory as a translating vertical line, one dimension expands into two in perception.⁵

The spatiotemporal development of the line of brightness is a perceptual construction drawing from the one-dimensional brightness plus movement. We experience not an “inverse-optics reading” of the two-dimensional sheet, but the sheet as generative function of stimulus and percept.

⁵ This dimensional expansion incorporates time and therefore “spatiotemporal” is used in the descriptions that follow.

2.3.2. Postulate 2, Experiment 2 (A line of brightness translates and grows)

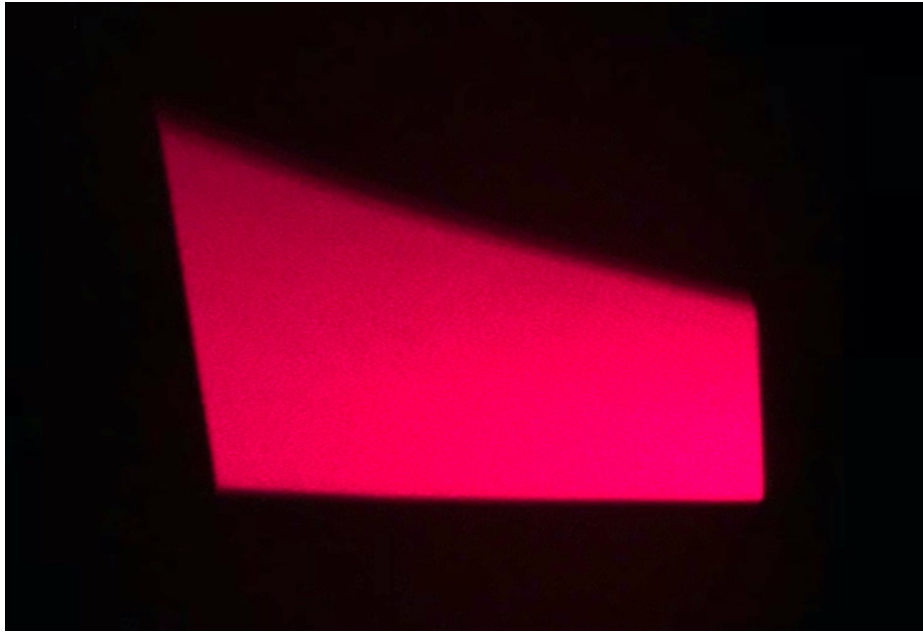


Figure 2.8: A line of brightness translates and grows. Photo: Seth Riskin.

The line of brightness sweeps right to left at higher speed (Figure 2.8), compared to Figure 2.7.

As it does, it grows larger, describing a trapezoid of brightness. The trapezoid may be interpreted as a rectilinear plane inclined about the z-axis relative to the viewer.

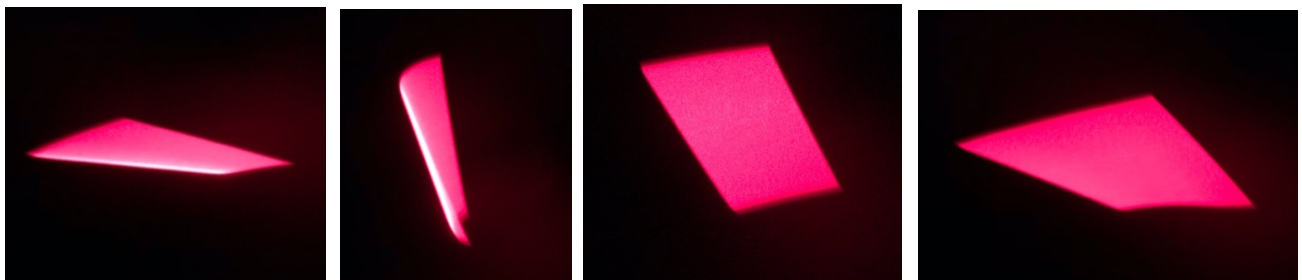
The two-dimensional plane of brightness in perception *indicates* a third dimension. It can be imagined that upon the first seeing of the trapezoid, a third dimension would not be directly implicated. Rather, sufficient experience with relevant transformations of two-dimensional shapes would be required to perceptually construct (integrate) a third dimension.

2.3.3. Postulate 2, Experiment 3 (A line of brightness translating about two axes and slowing)



The line of brightness translates about x- and y-axes and slows relative to the viewer. (See Figure 2.9, left). The resulting percept is a plane with curvature and brightness distribution that suggest three dimensions. The curved plane and brightness concentration at the near edge are further cues toward the perceptual integration of a third dimension.

Figure 2.9: A line of brightness translates about two axes and slows. Photo: Seth Riskin.



Figures 2.10, 2.11, 2.12, and 2.13, from left to right: Different planar shapes and their brightness-intensity distributions. Photos: Seth Riskin.

The line of brightness moves in different orientations, directions, and speeds, contracts, lengthens, and exhibits brightness concentrations, contributing to perception of a plane moving in three-dimensional space. (See Figures 2.10-2.13, above).

Time embodied in these perceptions: a trapezoidal plane perceived as a two-dimensional rectilinear plane *inclined* about the z-axis requires prior experiences of transformations of the two-dimensional plane, i.e., time. With experience, the plane is perceived as a semi-rigid object *moving in space and time*, i.e., the object, space and time are co-defined in perception.

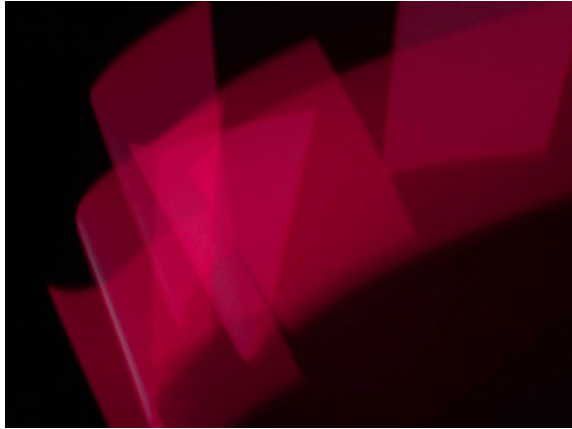
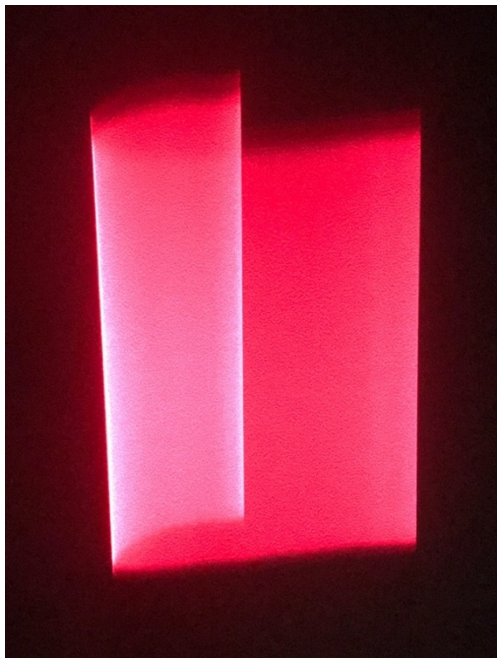


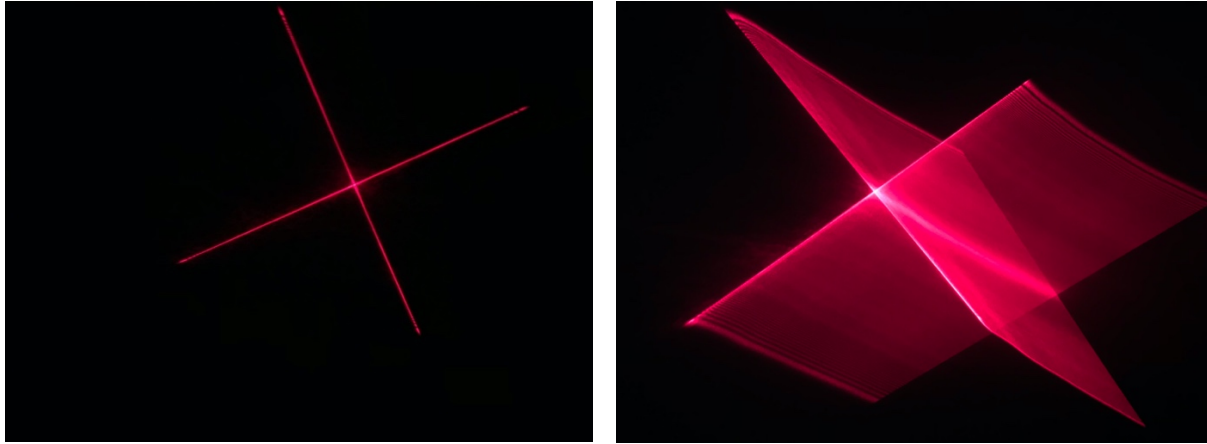
Figure 2.14: Multi-exposure of plane in motion. Photo: Seth Riskin.

This multiple-exposure image of the plane in motion (Figure 2.14)—changing position, orientation, size, shape, and brightness—shows varied transformations of the line of brightness, suggesting their perceptual integration into a higher-level percept: a semi-rigid plane moving in three-dimensional space and time.



Changes in the shape and brightness-intensity distribution across the plane cue a higher-level percept of a folded plane (Figure 2.15, left), a two-dimensional manifold (locally 2D surface of smooth curvature) in three-dimensional perceptual space.

Figure 2.15: A folded plane. Photo: Seth Riskin.



Figures 2.16 and 2.17, from left to right: Two-dimensional cross and “extruded cross.” Photos: Seth Riskin.

In Figure 2.16, a static two-dimensional cross provides no additional perceptual spacetime information. Movement of the two-dimensional cross readily “extrudes” a perceptual three-dimensional form (Figure 2.17). We see the movement/time element embodied (perceptually integrated) in the shift to higher spatial-dimension percept, one to two (in above experiments) and two to three in the current experiment.

In Figure 2.17, notice the brightness-intensity distribution and the slight expansion of the cross from right to left. In the Light Dance experience, such cues contribute to perceptual spacetime (change incorporated into higher-dimensional object/space), multidimensional structures constructed out of the low-dimensional unit of brightness plus movement in perception.

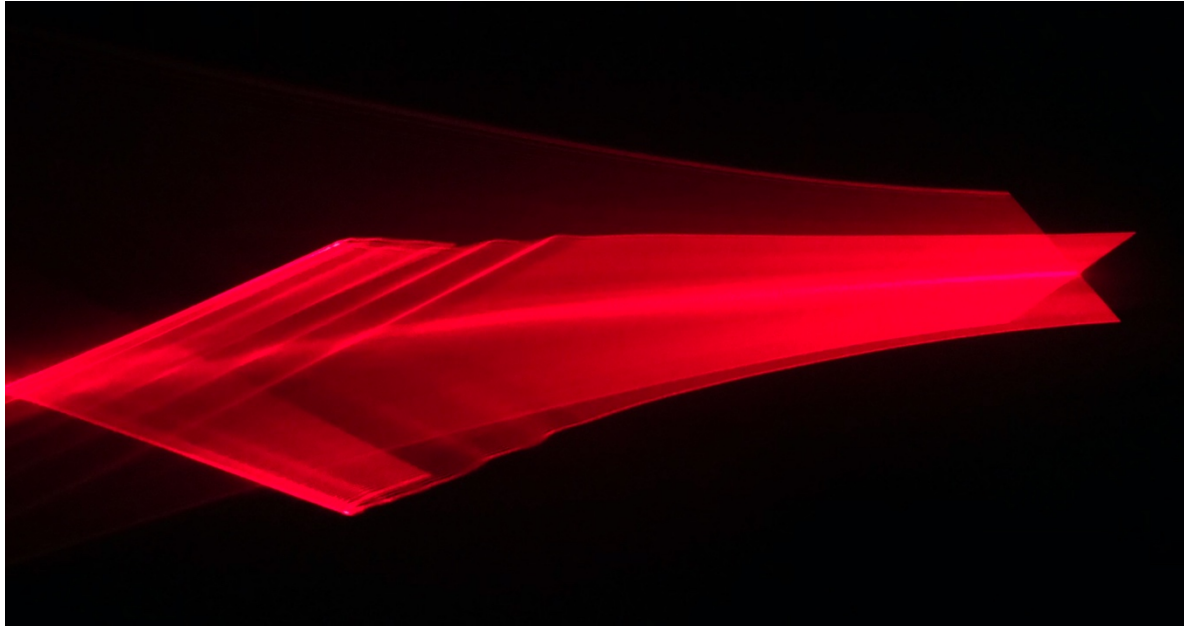


Figure 2.18: Deep cross “extrusion.” Photo: Seth Riskin.

As compared to Figure 2.17, increased speed incorporates more space into the movement time period, resulting in a deep cross, vividly evidencing the integration of two-dimensions plus change into the perceptual third dimension of space (Figure 2.18). The extended cross form reveals spatial curvature.

2.3.4. Observations on Postulate 2 Experiments:

One-dimensional brightness in perception *moves* to generate higher spatial dimensions in perception. Movement is displacement relative to the point of observation. We see the perceptual integration of multiple, displaced, one-dimensional percepts into two dimensions, and multiple, displaced, two-dimensional percepts into three dimensions. Higher spatial dimensions embody change, i.e., time. The Light Dance geometric reduction of light to one dimension affords reflexive perception of perceptual construction processes, i.e., visually evidences the role of the

mind in spatiotemporal percepts: the forms are not “there,” but continually construct in view from the moving, low-dimensional brightness unit.

From the above experiments, we see that the Light Dance experience is one of perceptual spacetime construction that derives from and returns to the geometrically elemental unit of brightness. For example, a vertically-oriented line sweeps left to right, perpendicular to the line of sight of the viewer producing in perception a rectilinear plane; changes in the orientation of the line and the direction and speed of its movement result in a variety of planar shapes (e.g., trapezoids, cylinder sections) and associated brightness-intensity distributions across those shapes that function as perceptual depth cues: the original one-dimensional brightness sensation is revealed as a unit of perceptual construction cohering higher-level spacetime brightness-sensation structures.

2.4 Experiments for Postulate 3: The visual space geometry experienced in Light Dance is the inverse of our ordinary visual perspective

We can now begin to inquire about the global order that accounts for the varied brightness structures and dynamics experienced in Light Dance. Global geometry refers to what is seen across multiple perspectives, whether afforded by time in a single viewer, or by the varied perspective of multiple viewers of the Light Dance event. The following two sets of experiments define principal characteristics of the global brightness geometry that suggest an inverse visual perspective: vanishing point located outside the plane of what is seen; incorporation of multiple views, polycentric; and resulting curvature of spatiotemporal structure.⁶

⁶ “Inverse (or reverse) perspective” is such that the projective point is in the space of the viewer, instead of in the view, as in common linear or visual perspective. Objects farther away appear larger and closer objects appear

2.4.1. Postulate 3, Experiment 1 (Comparison of brightness and material geometries: grid):

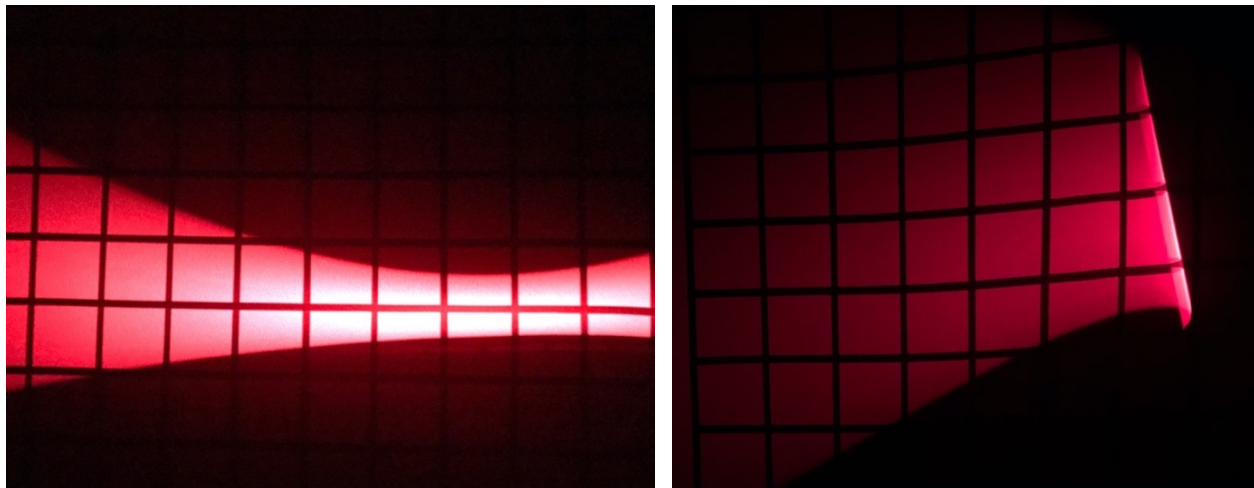
The current two set of experiments explores the relationship between the perception of the Light Dance brightness geometry and that of the wall surface. In the first set of experiments, a white plaster wall is marked with a 3'X3' grid with 3" black rules. The sources producing the line and the cross move at different orientations, angles, and accelerations in the volume of space in front of the grid, resulting in perceived brightness shapes and three-dimensional forms superimposed on the grid and captured by the camera. In the second set of experiments, a long plaster wall with parallel ruling is seen at an acute angle and therefore severely foreshortened. The line and cross are swept along the wall to reveal the brightness geometry of the resulting plane and "extruded" three-dimensional cross form in perception. Specifically, the plane and 3D cross are seen to expand with distance, contrasting the foreshortening/contraction-with-distance of the material wall. In both sets of experiments, the ruled walls and the perceived brightness geometry contradistinguish one another, foregrounding key features of the brightness geometry and features of the relationship between the brightness and material geometries.

smaller. Parallel lines diverge, rather than converge, toward the horizon. Inverse perspective is associated with Byzantine and Russian Orthodox icons. In the words of Pavel Florensky (2002), inverse perspective captures "impressions while in motion," therefore a "polycentric perspective"; "perception that gives the most profound cognition of reality"; "vivid moments observed at different times are presented in their pure state, already condensed." Apparent connections between the brightness structures in the Light Dance experience and historical inverse perspective methods and purpose, e.g., as applied in Russian icons, I believe indicate a fertile area for future research.



Figures 2.19, 2.20, and 2.21, left to right: Sequence showing original line projection, perceptual plane and manifold generated from right-to-left sweep. Photos: Seth Riskin.

Three-inch grid lines allow the planar wall surface to be seen as a rectilinear reference, contrasting the geometric features of the brightness geometry. Left (Figure 2.19): the original line of brightness; center (Figure 2.20): trapezoidal plane, a simple, two-dimensional manifold in three-dimensional perceptual space; right (Figure 2.21): more extensive manifold, revealing, against the grid, pronounced shape and brightness-intensity distribution that contributes to concept of the global, three-dimensional Light Dance brightness geometry.



Figures 2.22 and 2.23, left to right: Distinct, two-dimensional manifolds defined by shape, size and intensity distributions. Photos: Seth Riskin.

In the left image (Figure 2.22), the source of line of brightness sweeps right to left arcing toward the wall at center. According curvature and brightness concentration are seen in the resulting perceptual manifold. The inverse perspective expresses projective geometry relative to the point source.

In the right image (Figure 2.23), the source of the line of brightness begins near the wall (upper right) and sweeps away in an arc. Brightness concentration on the near edge of the plane, trapezoidal expansion of the plane, and attenuation of brightness at the far edge are seen. The size and speed of the light form increase with distance from the wall, accompanied by diminishing intensity.



Figure 2.24: Ribbon manifold. Photo: Seth Riskin.

In the above image (Figure 2.24) source of the vertical line of brightness begins near to the wall (right) and sweeps left away from the wall in x/y compound movements. The accelerations result

in curvatures concentrated in shape and brightness intensity that effect an expanding, ribbon-like 2D manifold in three-dimensional perceptual space.

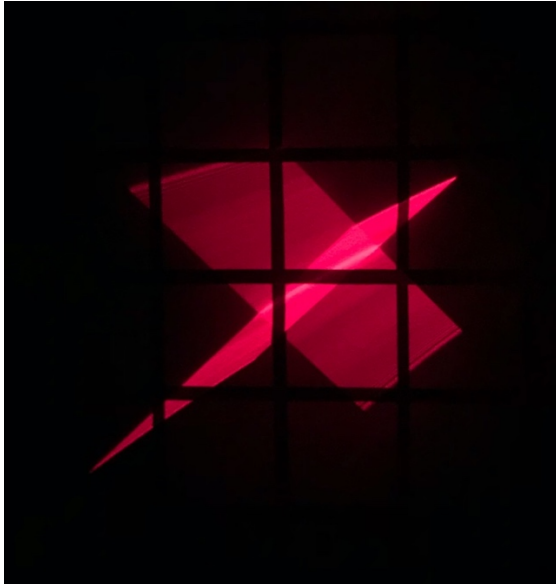


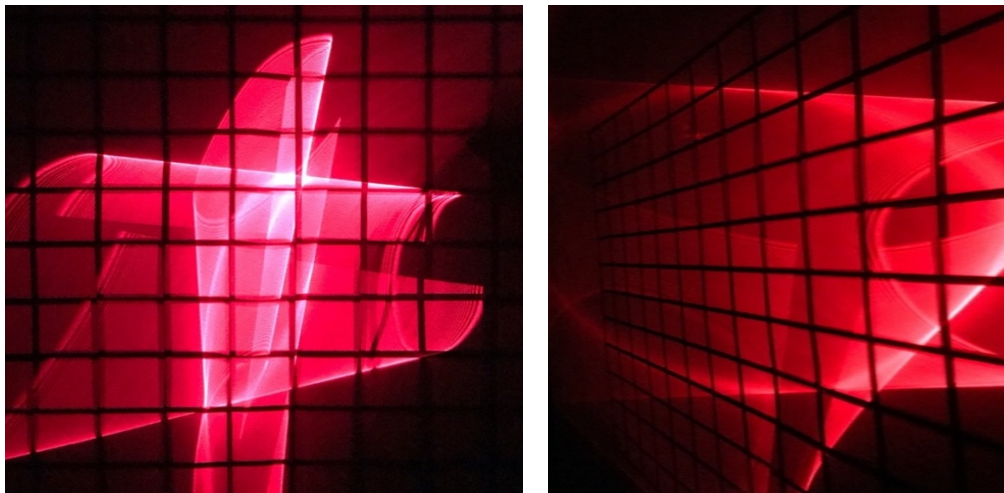
Figure 2.25: Movement of cross projection. Photo: Seth Riskin.

Slight movement of cross projection right to left expands the two-dimensional figure into a three-dimensional brightness form, owing significantly to the depth cues of the trapezoidal planes.



Figure 2.26: Long-sweep cross figure. Photo: Seth Riskin.

The source of the cross-figure projection begins on the far right and sweeps left at an arc diverging from the wall. The result is an expanding, three-dimensional form that contrasts the rectilinear grid. Notice the slight contraction of the grid right to left due to material perspective, size diminishing with distance. Inverse to this material perspectival contraction, the cross form expands.



Figures 2.27 and 2.28, left to right: Complex movement of two-dimensional cross figure. Photos: Seth Riskin.

With movement about multiple axes (Figures 2.27 and 2.28), the two-dimensional cross figure develops into complex manifolds with singularities. We can now see a “family” of manifolds, the result of multiple movements of the source and perceptual layering. The relationship between the local 2D surfaces of the manifolds and the global 3D experience can be discerned. Stark contrast is seen between the grid lines and the curvatures of the brightness form. Figure 2.25 shows a severely foreshortened grid wall with brightness manifolds generated by the cross in movement. Notice, relative to the converging grid, the expansion of the brightness forms as they reach down the material wall.

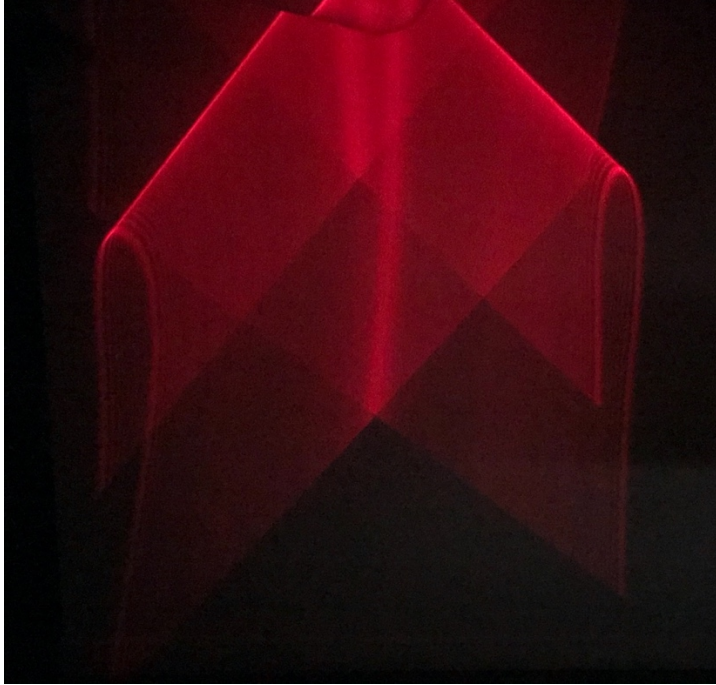


Figure 2.29: Detail of a locally two-dimensional manifold seen globally as a three-dimensional brightness form.
Photo: Seth Riskin.

Looping movement of the two-dimensional cross generates a gossamer form that exhibits delicate brightness concentrations (shoulders and intersection) and curves. The looping movement is tight compared to previous manifolds, offering a view beyond the surface to the entire form, whereby the local 2D manifold is seen as a 3D brightness form.

2.4.2 Postulate 3, Experiment 2 (Comparison of the brightness and material geometries: parallel lines):

The second set of experiments are set on a white plaster wall marked with horizontal lines: four parallel lines 15' long, spaced 6" apart.



Figure 2.30: Sweeping vertical line of brightness grows in size and speed with distance. Photo: Seth Riskin.

The vertical line of brightness sweeps right to left the length of the wall. As the material lines converge, the brightness plane shows no convergence. It expands at a rate that offsets the visual perspective. The brightness plane exhibits inverse visual perspective; it expands in size and increases in speed with distance.

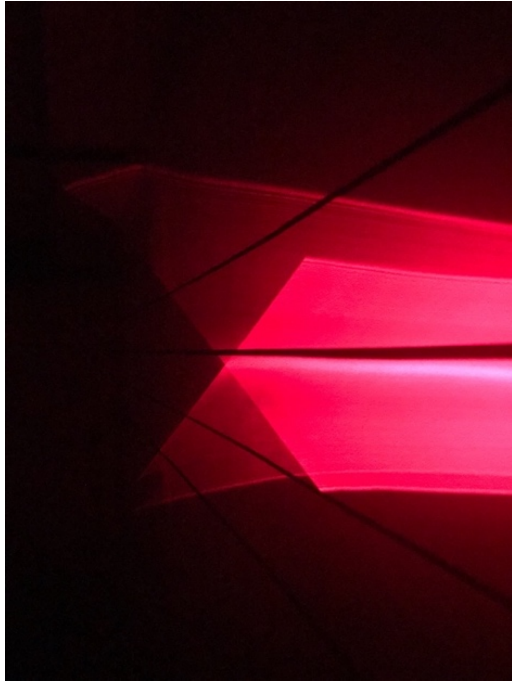


Figure 2.31: Relative to the sharply converging ruled lines, the sweeping cross exhibits inverse depth space. Photo: Seth Riskin.

The 2D cross sweeps right to left the length of the 15' wall. The parallel, ruled lines exhibit accustomed visual-perspective convergence. In contrast, the cross figure shows right-to-left expansion. As the converging lines perceptually cue ordinary perspectival depth toward a vanishing point, the expanding “extruded” cross form cues an inverse depth space, one that does not indicate a vanishing point in the view, but outside the image, in the area of the viewer. (This corresponds to “inverse” or “reverse” perspective, known from Byzantine art and other sources.)

2.4.3. Observations on Postulate 3, Experiments 1 and 2:

In the visual perception of material objects, the size of the retinal image is a powerful depth cue. Light reflecting off the object goes off in every direction from every point of the object. Only the

light that reaches the eye forms an image on the retina. The more distant the object from the eye, the smaller will be the angle subtended by the bundle of the rays that reaches the pupil.

Take, for example, a yardstick mounted vertically on a wall. Under ordinary illumination, rays of light reflect in every direction from every point of the object. In a clear, cubic room, these rays fill the space; we can see the object from every position and angle in the room. The farther the eye from the object, the smaller its image on the retinae; the closer the eye to the object, the larger the image. Changes in the size of the object image on the retinae cue depth space so effectively and consistently that we see spatial distance *through* them.

In the same cubic room, we now consider a projected line from the Light Dance instrument on the wrist of the performer. Light propagates from the point source until it encounters a material surface, where it scatters and becomes visible as a line. Like the physical yardstick, the line of light on the wall reflects rays in every direction from every point. In this regard, i.e., optically, the line of light is equivalent to the material object. It is an object in perception and its changes in size and speed will be perceived as spatial distance.

Unlike the physical object, the line of light grows in size and speed as distance between the source (as opposed to the eye) and the wall grows. The amount depends on the divergence angle of the light. The larger the divergence angle, the “faster” will be the increase in the size of the object over distance. This factor, as well as the material geometry of the room and the location and movements of the performer and the viewer, will determine the size and speed of the projected line and thereby the depth space that will open in perception. Experience in this

environment, the line changing size and speed in the absence of other light information, will build in perception a global geometry of spatiotemporal structure and dynamics. When this geometry is superimposed upon the material geometry, e.g., in a dimly lit room so both the Light Dance projections and the material surfaces are visible, it will be seen that the Light Dance geometry is, by its major features, the inverse of ordinary visual perspective.

The above experiments and perceptual evidence lead to the postulation that the light in Light Dance plays the role of vision; the line from the point source behaves like a slice of the receptive field projected into space. The line of brightness and its higher-dimensional perceptual constructions result from the receptive field conic section intersecting the material geometry, made visible by the Light Dance illumination inversion. How can this be further tested? The next set of experiments takes an approach opposite from the above experiments. Instead of studying transformations from a viewpoint in space, the following experiments study the original Light Dance unit of brightness static, as seen from multiple viewpoints, analogous to views of the actors in the Light Dance event, the viewer, performer and light source.

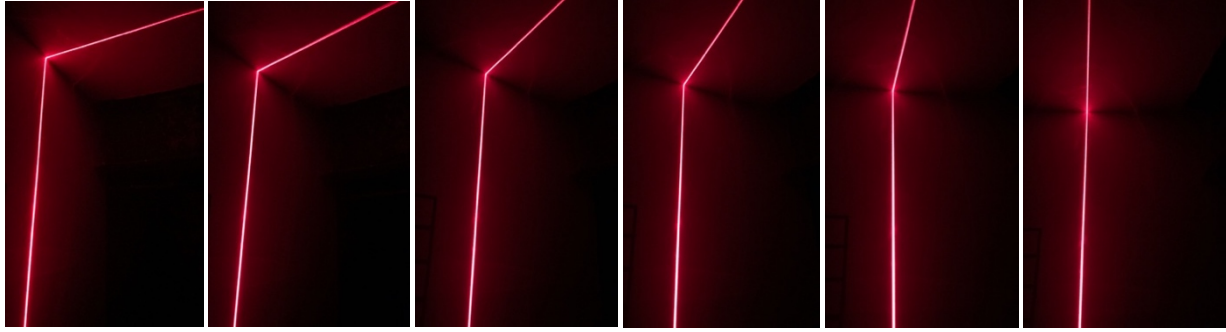
2.4.4. Postulate 3, Experiment 3 (Perspectives):

The Light Dance method begins with a spatiotemporal reduction of visual information, from the full-field complexity of the visual environment to a spatiotemporal minimum, e.g., one-dimensional brightness. Appropriately, the direct-perception experience of this line is one that is spatially and temporally primitive, i.e., experienced as not separate from the viewer. The perceptual construction of the line into higher-dimensional, spatiotemporal structures requires

movement of the line relative to the perceiving eye, including changes in orientation, length, and speed.

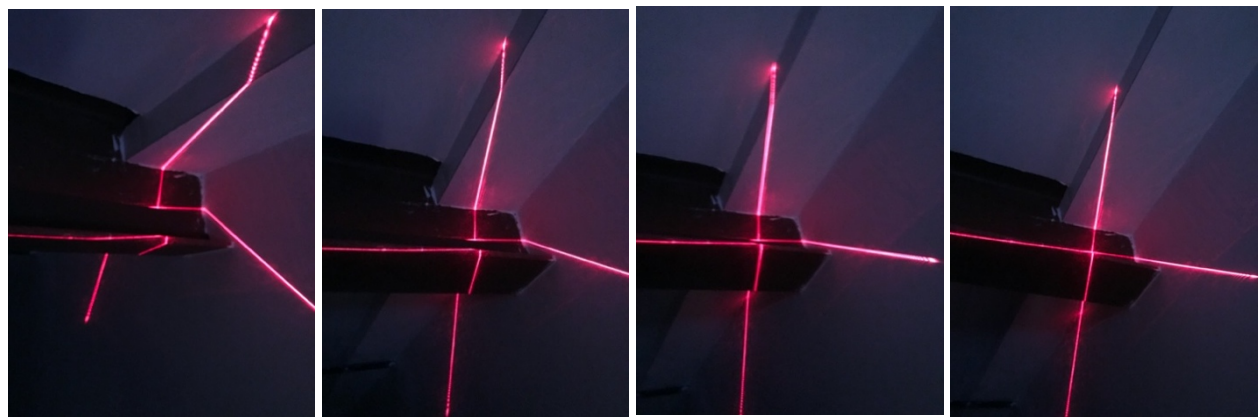
The Light Dance reduction allows us to see clearly the early perceptual geometry of the line that refers to the point source in terms of angular directions and radial distances. Put another way, the accustomed experience of the full-field complexity of the visual environment, including invariant three-dimensional objects and spatial depth of Euclidean measure, is the result of countless views perceptually synthesized. Light Dance takes the full-field complexity down, not only to one view, but *one dimension*, thereby removing cues to cognitive abstractions and allowing us to see early structures and dynamics of vision with features that may be described as “inverse perspective.” In other words, in Light Dance, we see not the material order, but that of vision.

The study of the three views of the Light Dance event – the viewer, the performer and the light source – illustrate the point. Multiple perspectives on a single line projection show proximate perspectives and the potential for their perceptual synthesis. It will be noticed that the view from the point source always shows the original line, is impervious to transformations of the line, such as its bending into a corner, and thereby remains spatially and temporally non-differentiated from the source which plays the role of the eye. A parallel between the point-source/light line and the eye/slice of the projected receptive field is observed. The Light Dance event may be considered two perspectives (performer and viewer) on a “seeing eye.”



Figures 2.32, 2.33, 2.34, 2.35, 2.36, and 2.37, left to right: Sequence of views on a line of light projected into an architectural corner. 2.37 (right) shows view from light source. Photos: Seth Riskin.

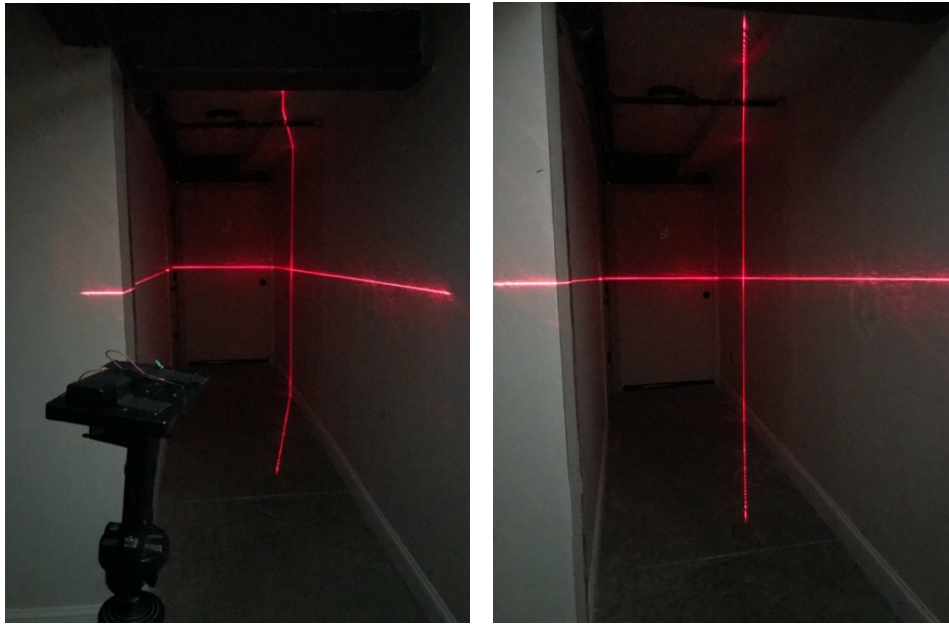
In the far-left image (Figure 2.32), a line of light is projected into an architectural corner with the camera view orthogonal to the projection at a distance of six feet. Figures 2.33 - 2.37: the camera eye is moved toward the position in space occupied by the light source. The bend in the light line disappears along with the spatial dimensions conveyed by the bent line. View from the source effectively collapses the scene to the original single dimension.



Figures 2.38, 2.39, 2.40, and 2.41, left to right: Sequence of views on a cross of light projected onto an architectural structure. 2.41 (right) shows view from light source. Photos: Seth Riskin.

In the far-left image (Figure 2.38), the source projects a cross of brightness onto a material structure as the camera views from an acute angle, relative to the source, at a distance of six feet. The line appears broken and bent in multiple pieces, conveying information about the material

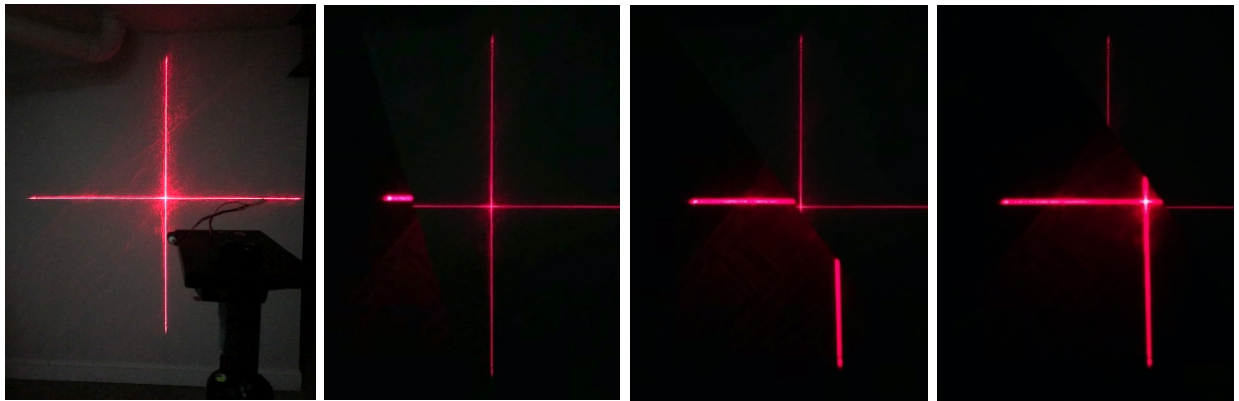
structure and associated depth space. Figures 2.39-2.41: the eye of the camera is incrementally moved to the approximate position in space of the light source. The breaks and bends in the cross disappear. The information that conveys material structure and spatial depth (the bends and breaks of the line) collapses to the original two-dimensional cross.



Figures 2.42 and 2.43, left to right: Two views of a cross folded into a corridor. 2.40 shows view from light source..
Photos: Seth Riskin.

In the left image (Figure 2.42), a cross is folded into the depth of a corridor (approximately 15'); the camera view is from an acute angle relative to the light source. In the right image (Figure 2.43), when the camera eye is moved to the approximate position in space occupied by the light source, the bends in the arms of the cross disappear. The original two-dimensional cross is superimposed upon the depth scene. Here, one can see the equation between the light cross and a cross-slice of the receptive field projected in visual space: light plays the role of the receptive field “attached” to the point-source/eye. One gets a visceral feeling of the spatiotemporal

ambiguity, or neutrality, of the light, equivalent to the neutrality of the receptive field. Pattern change is required for the construction of perceptual space, time and form in Light Dance, constituting the perspectives of the viewer and performer.



Figures 2.44, 2.45, 2.46, and 2.47, left to right: A cross of light projected to a wall, intercepted by a sheet of paper. 2.44-2.47 show view from light source. Photos: Seth Riskin.

In the left image (Figure 2.44), the cross figure of light is projected six feet to the wall; the camera is one foot behind the light source at an acute angle relative to the projection. In Figure 2.45, the camera eye is put as close as possible to the point in space occupied by the light source. Just in front of the light source, a sheet of black paper is raised into a small portion of the left arm of the light cross. The paper is raised further in Figures 2.46 and 2.47, showing that, from perspective of the light source, the cross figure retains the same size whether seen on the wall or the paper. The six-foot distance collapses in perception. Whether the cross is seen on a near or distant surface, the angle it subtends on the retina remains the same. Put another way, the size increase of the cross with distance is inversely proportional to the perspectival diminution of space, nullifying change, i.e., depth information.

2.4.5. Observations on Postulate 3, Experiment 3:

In the previous experiments, it becomes clear that the line and the cross of brightness are radial slices of the light sphere propagating from the point source. For example, the line can be imagined as the visible end of a circle sector of the light sphere, its apex at the origin of the sphere and its curved base (the line), a portion of the circumference. The base of this triangular section is what meets material surfaces, is what is seen as a one-dimensional figure of brightness. The permutations of this line—speed, contour, length—result from the conditions of the curved geometry of light meeting the rectilinear geometry of material: the material geometry, e.g., of the wall surface, “cuts” the triangular, planar section by which it becomes visible. The line of brightness is a line portion of the circumference of the propagating sphere of light, the origin of which is the point source within the Light Dance instrument. How the material geometry cuts the sphere, visible as the brightness contour, determines its shape, size and speed.

We now have a geometric model for considering the early structures and dynamics of Light Dance and the three perspectives, the viewer, performer and light source. Based on the premise that the point-source of light in Light Dance plays the role of an eye and the projection, a slice of the projected receptive field, Light Dance lets us step out of, and *see*, the subjective experience of vision. This is suggested by three observations in the preceding experiments:

1. Light is ordinarily transparent in vision by which we see the geometric order of material objects and associated space. Light Dance foregrounds, lets us see, the geometric order of the light interacting with *invisible* material surfaces.
2. The Light Dance elemental unit of brightness makes visible the projective geometry of the higher-dimensional brightness structures, relating them to the point source. We can step apart from this source-geometry and experience it from multiple angles, revealing its inverse-perspective structure.
3. As well, we can step back temporally. Compared to high-level, time-based spatiotemporal constructions of the accustomed visual-world experience, in Light Dance we can see rudimentary spacetime such as evidenced in the line of brightness that collapses perceptual experience to a single dimension, prior perceptual spacetime construction with movement.

The geometric reduction of the projected receptive field, e.g., to a one-dimensional slice, visible as a line when it meets material surface, allows us to witness the dimensional development of the visual spacetime. The development from one-dimension to a multidimensional brightness structure in the Light Dance experience parallels perceptual construction, from mere bright/dark boundaries and bounded shapes, to cohered and consistent, i.e., perceptually invariant, 3D objects/space, e.g., a cube, a perceptually-integrated, multi-perspective object.

The Light Dance light-cum-brightness experience is the prototype of, and touchstone for, the realization of “light” as the “artifact” of the perceived separation of vision and the object of

vision (the material world). The one-dimensional unit of brightness is sensation, material and light folded into one experience, i.e., prior to their perceptual differentiation. Through Light Dance, we watch the unfolding, the perceptually primitive spacetime of the line (representing a state of non-differentiation) and its development into two- and three-dimensional shapes, forms and spaces that embody duration as “concretized” objects in perception.

In the foregoing experiments, we examined early spatiotemporal features of the moving unit of brightness, visible by interaction with invisible material, unveiling the inversely proportional relationship of the brightness and material spacetime orders. That light can be used in such a way, to foreground the early spacetime of visual process, superimposes in the mind the complementarity of the orders of light and vision, signaling a principle of equivalence.

**2.5. Experiments for Postulate 4: The Light Dance elemental unit of brightness—
spatiotemporally constricted, originating from the body, moved to acquire information—
*plays the role of a slice of vision, if it, and not the material environment, were visible***

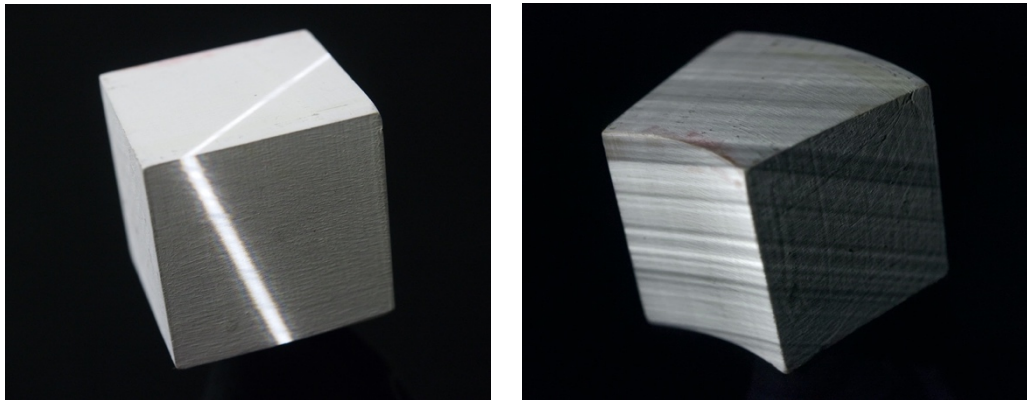
Light Dance is a seeing process. The point-source of light is the eye. The line of brightness is a bisecting slice of the projected receptive field. The movement of the line is the scanning of the eye, collecting and integrating patterns of information. The seeing process is time-based; images embody time. The sweeping movements of the line of brightness from the source are radial. The line grows in size and speed with increasing distance from the source.

In ordinary vision, we don’t see rectilinear, three-dimensional objects; we *think* them. Lines are seldom straight; angles are rarely 90°. We do not see three-dimensional forms all at once; we assemble them over time and by the cognitive integration of lower-level percepts, such as two-

dimensional shapes. Through artistic methods of inversion, significantly supplanting the concept of light with the experience of brightness, Light Dance reintroduces early, spatiotemporal structure and dynamics to visual experience; through light, Light Dance induces a reflexive study of vision.

The experiment applies Light Dance “seeing” to a familiar, rectilinear, three-dimensional, time-based object: a cube. The objective is to visually evince the Light Dance “seeing” by the transformations it imposes upon the cube and its intrinsic conceptual structures. We have here a superposition of early-vision spacetime effected by Light Dance and the cognitive spacetime represented by the cube, an expression of “seeing concepts.”

2.5.1. Postulate 4, Experiment 1 (Solid cube):

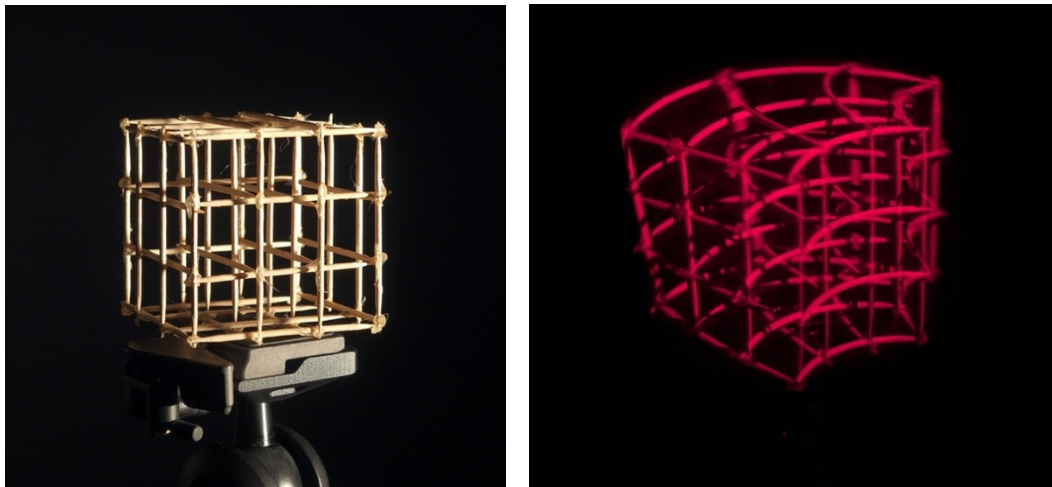


Figures 2.48 and 2.49, left to right: Fixed cube and line of brightness; transformed cube resulting from sweep of the line over rotating cube. Photos: Seth Riskin.

The cube (Figure 2.48) is mounted about its central axis on the shaft of a variable-speed motor. At the other end of the table, the Light Dance instrument casts a thin line of white light onto a rotating mirror, also mounted on a variable-speed motor. The mirror reflects the line to the

spinning cube, sweeping it periodically over the cube surface. The rotational frequencies of the cube and the mirror are individually adjusted in the range of 15 – 30 rotations per second. The resulting image in the eye of the viewer appears continuous, stationary, and solid (Figure 2.49). The brightness/darkness patterns compose a three-dimensional object in perception, one that shows radial reference to the source: lines are curved, perspectives are multiple and the vanishing point of the perspective lines lies in the space of the viewer—all indicators of inverse perspective.

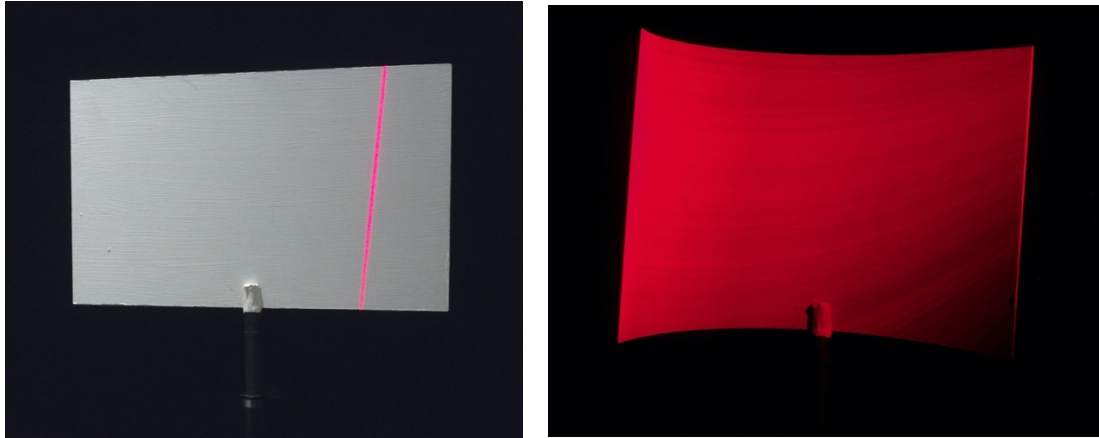
2.5.2. Postulate 4, Experiment 2 (Lattice cube):



Figures 2.50 and 2.51, left to right: A fixed lattice cube; a transformed lattice cube. Photos: Seth Riskin.

The lattice cube (Figure 2.50) is rotated about its central, vertical axis. A vertically oriented line of laser light is swept over the lattice cube, revealing it as a time-based image, one that embodies multiple perspectives form a point in space, that of the light source. Seen at an oblique angle, the lattice cube appears curved like a portion of a spherical sector (Figure 2.51). The object expands toward the back. This represents, in perceived material form, an aspect of the inverse perspective of the moving slice of visual field: it grows larger with distance from the source.

2.5.3. Postulate 4, Experiment 3 (Plane and line of light):



Figures 2.52 and 2.53, left to right: A fixed plane and a line of light; a transformed plane. Photos: Seth Riskin.

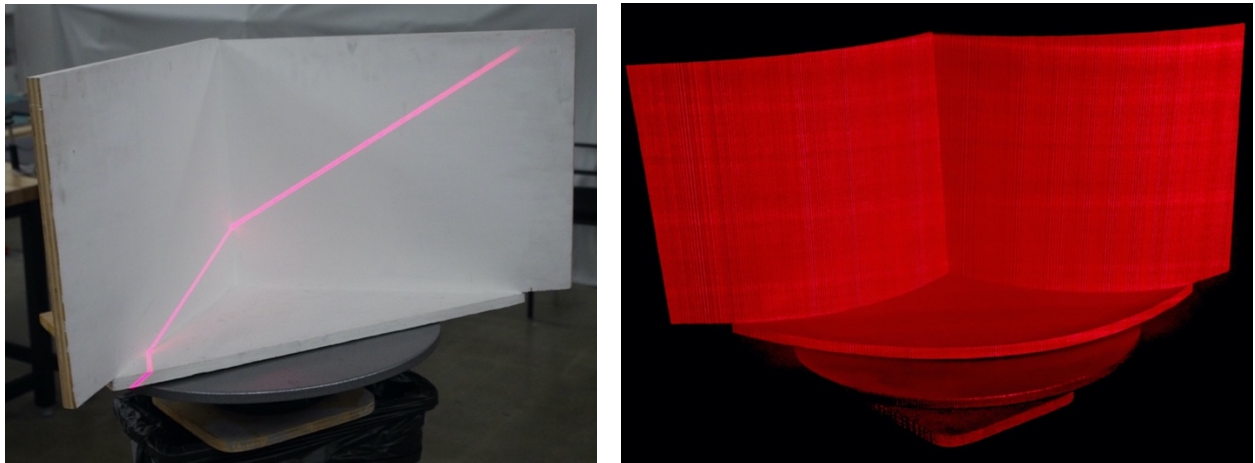
An aluminum plate painted white is mounted onto the shaft of a variable-speed motor (Figure 2.52) and set into rotational motion. A rotating mirror sweeps a line of laser light over the surface of the moving plane. The visual result is curvature, increasing toward the ends of the plane (Figure 2.53). In the course of its sweep, the line of light “sees” a given slice of material in a fraction of a second, resulting in complete clarity of detail across the object image.



Figure 2.54: A twisted plane. Photo: Seth Riskin.

By adjusting the direction of the sweep of the light line across the plane, a variety of transformations can be generated. (See Figure 2.54.) For example, the front and back of the object may be seen at once, highlighting the multiple perspectives embodied in a given image. Relatedly, the object can be turned “inside-out”, i.e., the object movement and the slice “seeing” combine to effect an inverted spatial order.

2.5.4. Postulate 4, Experiment 4 (Architectural corner and a line of light):



Figures 2.55 and 2.56, from left to right: A fixed wood inward corner and line; a transformed corner. Photos: Seth Riskin.

An inward, right-angle corner made of wood, approximately 28” wide by 15” tall (Figure 2.55). The corner is set on a turntable. A vertically oriented line of laser light scans over the corner as it rotates. The corner turns clockwise; the line scans counterclockwise (Figure 2.56). This experiment takes the path of inquiry of the Postulate 4 experiments into the realm of the Light Dance performance. The inward corner defines cubic space as related to the architectural surround of a Light Dance performance. The curved volume of perceived space reflects the

rotational movements of the material corner and the sweep of the “seeing.” In Light Dance, movements about multiple axes are generated by the body, e.g., the instrumented arm of the performer rotates about multiple axes. The convolution of the sweeping brightness interacting with rectilinear architecture generates complex, curvilinear brightness structures in perception akin to those seen above.

2.5.5. Observations on Postulate 4 Experiments:

The Postulate 4 experiments vividly show structure and dynamics of Light Dance “seeing” *through* familiar three-dimensional, rectilinear objects. This contrast reveals differences between the ordinary visual experience of material objects and environment and the visual experience of brightness structures afforded by Light Dance, listed in the below chart (Figure 2.54).

Light Dance Visual Experience	Ordinary Visual Experience
Perceived brightness	Perceived light
Light constricted to geometric minimum	Ambient light
Source at the viewer	Source remote from viewer
Light seen by way of material surfaces	Material surfaces seen by way of light
Perspective of light expanding from point	Visual perspective on material order (Euclidean)
Inverse visual perspective structure and rules (dynamics)	Visual perspective structure and rules
Unit of brightness changes orientation, position, speed to build up structure in perception	Eye moves over scene, collecting information of existent world

The world in experience (brightness structure) is spatially and temporally local, generated by body movements	The world in experience is spatially and temporally extensive, existent (non-local)
Visual perspective is seen through to a non-Euclidean spacetime of body origin	Visual perspective is seen through to a Euclidean spacetime of remote origin
The world originates from and refers back to the body	The world originates from and refers back to distant source (“universe”)
Direct perception, e. g, brightness patterns	“Seeing concepts”, e. g., “illuminated objects,” “light,” “three-dimensional space,” etc.
Unfolding, evanescent	Spatially and temporally extensive and existent
Stream of present sensations	Seeing through prior perceptual constructions/concepts
Viewer and visual world unity	Viewer and visual world duality
Light as sensation	Light as signal bridging space and time
Experience perceptual construction for fleeting physicality	Experience “hard” world for fleeting, transparent perception
Light/vision equivalence within holistic model	Light/vision duality within dualistic model

Figure 2.54: Comparison between Light Dance visual experience and ordinary visual experience.

Taken together, the listed differences articulate an inverse relationship, principally in spatiotemporal terms, between ordinary visual experience and Light Dance visual experience. In turn, this informs the relationship between light and vision at the core of the Light Dance experience: *light plays the role of vision if it, and not the material environment, were visible.*

Light *as* vision, not representing it: this inversion, and its perceptual spacetime effects, is made visible in spatiotemporal terms by the geometric reduction of light and correlate reduction in perception, from high-order priors to low-dimension direct percepts. Light and vision integrally cohere in Light Dance in a primary experiential instance, the unit of brightness, that reflects two intersecting epistemic orders: visual experience accounting for light and light accounting for vision. The dualistic model of light and vision is encompassed by a holistic one; the hierarchical conception/causal chain of light and vision is relativized by their continuity in Light Dance perception.

Within this expanded paradigm, light informs vision and vision informs light. The common question of how separate light and vision interact to give us seamless, consistent, accurate visual experience is ill-founded. We can think about light through vision and thereby come to their unity, reflected on perceptual and conceptual levels. Like an epistemic thread, we can follow visual experience to light concept. In light experience we experience spatiotemporal “collapse”; when light is pursued as an object of perception it vanishes, leaving sensation, i.e., visual experience located at the observer. This twofold experience of light scales up: light is at once remote in its physical features and implicit in the spatial and temporal immediacy of visual experience. It is as if the physical world, in its complete spatial and temporal extensivity, ever holds trace of the knowing of it, lending “curvature” to all we know, spatially and temporally directing back to the self-experience. “Light” is that “hole,” the illogical, but experientially ineluctable, identity of physical light and “light of mind.”

2.6. Conclusion

Through physical means, the experiments have visually tested and detailed direct perception of Light Dance phenomena. Guided by the postulates, the experiments explored the intersection of the aforementioned “two ways of seeing light,” “seeing concepts” and by direct perception, relatively free of higher-order thought abstractions. To the first research question posed in the Introduction – “Does art focused on visual perception work within the same knowledge paradigm as vision science, or can a case be made for experiential research in the manner of visual art leading to fundamentally new discoveries?” – we now have an answer. Direct perception of Light Dance phenomena reveals spatiotemporal order contrasting that of the physical room. A curvilinear spacetime is experienced, one continually and radially unfolding from the point source. Light in Light Dance plays the role of vision.

Light Dance affords two angles of view on the use of light as a visual art medium: 1. light effects presenting “absorbed” physical theory, “physics”; and 2. seeing through the light to a reflexive experience of vision. Now, we are prepared to address the second set of research questions posed in the Introduction: Are these two approaches evidenced in the history of Light Art? Do we find precedents for the Light Dance approach to light as reflexive study of vision? What handling of light evidences “units of reflexive vision” distinct from the light effects that characterize the Light Art tradition? What thinking surrounds the practice, and is there evidence of practice-based theory that informs the Light Dance approach to thesis? As a work of Light art, Light Dance begins in the wholeness of light/vision experience and works toward its perceptual and conceptual elucidation by physical means. The following chapter will explore Light Art for

historical context and precedents of the Light Dance art form, reflecting its approach and techniques, perceptual experiences and the conceptual order they constellate.

CHAPTER 3: Approaching Light as Reflexive Vision: Precedents of the Light Dance Art Form

3.1. Introduction: Light Art

In what contexts, historically and conceptually, does Light Dance situate? What traditions does it follow, and toward what purposes? As an art form, Light Dance cuts across genres -- Light Art, performance art, dance -- as well as disciplines, as the work's pursuit of knowledge relates to the study of vision and light. The work derives from and seeks to collectively generate new visual experiences as it pursues the intellectual articulation of knowledge latent in the experiential.

In this chapter, my intention is to identify Light Art precedents for the Light Dance art form and experience. I'm interested not in likenesses of form, but perceptual experiences of the artists and viewers; I'm interested in the practice and thought of artists drawn to light, not as a new sculpture medium, or reflection of scientific knowledge, e.g. concerning color and the eye, but as a consequence of the experiential penetration of vision, cultivating consciousness of the seeing process, affording perception of elements of early visual processing, like bright/dark edges and patterns, shape changes and cues to depth. In working with light to access and articulate knowledge of vision, Light Dance finds its clearest coordinates in Light Art.

For many, works of Light Art are merely "light effects." Light—shaped, colored, moved — remains the accustomed object "light," physically and fundamentally distinct from the observing subjective consciousness. Many so-called light artists have pursued work with the medium this way, crafting effects that are "dazzling," firmly within the context of our physical worldview

(Lippard 1967).¹ Light Art may derive from and feed this mentality, but it may equally reflect a different line of pursuit. The history of Light Art also presents evidence of a perception-oriented approach that takes the artist through light to a reflexive study of vision and consequently conceptual order that contrasts the above “materialist” approach.

Indeed, the art historical concept of Light Art is divided between an objectifying impulse and a means of exploring perception. In *Light Art from Artificial Light*, Peter Weibel (2006, p. 27) conceives of the development of Light Art as “codetermined by the application of technical innovations, from the simple light bulb via the neon tube, the cinematographic film, the laser beam, the fluorescent lamp, ultraviolet light, the discharge lamp and LEDs to the latest technological developments in light such as electroluminescent strings and plates.” In this respect, it is difficult to sever the tradition of Light Art from artificial light rooted in scientific thought and resulting technologies:

Diverse though the lines may be that led in the twentieth century to the use of artificial light as the medium of art and to the development of Light Art as an independent genre, they are coherent. While until the end of nineteenth century, painting merely depicted light, indeed primarily sidereal light (the sun and the stars), as of 1900 a paradigm shift took place away from the representation (of light) to the reality (of light): Art started working with real light; It was not natural light that was depicted illusionistically, but artificial light that was really used. (Weibel, 2006, p. 86)

This tension between the representational ends of light and the desire to penetrate its reality has understandably created an uneven legacy for Light Art as an artistic tradition. It has also left it with an uncertain future. Reflecting on the future of Light Art in 1968, Jack Burnham writes:

“For over forty years Light Art has remained the child of future technology. (...) Light Art must

¹ See Lippard’s (1967) account of Light Art: “...for a good many younger artists today have still not sufficiently overcome the luminous medium’s power as a technique nor learned to cope with the color peculiar to artificial light. Too often, the technically dazzling but aesthetically derivative statements that emerge seem to imitate older painting styles.”

solve its practical problems not only to progress but to survive as an art form. Such devices as color-corrected fluorescent tubing, high-intensity mercury-vapor lamps and electroluminescent tape are only the first steps toward a much-needed flexibility” (p. 308). Burnham (1968) also saw the driving interest in Light Art to get beyond the perceived object for perception itself, diminishing distinctions between the subjective and the objective: “At its present stage emitted light best demonstrates one of the primary qualities of systems: the tendency to fuse art object and environment into a perceptual whole” (p. 285). In light, György Kepes (1968) saw a common denominator between academic disciplines and a manifold technological resource for the visual artist, a medium of scale to address the “urban lightscape, [requiring] a great new art: orchestration of light.”

As suggested above, the origins and casting of Light Art, the social and cultural contexts of its development; instrumental technologies, and dominant art-historical, curatorial, theoretical discourse, hold character of the modern scientific worldview: mentality and principles antithetical to the knowledge that would otherwise be drawn from the art itself. Light Art owes to physical science and technologies, yet this approach, with its “[l]ight boxes, light objects, and light environments” I will put aside. I want to focus on evidence of another artistic mentality: artwork and thought that takes a reflexive approach to artistic perceptual engagement with light as an instrument for shaping visual experience, thereby revealing both light and vision. When György Kepes (1944) holds light as substrate of “the language of vision, (...) one of the strongest potential means both to reunite man and his knowledge and to re-form man into an integrated being” (p. 13), he is looking beyond the physical phenomenon to integral human importance. When Willoughby Sharp (1967, p. 9) says that “A new generation of artists has

sensed that the vanishing point has vanished. They strive toward total integration—the Self merged with the One,” he is speaking of kinetic Light Art as *experience*, not object or environment. When Lucy Lippard (1967) speaks of “Total Light”: “A single transcendent light is a vehicle of totality and ultimately of abstraction,” she is reflecting upon the transmutative power of light upon the subject matter in the artist’s experience and artworks. In the current context of the “impoverishment of subjective perception” (Boehme, 1993, p. 38), there exist few models or methods for knowing the subjective in terms of objective, physical reality, i.e., within context of a combinatory concept of the subject and object of perception. Art may be considered a method of physical experimentation and study that resolves and reflects subjective order in the perceived physical phenomena. Its first principles, priorities of purpose, and possibilities of discovery are wholly different from, yet complementary to, a reductive, materialist approach. Art works toward knowledge of interrelationship of subjective and objective orders that are like two sides of a coin of human experience in concept. I want to reveal Light Art as a natural development of the artistic pursuit of a unified relationship, reconciliation between subjective and objective orders, which is what the direct experience of light itself ultimately affords.

In my view, visual art practice and artworks concern perceptual experiences. When in 1912 Boccioni says “...interior or exterior electric lights can indicate the planes, the tendencies, the tones and half-tones of a new reality” and when Fontana says “[a] new aesthetic is taking shape: luminous forms through space,” they are referring to the opportunity of shaping visual perception through means of light (cited in Popper, 1966). In contrast to representation or symbol-making, they are speaking of the artistic shaping of experiential reality. The significance here is not simply a new medium, but a shift in the function of art from being *about* visual reality to *generating* visual reality in perception.

“Vision in motion,” “purity of light,” and “perceiving perception”: these three phrases respectively by László Moholy-Nagy, Otto Piene and James Turrell allude to models of subjective experience originating from perceptions of light in art practice. In what follows, I will examine these three Light Dance precedents, each in two parts: the artwork/practice and emerging concepts. In the case of Moholy-Nagy, I will look at *Light-Space Modulator* in relation to “Vision in Motion”; for Piene, *Light Ballet* and “Purity of Light”; and Turrell: the concept of “perceiving perception” as derived from experiences in his early projection and ganzfeld artworks.

What are the essential/salient qualities and characteristics of the visual experiences of these works? What is the role of light in the thought order that emerges? What structure does the thought take? And how do the visual experiences and concepts cohere in describing order, framing a model?

I am positing that one approach to visual art is not about the objects of the visual world but *through* them to the vision itself – that if we study the visual world intently, the threshold between the subject and object of vision is crossed and we find ourselves exploring a united realm where causal structures collapse, spatial and temporal distances are relativized by conscious apprehension that “light” is common to the mind and world. Between the *Light-Space Modulator*, *Light Ballet*, and *Light Dance*, there is lineage of technique and purpose and, I believe, a consistent, emerging conceptual model concerning subjective and objective inverse spatiotemporal structures that intersect through light as both object and experience. The three art forms use light articulated through apertures, expanding into cubic space, “melting” its geometry

in the viewer's experience. The instruments—the sculptures of the Light-Space Modulator and Light Ballet and those that mount on the body in the Light Dance—squeeze down the light to “forms” that, so delimited, show edges by which they are seen to grow and shrink, curve and slow. In other words, as the room goes dark, light becomes the space-defining object in perception and the room loses its “ordinary cubicity” (Piene, 1965). In these three art forms, the light, from a point in space, constricted, shaped and projected, “sees” the room according to its own propagating geometry, as the viewer sees the seeing and cognizes the relational unfolding between the source and encompassing spacetime. Light is used in the manner of vision, revealing vision to itself and alerting the mind to a principle of equivalence that breaks the spell of passive perception.

The techniques of Light Dance and Turrell's projection pieces leading to his ganzfelds are connected inversely: as the ganzfeld fills the field of view with equiluminant light, Light Dance reduces light to a sliver or an array of points in otherwise total darkness. However, as I will show, the two approaches appear to lead to the same realization of equivalence between light and vision. At the extremes, maximum and minimum light fields, the perceptual context within which light ordinarily operates is removed. Light itself becomes the focus of perceptual study. Achieved through the work at the visual extremes, the “thingness” of light fades and the viewer, left with the experience of selfsameness of light and brightness, i.e., perception. In other words, the lack of spatiotemporal context lets us see the coincidence in space and time of light and vision.

Below, I will explore these artworks and related concepts in view of the Light Dance art form and postulates. I am interested in how the artworks inform one another, as well as the evidence

they provide for generative interaction of artistic practice and thought. Before addressing works of Moholy-Nagy, Pienes and Turrell, however, I will look at Thomas Wilfred's *Lumia* art form and concept of the First and Second Fields. Study of the Light Dance practice has distinguished two experiences of light: 1. seeing it as a wholly physical phenomenon to be shaped for visual effects, and 2. the realization that light, as an object of perception, cannot be maintained for the visual perceptions it stimulates, i.e., the necessity of approaching light as reflexive vision. *Lumia* provides clear and unresolved examples of these two experiences of light, reflected more broadly in tendencies and historical progressions manifest in works of Light Art, and sets up, in this chapter, a framework for discussion of the precedents of the Light Dance art form.

3.2. Thomas Wilfred: *Lumia* and the First and Second Fields

Study of the Light Dance practice has distinguished two experiences of light: seeing it as an entirely physical phenomenon to be shaped for visual effects, and realizing that light as an object of perception cannot be maintained for the visual perceptions it stimulates. To give a clear example of these two experiences that result in tendencies manifest in works of Light Art; to situate them historically and to set up, in this chapter, further discussion of the precedents of Light Dance, I will explore Thomas Wilfred's *Lumia* art form.

Lumia serves to illustrate practical and conceptual tendencies in Light Art that, by example and contrast, define key characteristics of the Light Dance art form and its precedents. For this purpose, Wilfred's work is well situated at the outset of the Light Art tradition and between traditional and technological media, abstraction and representation, pictorial and optical light,

and “material” and “spiritual” purviews that hold light, as subject and medium, squarely at the juncture.²

In *Lumia*, light is abstracted and isolated from its ordinary function of illumination and presented to the eye as a discrete object of perception. In an interview with Patricia Marx (1968), Wilfred described it as follows:

In Lumia, the basic factor is darkness, utter and complete darkness. You must begin with that, not only that, but you must begin imagining endless dark space in front of you, so that you are at liberty to build a form miles out, and move it, and make it come toward you and make it enlarge and make it pass in over you, as though you were sitting in some fantastic spaceship with a huge window in the nose.

In the prepared *Lumia* environment, in the “utter and complete darkness” that erases visual context, the viewer sits opposite a translucent screen of ground glass (the optical, mechanical, electrical workings of Lumia boxed inside a cabinet, or backstage). Within the bounds of the two-dimensional screen, light forms evolve in sculptured brightness, degrees of focus, color, size and shape. Reduced to essential elements adjusted in variation and magnitude by the “composer” through the sliding potentiometers of the control panel, the light forms evoke “primitive visual experiences” of perceptual form, space and time that supplant the physical reality.

In *Lumia*, Wilfred saw clearly the intersection of the physical—the luminous imagery moving within the bounds of the frame—and the resulting perceptual “volumes” that opened in the viewer’s imagination far beyond the frame. Wilfred called these respectively “The First Field” and “The Second Field” (see Figure 3.1).

² See Wilfred’s (1948, cited in Sharp, p. 5) reflections on Light Art: “Shall we ... use the new art as a vehicle for a new message (and) express the human longing which light has always symbolized, a longing for a greater reality, a cosmic consciousness, a balance between the human entity and the great common denominator, the universal rhythmic flow?”

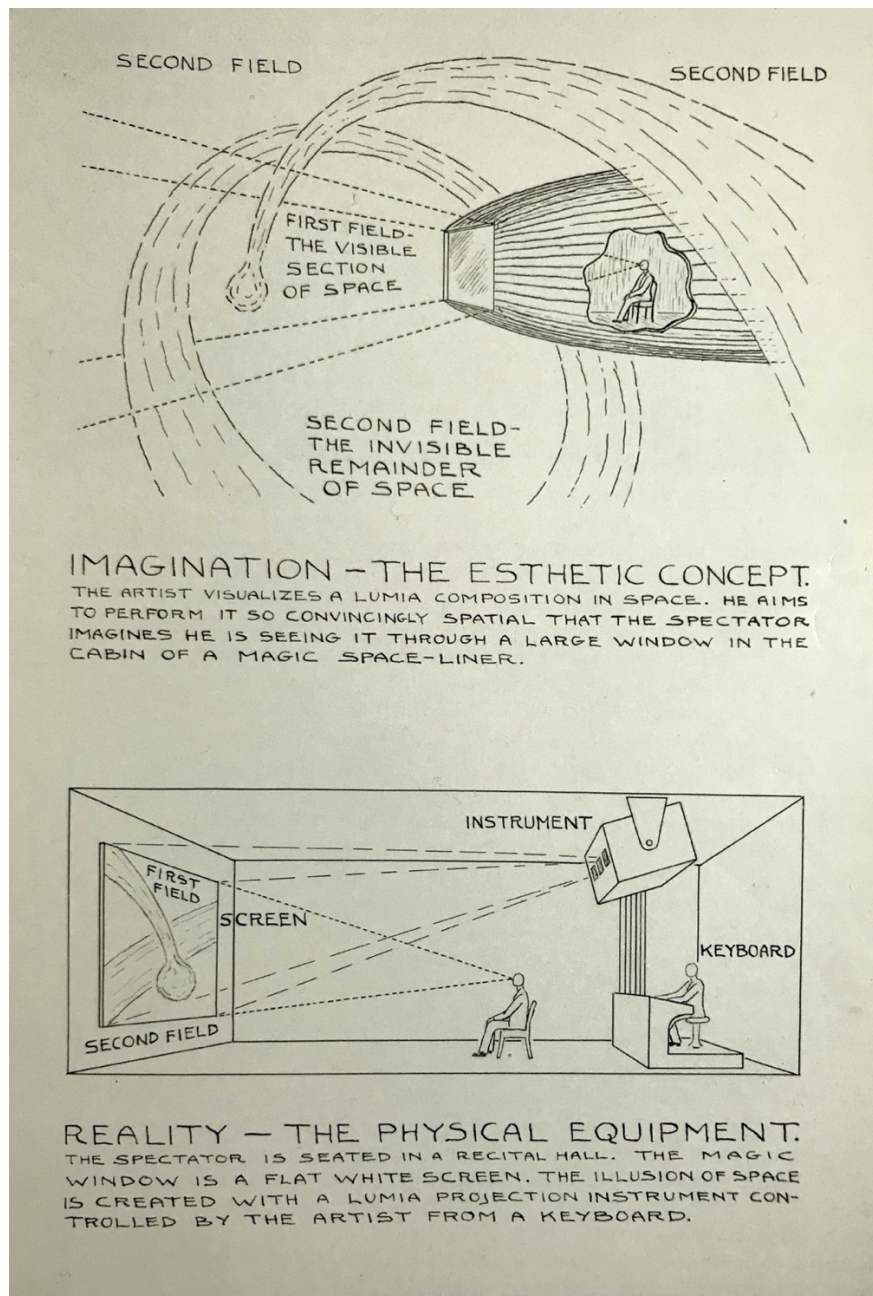


Figure 3.1: Wilfred's illustration of the "first and second fields" in the Lumia experience. The "first field," the physical, luminous imagery moving within the bounds of the frame generates the "second field," the perceptual space that extends far beyond the frame. Source: *Lumia: Thomas Wilfred and the Art of Light*, Yale University Press.

Although Wilfred's aim was an experience akin to "sitting in some fantastic spaceship with a huge window in the nose," he adhered to the frame. Whether the size of an early television screen, or cinematic scale, Lumia frames a window between realms of the mind and physical

world (Orgeman, 2017). As Lumia marks the two realms, it pursues light's capacity to dissolve the divide between the mental and physical in experience.

Wilfred's work demonstrates a profound disconnect between experience and thought, one that highlights the situation of light art, marked by the aforementioned "two experiences" that compel, but elude, synthesis. Wilfred experienced light as both physically fundamental and "spiritually" efficacious, a twofold perception that set the trajectory of his work toward physical systems designed to transcend their own physicality. He saw Lumia as capable of generating in the viewer not only "space visions" (cited in Marx, 1968), but experiences of moving "through a crowded city street, or through a beautiful suspension bridge, that he can enjoy the music of the interlacing steel girders, or indeed a primeval forest." The border between the mental and physical did not exist in Wilfred's experience of Lumia. He and others saw Lumia and the contemporary science of light (e.g., Einstein's relativity theories, related astronomy and cosmology) as counterpart activities, stemming from the same unearthly realms of light. This is how Lumia is the "integral spacetime art" (Jewell, 1939) that "participates in an interdisciplinary exploration of space and time, as opposed to merely simulating an otherworldly drama" (Orgeman, 2017, p. 42).

Vivid as the Lumia experience may be, Wilfred's work and thought make few contributions that would change the prevailing knowledge hierarchy that reduces perceptual phenomena to the physical. In this view, whatever the artistic affordances of light, whatever the perceived impact and import of the experiences of art, light remains a physical phenomenon, relegating vision to

an inverse problem and therefore limiting the work and the experience of art to the realm of representation.

The impulse toward reconciliation of the two experiences of light—seeing light as a one-hundred-percent physical phenomenon and seeing light, in some degree, as a function of perception—I believe compelled light artists such as Moholy-Nagy, Piene and Turrell to pursue environmental works, pushing beyond the frame to fully immersive experiences, collapsing the spaces of the art object and viewer to one. Though 50 years earlier, Wilfred (cited in Marx, 1968) describes the nascent method of Piene’s mature Light Ballet: “I cut some holes in a cigar box, put a small electric bulb inside, got some colored glass from the glazier and began to project patterns on the ceiling,” the intentions of these artists were wholly different. Wilfred worked within the traditional, social confines of art (even as he pushed Lumia as the “eighth art”), while Piene pursued art as a means of changing social order. For Piene, Moholy-Nagy and Turrell, art *was* reality, and they worked to change thought around the art, through the art, as in Piene’s physically commanding Sky Art, and the physical/perceptual ambiguity of Turrell’s spaces, and by other means, such as Moholy-Nagy’s treatise *Vision in Motion*. Light is paramount in these efforts, an instrument spanning the interior and exterior of human experience, leveraging the experiential intelligence of the artist in their effort to transform physical and thereby conceptual order.

3.3. László Moholy-Nagy: *Light-Space Modulator* and “Vision in Motion”

“He crossed his spread fingers in the form of a grill, a gesture I later came to accept as the most characteristic expression of his drive toward integration” (Moholy-Nagy, S., 1950, p. 60).

Linkage between spacetime, light and vision Moholy-Nagy saw early as source and purpose of his calling as an artist. The final lines of his philosophy of vision, written in 1917 when he was wounded in the war at 21 years old: “And nothingness, so vainly measured out/ In time and space, transforms the darkened man—/ Light, total Light, creates the total man” (Moholy-Nagy, L., cited in Moholy-Nagy, S., 1950).

In the social context of the immediate post-war, he struggled with the clash of his artistic impulse against the needs of society, reconciled in awareness that his gift was to project his vitality and building-power through light, color and form. “I can give *life* as a painter” (Moholy-Nagy, L., cited in Moholy-Nagy, S., 1950, p. 12). The effort to align art and technology, vision and light, advancing the human condition and perception formed the axis of his work of experientially unfolding the relationship of spacetime, light and mind: “He [the artist] can sometimes concentrate his forces on the central problem of visually constituting the world in *statu nascendi* and only treat the shortcomings of society as transitory facts on the periphery of his efforts. In a deeper sense, the interpretation of space-time with light and color is a truly revolutionary act” (Moholy-Nagy, L., 1945).

The *Light-Space Modulator* is the culminating expression of Moholy-Nagy’s vision (see Figure 3.2.). Perforated discs, grills, screens of polished metal and acrylic revolve in a complex network of orbits, reflecting and sifting light and shadow onto the surfaces of the cubic surround. Every nuanced variation of the light and shadow is a modulation of spacetime in the viewer’s perception. This is spatiotemporal “sculpting” in optical brightness/darkness, effecting spacetime in the eye of the viewer beyond the order of linear perspective. Developed over the period 1922-

30, the *Light-Space Modulator* was conceived as a “light machine,” an instrument with which to revolutionize perception, collectively at social scale. The artwork, one of the earliest electrically powered, kinetic sculptures and the most sophisticated in concept and design of the Bauhaus light experiments, embodied Moholy-Nagy’s vision aligning technology and art, and physical and perceptual spacetime.



Figure 3.2: *The Light-Space Modulator*. Source: Harvard Art Museum.

The light machine breaks light into its perceptually fundamental, binary language of brightness and shadow, building blocks of visual spacetime experience. Light is generated and shaped into a beam, cast onto the surfaces of new materials, set into complex motion by an electrical system.

Through technologies, artistic vision is manifest. Light can be worked in terms of its perceptually elemental relativity of brightness and darkness, acting upon the perceiver and thereby reflexively revealing perceptual function.

“Vision in motion” was Moholy’s maxim. Acuity in the visual experience of motion brings awareness of space and time as functions of light and motion, and, in turn, their integration, directing the mind to light. In contrast to a “snapshot” conception of the world, Moholy advocated “vision in motion,” a synonym for simultaneity, multiple perspectives and spacetime seeing while moving: “...changes wrought by shifting light and shadow could express “vision in motion” (Kirkpatrick, 1988, p. 65). With increased frequency and speed of movement due to, e.g., the automobile, train and plane, one’s sensibility to vision-in-motion is heightened. Moholy-Nagy (cited in Moholy-Nagy, S., 1950, p. 83): “How rarely does one actually see in sharp focus! There is an interplay of advancing and receding forms in every movement.” Advances in scientific knowledge and technologies afford opportunities for art; the human experiential realms they open, explored and communicated by the artist, in turn, benefit the scientist and industry. Moholy recognized this shift in collective experience and conception of the unification of space and time as equally relevant to pursuits interior/perceptual and exterior/physical. Vision in motion, "simultaneity in space-time" and "a means to comprehend the new dimension" is equal to the “projective dynamics of our visionary faculties” (Moholy-Nagy, L., 1945). Moholy-Nagy (1947, p. 12): “Vision in Motion is simultaneous grasp. Simultaneous grasp is creative performance—seeing, thinking, feeling in relationship and not as a series of isolated phenomena. It instantaneously integrates and transmits single elements into a coherent whole. This is valid for physical vision as well as for the abstract.”

With regard to vision in motion, two elements in the artwork of Moholy-Nagy are especially salient, alerting the mind to spacetime: the interplay of light and shadow and “strips.” The interplay of light and shadow (or brightness/darkness) represents original and generative opponency in perception, a binary code from which the eye extracts geometrical information (see Figure 3.3). In the interplay of light and shadow, the artist has the means of shaping dimension in perception, from a zero-dimensional point of brightness in darkness, to three- and four-dimensional (including movement) spaces. The “strip,” often a long parallelogram in Moholy’s work, is the exemplar of a two-dimensional shape encoding three dimensions in perception. It is a prototype for the concept of vision in motion. The 2D shape may be seen through to a rectangle in depth, i.e., in 3D space, and, as such, embodies time and movement. Only through visual experience (vision in motion) do we come to perceptually integrate the parallelogram into a higher-order, dimensional model where it is a rectangle angled in depth. “I find that during the last twenty-five years, since I began my abstract paintings, I did not paint any shape which was not the interpretation of the... strip, used in my first collages” (Moholy-Nagy, L., 1944, p. 86).



Figure 3.3: Still from *Lichtspiel Schwarz-weiss-grau* (1930) showing the results of a beam of light cast through a perforated disc: light/shadow interplay.

Whether through the spatially evocative geometry of his paintings, or the transparency of his Light Modulator sculptures of Plexiglas (at times set into motion), Moholy's varied works cohere under the concept of vision in motion. He was reaching for media and methods that would prepare for and evince the emerging "culture of light" (Marcoci, 2012) with its necessity of expression and proliferating tools of light. In this regard, the combination of kinetic light sculpture and film in *Lichtspiel Schwarz-weiss-grau* is a pinnacle artwork. Motion pictures "more than anything else fulfill the requirements of space-time accentuated visual art" (Moholy-Nagy, L., 1947, p. 271). In it, the Light-space Modulator is an instrument for dimensional creation in light and shadow, as film provides the means of spatial and temporal image layering for "light chronology."

Moholy-Nagy's non-mimetic art should be set in context of his objective to "revolutionize human perception" (Harvard Art Museums). For Moholy-Nagy, space-time art was to be based on research into human perception. As Dianne Kirkpatrick (1988, p. 64) writes, "[h]e wrote of the importance of an understanding of how we grasp 'the dimensions: one, two, three, and more' of spacetime.'" In his practice and thought, light is, at once, transcendent and embodied, experienced as spacetime—vision-in-motion. "Light, ordering Light... Light, total Light, creates the total man... Space, time, material—are they one with Light?" (Moholy-Nagy, L., 1917 cited in Moholy-Nagy, S., 1969, p. 11).

3.4. Otto Piene, *Light Ballet* and “Purity of Light”

The complex, evolving light forms of Otto Piene’s *Light Ballet* derive from the incandescent filaments at the heart of the sculptures. ‘Incandescence’ denotes the emission of light due to heating; the filaments of the *Light Ballet* burn.

In his studio, in the ruinous building at 69 Gladbacherstrasse, Düsseldorf, Germany, in response to experiences in the war, Piene turned burning from a destructive to a generative force. There he first punched the holes of the grids through which he applied smoke, paint and light. The *Rasterbilder* set painting surfaces into optical vibration. The smoke paintings he titled *The First Attempt to Burn the Night*; *The Second Attempt to Burn the Night*, up to *The 27th Attempt To Burn The Night*. Piene also ignited solvent and executed “a choreography of fire on the canvas” and a “fire dance on the retina” in creation of his *Fire Flowers*: “...pictures grew within seconds on a borderline between destruction and survival” (Piene, 1965). The artist’s attention turns away from the rules of geometry toward “organic forms which derive from melting and technological processes” (Piene, 1965).

Through the grids, Piene directed the beam of a handheld spotlight to create the first “archaic” Light Ballets (Piene 1965). The light “appeared in manifold projections around the entire rooms” (Piene 1965). In light, Piene found the physical analog to the qualities of mind that he wanted to propagate:

...it reaches everywhere in a given space. This is how the observer gets the impression that he is at the center of the action: the light ‘passes through’ him; he ‘feels to be a part of the light.’ A dynamic sensitivity to the space is created, and thus the force of gravity loses its spell (Piene, 1960).

Experiences reported by viewers in the *Light Ballet* environment: “...tranquility, suspension of normal balance, and an increased sensation of space” (Piene, 1965). The light of the *Light Ballet* does not illuminate, it structures the perception of space and time, dissolving the experience of the “hard” architecture (Piene 1965):

The farther the distance between the projecting device and the light-catching confines of a room, the larger are the light forms. And when they are large, the claustrophobia caused by the ordinary cubicity of our interior spaces recedes.

The organic, evolving light forms of the *Light Ballet* relate directly to the light sources and reflectors used within the sculptures. A large, linear filament is set within a concave reflector, shaping the light into a beam. As the beam is directed through the sieve of Piene’s grid, the manifold images within the light resolve and blossom into the room.



Figure 3.4: Close of *Light Ballet* filament and reflector. Photo: Allan Doyle, 2018.



Figure 3.5: *Light Ballet* filament projections. Source: Seth Riskin.

The *Light Ballet* sculpture is a camera obscura in reverse. Through the holes in the body of the sculpture, the radiant complexity of what takes place inside the sculpture is transposed to the surfaces of the outer environment. Filaments are imaged in multitude and from myriad angles by the holes of the sculptures.

...the way in which light reacts to holes through which it is shone is such a complicated business that all those who are working on it at the moment, and those who will occupy themselves with it in the future, will have their work cut out. (Piene 1973, p.149)



Figure 3.6: *Flying People*, Otto Piene, 1952. Photo: Seth Riskin.

“Dreams of distance” Piene (1990) said, describing a sensibility that experientially transcended limits of gravity and body, imaged in his *Flying People* series. This sensibility possibility originated in Piene’s intuition of the oneness of human interior space and the exterior space of the physical world, ultimately compelling his assertion that, through work with light, the artist can invert the ordinary hierarchy of subjective and objective experiences.³ The viewer becomes the origin of the action, experiences identity with the light, dissolving the duality: “Mind, which

³ See too Piene’s “Story of Light Art – Night and Day Ad Infinitum” (1988, p. 35): “Outer space is inside us, in the human mind, limited only by human intellectual definition.”

is really body, and body, which really exists in mind, do not wish to allow us to treat them as separate entities” (Piene, 1988).

Light was the portal for Piene. “The man who uses his body to enclose his mind and his mind to lift up his body, who lives this timeless moment, this heavenly reality, in order to stride freely through space, this man has paradise in him. He follows the beams of light that he creates, they envelop him and the universe, the light passes through him and through it” (Piene, 1958). The perceptual space and time embodied in the light has to be released and articulated in movement and this light is used to pierce the darkness (Piene, 1958) to achieve “...liberation from the rules of optical exploitation of geometry” (Piene 1965).⁴ One is reminded of Moholy-Nagy’s vision of realizing “new optical laws” beyond the purely optical picture of the photographic apparatus and “the elimination of perspective” in light compositions (Moholy-Nagy, L., 1923).

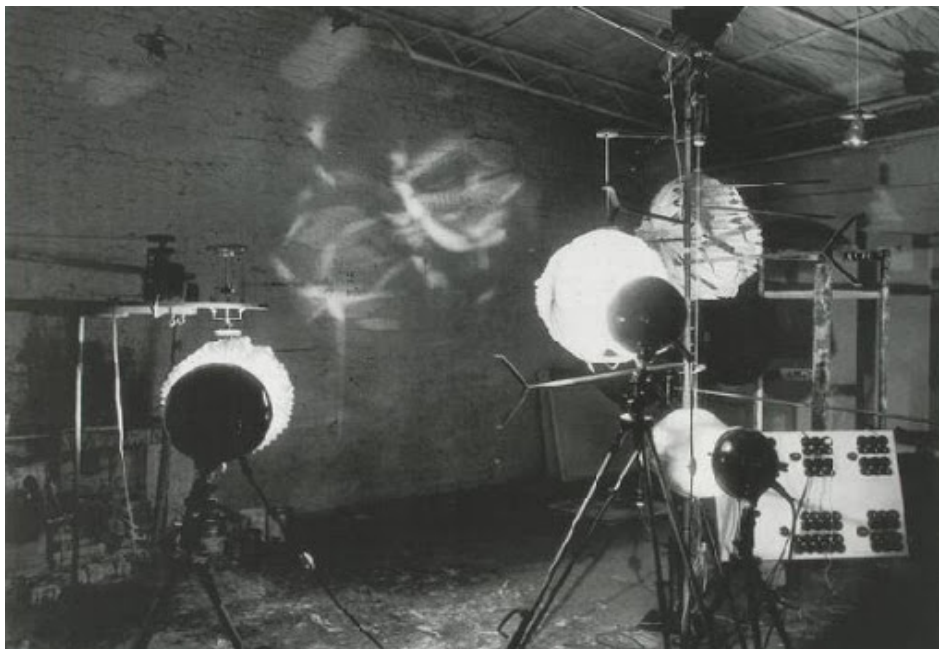


Figure 3.7: Early mechanization/electrical programming of Light Ballet, first solo exhibition in Düsseldorf, 1959. Source: Center for Art and Media, Karlsruhe, Germany.

⁴ See again Piene’s “Story of Light Art – Night and Day Ad Infinitum” (1988, p. 30): “The time-space relationship is—when it comes to life and reality—better described as time-space-light relationship.”

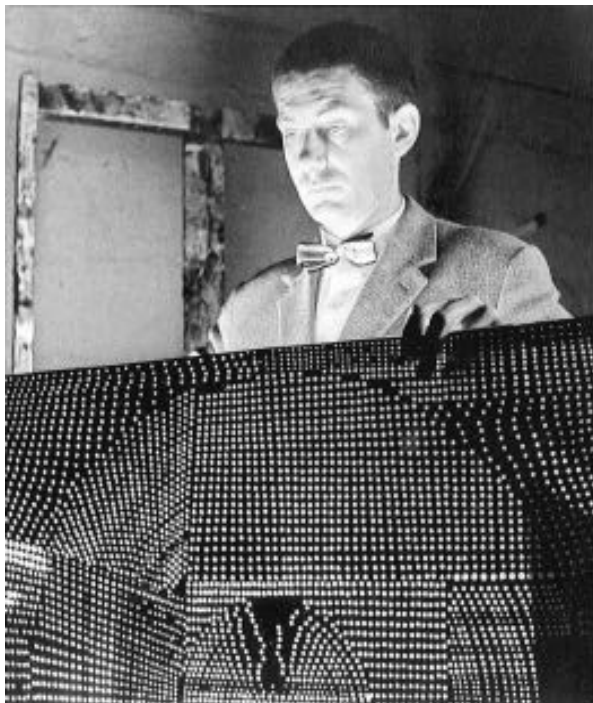


Figure 3.8: Hand-cut grid for early Light Ballet, 1961. Source: ZERO Foundation, Düsseldorf, Germany.

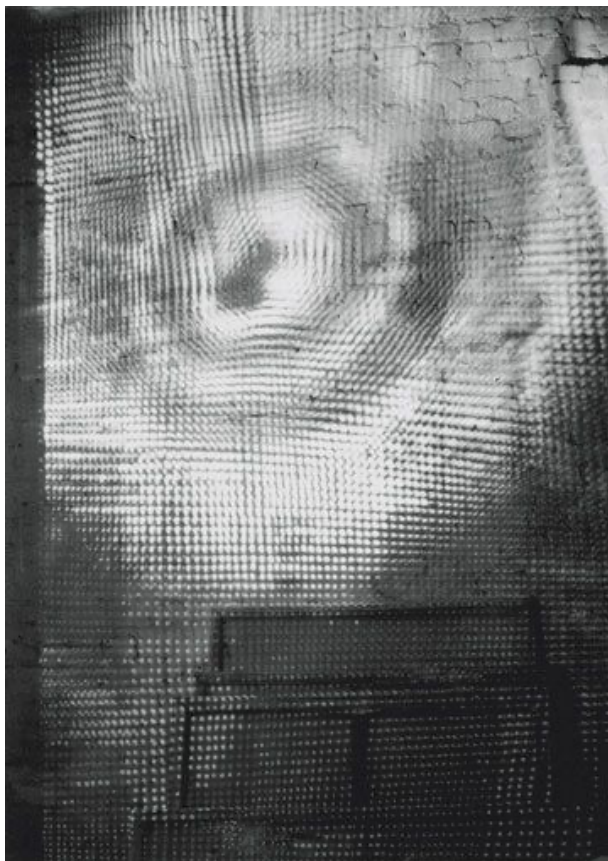


Figure 3.9: Early Light Ballet projection through grid. Light Ballet was originally a hand-operated performance, later mechanized. Source: ZERO Foundation, Düsseldorf, Germany.

In his essay “On the Purity of Light,” Piene (1973) describes light as a guiding experience in artistic practice that historically drives development through representation of light to its use as a medium, by which the experience of light as an object is transcended and the “purity” of light is tapped. Of Rembrandt’s paintings, Piene (1973, p. 46) says “at the same time that he used lights and darks to affirm reality, he used radiance to transcend it.” This points to loose brushstrokes of white pigment on Rembrandt’s canvases that go beyond the representation of highlights, to the function of reflection of incident light off the canvas. These painting fragments become reflectors, early examples of the artist working with light itself. Imitation of nature and tapping nature for art are contrasted within the artistic paradigm that drives toward experiencing and expressing light itself.

Piene (1973, p. 47) prioritized the primacy of perception in artistic practice that left no room for light as an object, rather inhabited light as something of one’s own human “energy,” that could be collected and communicated through art: “The energy of light emanating from the field of the painting is converted mysteriously into the spectator’s vital energy.” Light Ballet is a kind of “autobiography of light” in space and time that operates through the artist. The sculptures, with perforated bodies containing brilliant, moving, concentrated sources of light, are inverted camera obscuras. They project the multiple perspectives of a multi-eyed vision process into the surrounding space. In the spacetime-defining articulations of the projected light forms, the viewer experiences the coherence of light, space, time and perception, transcending their division in concept.

Light Dance follows Light Ballet as a vision process that, in placing the sources on the body, geometrically reducing light, and moving in the manner of seeing to construct perceptual space and time, reveals to the mind an inversion of light and vision.

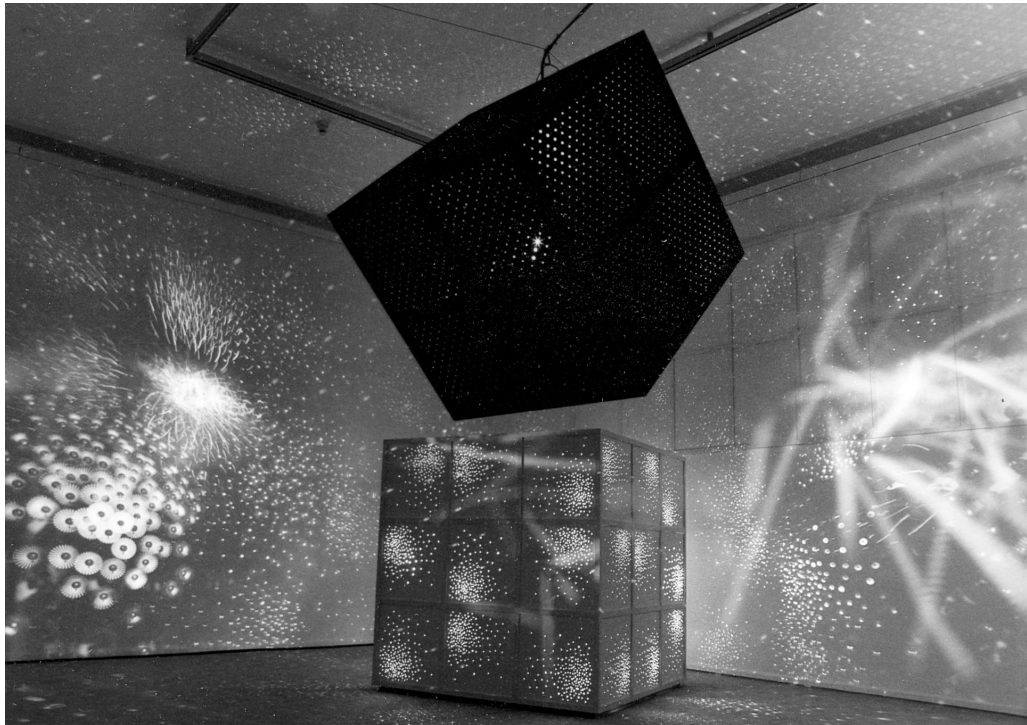


Figure 3.10: Developed, mechanized *Light Ballet* (2000s). The light sources turn on and off in sequenced program. Source: Seth Riskin.

3.5. James Turrell: Equiluminant Light Fields and “Perceiving Perception”

First, I am dealing with no object. Perception is the object, Secondly, I am dealing with no focus to particular place to look. With no object, no image and no focus, what are you looking at? You are looking at looking. This is in response to your seeing and the self-reflexive act of seeing yourself see. (Turrell, 1993, p. 26)

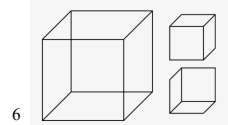
In 1969, James Turrell, collaborating with artist Robert Irwin, participated in the Los Angeles County Art Museum Art and Technology Program [LACMA] (1967-71). “New Metaphor” was stated as a primary purpose of the program, linking artistic exploration and creation with corporate resources and technological forefronts (LACMA, 2013). The “experiment” was to

productively connect art with science and industry. Industrial experiments radically change the world and the subjective and humanistic orientation of the artist is needed to keep things balanced. The program paired artists with major corporations. Turrell and Irwin stated their unique objective: for “people to perceive their own perceptions” (cited in Wagley, 2013). As an artistic objective and viewer experience, what is the significance of “perceiving perception” and how does it connect Turrell’s work to *Light Dance*?

“Perceiving perception” reveals at once a premise and experiential goal of artistic pursuit. Turrell talks about light as a “thing” that he wants to show as such, a medium for generating perceptual space and a means of transcending the object in experience for the experience of perception itself.⁵ Of these three artistic objectives working with light, I believe “perceiving perception” subsumes the other two in Turrell’s work.

The trajectory of Turrell’s work shows long, experiential exploration with perceptual ambiguity and multistable perception in the encounter with light. Perceptual ambiguity is fundamental to light experience. We are accustomed to seeing perceptual ambiguity in the form of “optical illusions,” e.g., the Necker cube is an example, a wireframe figure that cues perception of a three-dimensional cube perceived equally in two orientations.⁶ Perceptual ambiguity goes to the root of visual experience. Information on the retinae is coarse, two-dimensional and fragmentary.

⁵ See Turrell’s interviews with *NPR* (2013), *Interview Magazine* (2011), and *The Guardian* (2018).



Size, orientation and distance conflate, making the mapping of retinal patterns to physical cause uncertain.

Turrell takes perceptual ambiguity to architectural scale, working with light, material surfaces, physical space and time. By removing texture from a wall or reducing an architectural corner to a demarcation of light and shadow, Turrell reduces visual information to minima, and the eye is suspended in an environment at once entirely real and uncertain. A luminous sharp-edged shape hovers in darkness. Is it a reflective surface, or an opening to a brightly lit space? In this environment reduced to elemental stimuli—a bounded field of brightness within darkness—distance, surface, and size are unclear and changeable. Material may be taken for light, light for space, and perception for reality. Here begins Turrell's exploration. Cues to the construct of the world in experience are removed. We are left experiencing the formations and projections of our own perceptual process. This is "perceiving perception."

I will relate three works by Turrell that, by different approaches, lead through light to encounters with our own visual perception. Turrell's work vividly and multiply demonstrates fundamental ambiguity between what we call "light" and "perception"; that light may be used reflexively to consciously penetrate our own vision. This sets the stage for *Light Dance* that begins with the fundamental ambiguity of light and vision and shows how one converts to the other in experience; one embedded in the other in concept.



Figure 3.11: James Turrell, *Afrum I (White)*, 1967. Source: Solomon R. Guggenheim Museum.

An early *Cross Corner Projection*, titled *Afrum I (White)* is experienced as a brilliant, cubic volume of light hovering in the corner of an otherwise dark room. As one moves back and forth at a distance, the front edge of the solid follows, pivoting the entire form. Moving closer, the form collapses and is revealed as a two-dimensional projection into the architectural corner, sharp edged and shaped so that the distortion of the light mapped to the right-angle recess strikes the hexagonal contour of a cube. In *Afrum I (White)*, light perceptually borrows from the architectural corner to become solid, demonstrating the fundamental ambiguity of light and form.

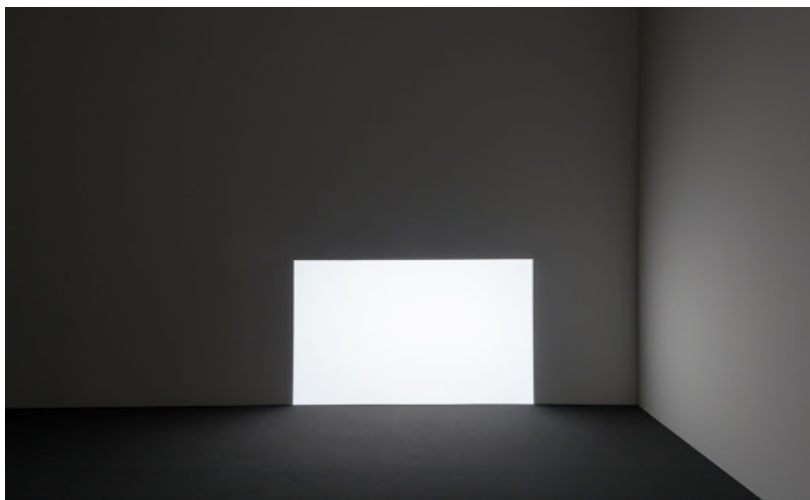


Figure 3.12: James Turrell, *Prado (White)*, 1967. Source: Solomon R. Guggenheim Museum.

Prado demonstrates the converse approach, the interaction of light and material revealing the perceptual ambiguity of light and space. Like *Afrum I (White)*, *Prado (White)* uses a high-intensity projection onto a wall surface. Texture is removed from the wall surface so as to not visually signal its presence. The uniform brightness has a clear-cut edge that can be brought in and out of focus. “By focusing the beam of light just in front of the wall, Turrell found that he could create the appearance of a flat plane floating in the viewer’s space. If the projection is instead focused at a point just behind the wall, as in *Prado (White)*, the rectangular panel of light opens a visual portal to some other, unknown space beyond” (Giménez and Trotman, 2013, p. 74).



Figure 3.13: James Turrell, *Perfectly Clear (Ganzfeld)*, 1991. Source: The Massachusetts Museum of Contemporary Art.

In the experience of *Perfectly Clear (Ganzfeld)*, the largest of Turrell’s Ganzfelds, the viewer walks *into* the ganzfeld. Approach to the piece, passage into, and complete immersion within the ganzfeld heighten features of the experience, specifically the transition from experiencing light as a physical phenomenon, an object of perception, to light *as* perception itself, which, without

change, falters and fails; whole-field brightness may be experienced as darkness. One approaches *Perfectly Clear (Ganzfeld)* from outside the room and below. A luminous, monochrome rectangle—surface or opening?—is seen from the base of a short stair. As one ascends, the rectangle fills the field of view, ultimately enveloping the viewer. Visual context—stairs, walls, passage through the rectangle—fade from memory. Equiluminant brightness fills the field of view. There is no shadow, or highlight; no contour, or value difference for the eye to grab onto. Edges, forms, colors appear from within; perceptual processes are observed. The luminosity appears “thick,” both near and far. With no change, the sensation of brightness fades to black. One can blink to refresh the brightness perception, but there are times when one cannot tell whether one’s eyes are open or closed. The *Ganzfeld* experience requires the interaction of light, material and perception, but features none of these; rather, it brings the viewer to a state of their interdependence: “Turrell has obliterated the philosophical and actual barriers between subject and object, as if the ideal forms and their shadows on Plato’s cave wall have merged into one ultrareality” (Govan and Kim, 2013, p. 33).

Afrum I (White), *Prado (White)* and *Perfectly Clear (Ganzfeld)* demonstrate the interconvertibility of light, material and perception in experience. Through artistic handling, each can be foregrounded by the others. Turrell’s reduction of light is to uniformity, visual-field completeness, by which spatiotemporal structure vanishes. *Light Dance* takes an opposite approach: squeezing light down to a geometric minimum, the inverse of a ganzfeld. Nevertheless, in *Light Dance*, we begin on experiential ground similar to Turrell’s, where light, material and perception are collapsed into one-dimensional brightness. Movement of this line then generates higher dimensions in perception, illuminating not the physical space, but vision to

itself. From “perceiving perception,” Light Dance takes another step in the reflexive study of vision: light is used not only to show vision to itself, but to show the mind that *light can play the role of vision*, indicating a fundamental equivalence.

The connection between Turrell’s ganzfeld artworks and Light Dance is the reduction and inversion of visual information such that the object of perception is light itself. Turrell’s ganzfeld presents to the eye an equiluminant light field with edges. Seeing through light to perception: Turrell’s work guides a reassessment of light concept and the identification of artworks that herald a new thought paradigm through experience. The difference in perspective I want to draw out, that will contextualize and inform Light Dance, is one anchored in the experience of the indistinguishability of light and one’s own perceiving. In direct perception, light is not experienced as an object but as a function of perception itself and therefore coincident with the perceiver. One way to describe the experience is as a “hole” in the spatiotemporal structure of the perceived world. I look onto the environment of surfaces, distances, objects and realize that the glint of light on the edge of the object is *experientially no object*, no distance. It is a miniature ganzfeld. In the depth of the scene this is a “hole” to me, a spatiotemporal collapse of distance between the subject and the object of vision. Recognized here is the selfsameness of light and vision in experience and therefore the conditionality and contingency of the visual world and the artistic potential of shaping that world-in-perception by manipulation of light.

I have tried to take this work further. Where Turrell takes us to a space of light presence that is somehow equally perception, I have endeavored to show how light *is* perception, to reveal a co-equivalence between what we call “light” and what we call “vision.” Whereas Turrell eliminates

information of material leaving uniform light that leaves perception in awareness, I go to the other extreme, constricting light so it does not illuminate, rather becomes the object of vision, e.g., a line. From the ordinary structure of the world in experience, Turrell takes us to a zero-point where we are left with our own perceptual awareness. Yet Light Dance begins at the zero, where the light is constricted so far as to not illuminate, but to become the object of perception, revealing perceptual-world construction e.g., from edge, to shape, to object, that, in perspectival structure and dynamics, is the inverse of the ordinary world-construction. From the concept of a hard, material world and counterpart invisible perception, Turrell takes us to awareness of perception. Light Dance inverts the roles of light and vision revealing their interdependence, fundamental equivalence and therefore interconvertibility.

3.6. Perceptual Inversion

As Otto Piene and Laszlo Moholy-Nagy demonstrate, the work of light/vision artists and light/vision scientists may represent complementary approaches to the same phenomena, materials and perception. To the extent that the two disciplines are effective in their methods and results, an embracive model is inherent in the complementarity of their approaches and the commonality of their shared concern: knowledge of light/vision. In this way, the light artist does something quite important within the contemporary, collective, materialist mindset: work with materials and physical phenomena “mind-first”. This is to say that the whole physical environment turns “subjective” under the spell of the artist, first and foremost for himself/ herself and for viewers. To the extent that he or she can turn materials transparent to mental forces and contents, others will experience it too. Through their careful operations, the environment, or the object, becomes “transparent” to human inner dynamics. The artist experiences the physical

realm this way and moves things to accord, adapts and creates things to manifest interior forces. The very same object that measures out lifeless and completely objective, suddenly, as art, holds power within a psychic realm that is coincident with the physical space, time and material. This is the power of working with light that spans experiences of what we call the “mind” and “physical reality.”

Such looking into light to see vision is not the norm but exception in light art. Concerning the genre, the prevailing thought and handling of light, still, is as an object, manipulating light like a plastic medium: luminous objects, light sculpture, projected light effects, the tendency intensified with technologies such as programmable LEDs. In other words, a modern scientific worldview is applied by the artist, historian, or curator, often unreflectively. As an example, the most recent and comprehensive exhibition of Light Art was mounted by Peter Weibel at the Zentrum für Kunst und Medien, Karlsruhe, Germany 2005-06. The exhibition catalogue (Weibel and Jansen, 2005, p. 27) declares: “Light Art from Artificial Light is the first comprehensive, indeed encyclopedic, show of artists’ engagement with artificial light since the exhibition *KunstLichtKunst* (1966) in the Van Abbe Museum, Eindhoven, the Netherlands.” The comprehensive approach alone signals and demands the simple, available curatorial criterion: artificial light as medium. Totalling over 700 pages and including numerous documented artworks and essays, the catalogue explores the history and contemporary artistic expressions of “artificial light.” The title captures the tone of this exhibition, reinforced by the first catalogue sentence: “Light continues to be a fascinating and enigmatic phenomenon for all of humanity, not just for Einstein” (Weibel and Jansen, 2005, p. 27). Light is approached as an object of study, manipulation, fascination.

As I have argued, seeing light as an object prohibits seeing through light to vision. Objectivity is gained by being once removed in knowledge and beliefs. “To acquire a more objective understanding of some aspect of the world, we step back from our view of it and form a new conception which has that view and its relation to the world as its object” (Nagel, 1979). Art offers a method of stepping into light, exploring it as an experience and, critically, evidencing subjective experience in physical form. By forming new conceptions of light from the subjective viewpoint, art may be produced that communicates continuity of the mind and world. Mind-world continuity is first-person. It is *experienced* which stands at the lead of its structure and dynamics; the world-in-experience centers on and is borne of experience. The world we experience is at once physical and mental. The problem we are faced with is not reduction, but the *reconciliation* of opposites: in pursuit of knowledge, itself a cognitive act with cognitive ends, it is not admissible to reduce the physical to the mental, or the mental to the physical. Light Dance suggests a model for reconciling opposites, one that admits the coexistence of the physical and mental and conversion from one to the other in two spatiotemporal orders, perceptual and conceptual. This approach does not undermine prevailing models, but rather shows them as limited cases within a larger scope that includes the mind. Though direct artistic precedents of Light Dance use technologies to address experiential dimensions of light, juxtaposing concept and perception, they do not conceive a model reconciling physical and experiential orders of light knowledge.

We come now to *perceptual inversion*, like a condenser lens acts on a beam of light, converging it to a focal point and turning information upside-down before it re-expands, the same as happens

in the eye inverting the image on the retina. By artistic approach to light/material interaction, flipping the illumination function whereby light becomes the object of perception, the artist shows vision to itself by external means. The de-contextualized, low-dimensional brightness, sensation without perceptual cause, collapses the visual world in experience; the object becomes subject, allowing the viewer to recognize the role of the perceiving mind in construction of the world-experience upon the “light.” What was external/concrete delivered to the eye by light, is pivoted upon light, revealing perception behind.

Through artistic practice with light, Wilfred, Moholy-Nagy, Pione and Turrell come to the threshold of an inverse experiential order, the physical instantiation of Plato’s Allegory of the Cave, where constriction of light expands awareness beyond the edges of objective reality, relativizing it in relation to the perceiving mind. Precedents of Light Dance bring us to the point of conception of an inverse model of vision and light, one wherein “space and time adjust themselves to the geometry of light” (Reichenbach, 1942, pp. 67-68) is experiential reality when light is recognized as sight. “As one plumbs a space with a vision, it is possible to ‘see yourself see.’ This seeing, this plumbing, imbues space with consciousness. By how you decide to see it and where you are in relation to it, you create its reality” (Turrell, 1985).

Here, we are in a position to answer the second set of research questions originally posed in the Introduction: “Is there anything to be learned from the history of light art? Does it evidence the prevailing distinction between subjective vision and objective light, and/or may evidence be found for an integrative approach?” With Light Dance, I endeavor to advance upon the artistic tradition of working the medium of perception, laying ground for new conceptions. Reducing

light to geometric minima, articulating light as sight geometry, I open inverse perspective in the mind of the viewer. And further—and this is the critical step that I believe is implicit, but not realized in the work of Wilfred, Moholy-Nagy, Piene and Turrell—I place the source of light on the body and move it with the body *in the manner of vision*, enacting light/vision equivalence as a shared experience.

Chapter 4 builds the thesis argument through Light Dance imagery. A single performance is examined through photographs that detail visual evidence of the postulates and builds a view, a way of seeing the thesis. The critical act in Light Dance (in art in general) is that it shapes the physical world in the image of its beholding, piercing the concept that separates object and percept. The work is fundamentally, *manifestly* reflexive. Chapter 4 makes the visual claim for the thesis, eliciting further discoveries and demonstrating practice as the impelling, ordering force behind the thought.

CHAPTER 4: Light Dance Paradigm and Analysis of a Performance

4.1. On the Reflexive Experience of Vision

Throughout this work, I have distinguished between two conceptions of light within the Light Dance practice: as a physical phenomenon wholly separate from the perceiving subject, and as a reflexive experience of vision. The two approaches are equally important in pursuit of the work. The dualistic paradigm that holds light as a physical phenomenon, an object of study and a technological vehicle, permeates the knowledge and equipment that affords control of light. Yet in Light Dance, that control is applied to generating the perception of light as vision, i.e., making light transparent to structure and dynamics of early visual processing. One and the same light may be looked at or through; light may serve a dualistic paradigm based upon the fundamental separation of the perceiving subject and the physical phenomenon, and/or light may be applied to generating experiences within a unitary paradigm wherein the phenomenon we call “light” is recognized as containing an element of what we call “vision.” To be clear on the intended meaning: not representation, but light *as* vision, its cognitive projection, and therefore, inversely, “vision” as the pre-conceived “inhabiting” of light; perceptual/conceptual ambiguity. This suggests a major ontological and epistemic shift in how we conceive and think about light.

4.1.1. Overview of Chapter

While this shift is certainly of interest and touched upon in the conclusion, my purpose here is simply to make clear the nature of the thesis argument for what follows. The primary function of the Light Dance artwork is to realize *at the perceptual level* an experience of the equivalence of

light and vision. The perceptual experiences motivate and guide conceptual development, the effort of this dissertation. I will now bring the Light Dance artwork back to the fore. From the Introduction: “Light is the medium by which the artist shows vision to itself” and “The dissertation is organized around the goal of drawing thought from perceptually rudimentary Light Dance experiences and building theoretical framework upon art perception.” In this final chapter, I will correlate visual evidence from the Light Dance artwork with the thesis claims. I intend to make and build upon these claims visually, tying percepts and concepts, visual and textual information for the most cogent presentation of the thesis argument.

To do so, I will use a sequence of images from a single Light Dance performance, *Circles*, and, through them, demonstrate visually the claims of the thesis argument. The performance uses fine, white-light circles projected from the arms. While related in core principles to the light line experiments of Chapter 2, the two-dimensional circle offers additional information. Like the line, the circle represents a slice of the projected receptive field, or “cone of vision,” but a circular one, a conic shell, concentric with the cone of vision, seen as a circle/ellipse/oval/parabola, etc. in cross section when intersecting material surfaces. Compared to the geometry that unfolds from the line, the *Circles* performance images illuminate further geometric discoveries of the visual field intersecting with the material environment.

4.1.2. From Perceptual Observations Back to Concepts: Rearticulation of Thesis

As a template for what follows, I will now present an abbreviated account of the thesis through the list of claims made in the progression from perceptual observations to concepts in the

foregoing chapters, concluding with the thesis statement.

1. The Light Dance projection does not illuminate the material it interacts with, but is itself thereby revealed. Light becomes the object of perception.
2. The light, de-contextualized, linear, equiluminant and motionless, is (apart from its single dimension) spatially and temporally ambiguous and therefore coincident with the viewer in experience.
3. “Light,” and related high-level concepts such as “three-dimensional space,” have no place in this reduced experience of elemental percepts. “Light” is experienced as one-dimensional brightness *between* the subject and the object of vision. The viewer experiences a spatiotemporal collapse of distance.
4. Directed by the body, as the elemental geometric unit of brightness moves, it undergoes transformations, changes in size, shape, speed and brightness intensity.
5. The transformations compose higher-order geometries in the mind of the viewer. With movement, the original unit of brightness unfolds into spatiotemporal structures in perception: the “brightness geometry.”
6. Characteristics of the brightness geometry in perception: the structure constantly unfolds from the moving present and location of the body/light source; the brightness geometry embodies time

in perception; the structure is defined by angular directions and radial distances from the body/source.

7. The brightness geometry exhibits structural and dynamic features that are inversely proportional to our ordinary visual perspective, e.g., size and speed grow with distance; instead of foreshortening, shapes elongate; curvatures are opposite.

8. The Light Dance elemental unit of brightness, e.g., a line, plays the role of a slice of the cone of vision (the total receptive field projected into three-dimensions) if it, and not the material environment, were visible.

9. Light Dance brightness geometry shows us the slice of the projected receptive field as it is cut by material architecture. This concept accounts for the transformations. They are cross sections of the slice of the projected receptive field. In Light Dance, we see the time-based structures of the slice of the projected receptive field (brightness geometry) extending and moving from the body, intersecting the material architecture in a sequence of angles and distances.

10. Perspectives of the viewer, performer and the light source on the brightness geometry generalize to a higher-order conception. In Light Dance, we see the vision we ordinarily see through. The light source plays the role of the eye, the projection, a slice of the projected receptive field and the global brightness geometry, a time-trace of the projected receptive field interacting with material surfaces. With increasing proximity to the location in space and time of the source, the transformations and dimensionality of the brightness geometry diminish to zero at

the source.

11. The perspective of the light source on the elemental unit of brightness never changes.

Relative to the light source, here equal to the eye, the unit of brightness remains fixed, as would be expected according to projective geometry. The projection is “attached” to the source as the projected receptive field is “attached” to the eye.

12. The foregoing claims suggest the thesis statement: Light Dance demonstrates a principle of equivalence between vision and light. The Light Dance projection is equivalent to a geometrically elemental portion of the projected receptive field, which, in itself, holds no spatiotemporal information, rather responds to changing patterns of visual information.

4.2. *Circles*

In view of the thesis claims and statement, I will now annotate the sequence of Light Dance images. My purpose is to direct attention to visual information that will inform and enrich the thesis. To set the physical context of the following images: a paper backdrop is suspended from the ceiling of a room approximately 30’ square and 15’ high. The paper forms a parabola approximately 25’ diameter at the rim and 15’ along the axis of symmetry.¹ The parabola arcs around the artist situated near the focus. Two identical projectors, battery-powered with finger switches, are mounted just above the wrists of the artist, on the back side. The projectors cast

¹ A curved surface, instead of planar wall, was chosen for extending the projection area in the small space available. While the wall’s curvature contributes in small ways to the transformations of the projected light forms, it does not interfere with the presentation of the Light Dance principles discussed.

fine white light circles diverging at 30° . The room is made totally dark. One projector is switched on. A circle of light appears on the backdrop surface. Its size is determined by the divergence angle of the light projection and the distance between the artist's wrist and the wall. The greater the distance traveled by the light, the greater the diameter of the circle. The shape the circle takes is determined by the projection angle relative to the wall surface. These factors apply to every point on the circumference of the circle, leading to a range of size, shape, speed and brightness-intensity transformations.

The images show photographic exposure times of 0.25-2 seconds. In a given exposure, the body moves, shifting the light, whereby time-traces of the circle are recorded, revealing spatiotemporal structures generated by the light. The photographic exposure time bears relation to persistence of vision and cognitive integration (memory) across time in vision that generate spatiotemporal brightness structures in the Light Dance experience.



Figure 4.1: In total darkness, light is cast from the performer's body. Source: Seth Riskin.

In Figure 4.1, the precise projection does not light the room, but delineates a circle.² With the contextual information erased by darkness and the circle motionless, its depth and size are ambiguous. The circle could be large and distant, or relatively small and near. Further, the projection does not illuminate the material it interacts with, but is itself revealed. “Light,” as a concept implicating physical surface, multidimensional space and time, have no place in this perceptually elemental experience. The coincidence of “light” concept and “brightness” percept is experienced.

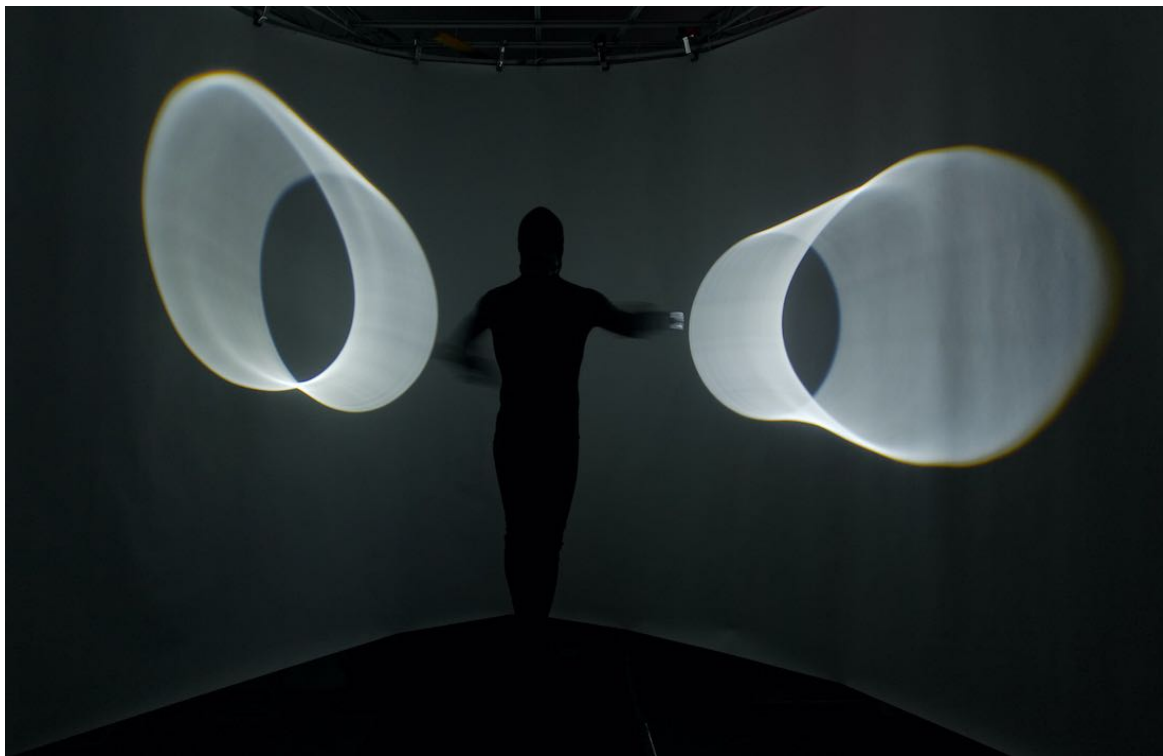
² Though many shapes and curves are generated in the Light Dance performance, for clarity I will not differentiate oval, ellipse, etc., but simply use “circle” in all cases.



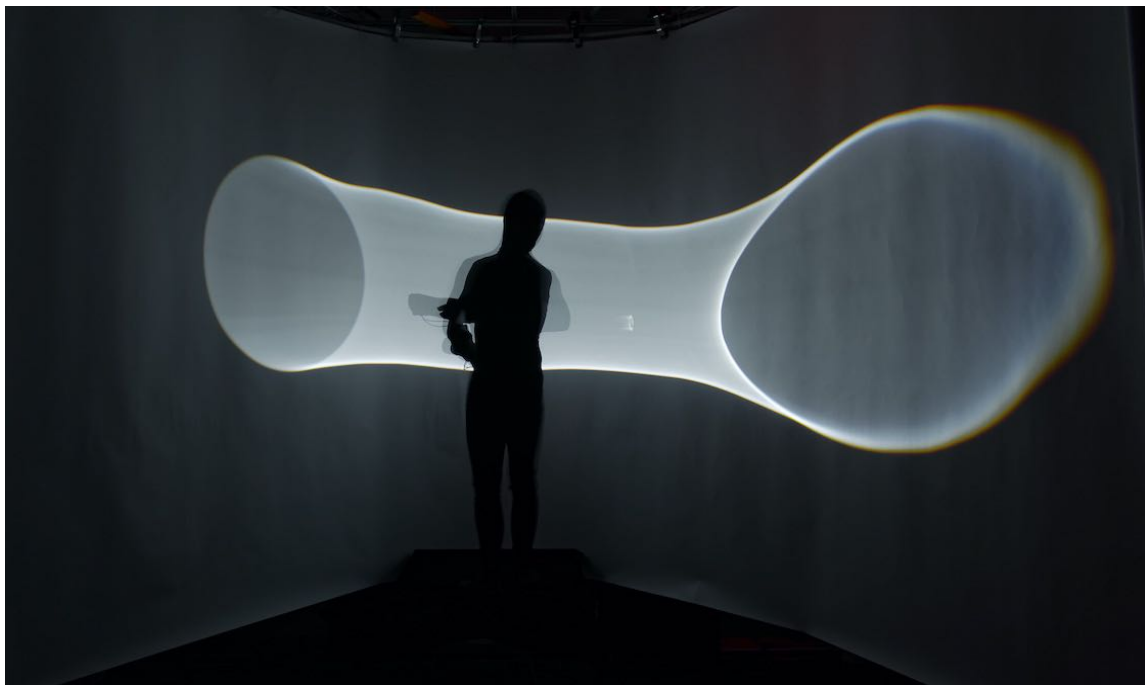
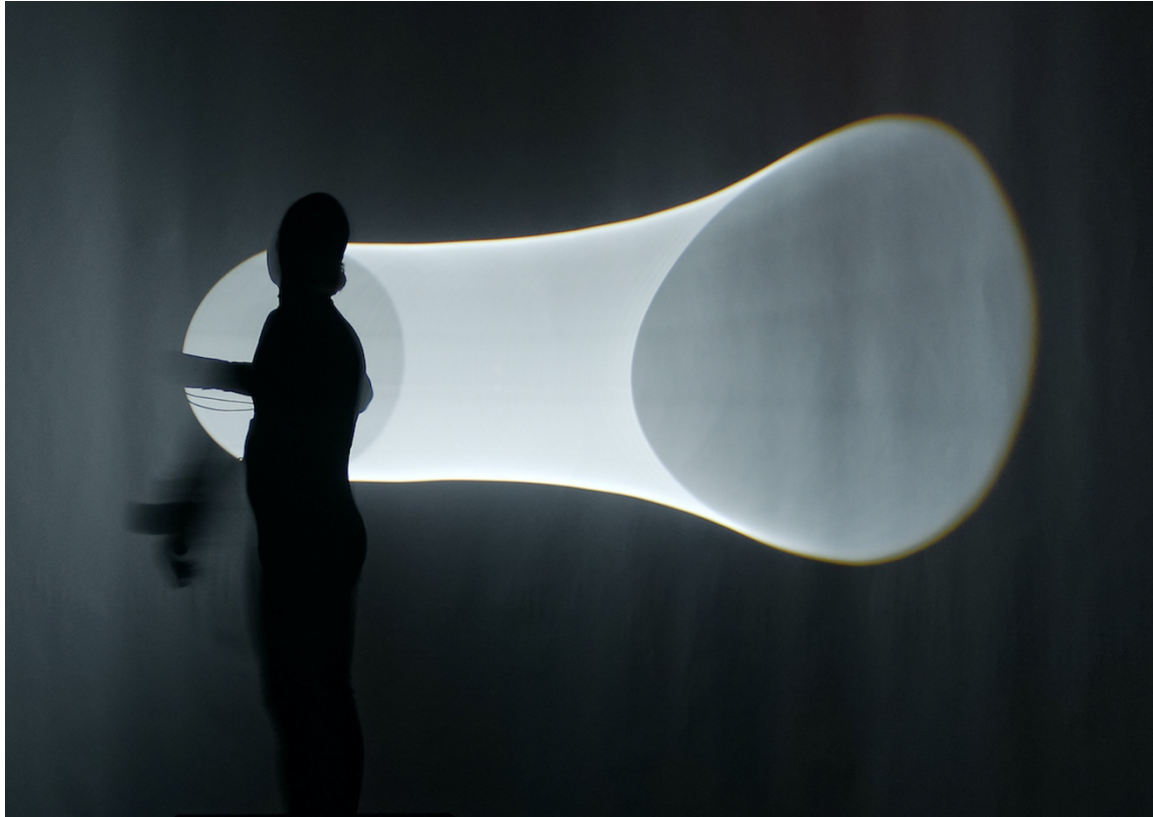
Figures 4.2 and 4.3, from top to bottom: With the slightest movement, the circle expands spatially and temporally, as changes to the shape, size and speed manifest visually. Source: Seth Riskin.



Figure 4.4: With movement, the circle becomes a time-embodied form, continually unfolding in perception from the moving present and location of the light source. Source: Seth Riskin.



Figures 4.5 and 4.6, from top to bottom: Linked space, time and form open in perception, clearly of a different order than the space and time of the “host” environment. Source: Seth Riskin.



Figures 4.7 and 4.8, from top to bottom: With movement, the original, two-dimensional circle expands into a spatiotemporal structure in perception. Perceptually-integrated changes (transformations) articulate higher-order geometries in the minds of the viewers and performer. Source: Seth Riskin.



Figures 4.9 and 4.10, from top to bottom: Structure and rules of the perceptual spacetime defined by the brightness begin to reveal themselves, e.g., the cylinders grow in size and speed with distance from the body. Source: Seth Riskin.



Figure 4.11: Global characteristics of the spatiotemporal brightness-structure in perception: continual unfolding from the moving present and location of the point source on the performer's body; radial geometry, originating from and referring back to the source. Source: Seth Riskin.



Figure 4.12: The Light Dance elemental unit of brightness, in this case a circle, plays the role of a concentric, circular slice of the projected receptive field, if it, and not the material environment, were visible. Source: Seth Riskin.



Figure 4.13: Light Dance geometry shows us the slice of the “cone of vision” as it is cut by the material architecture. This concept accounts for the transformations. They are cross sections of the slice of the “cone of vision”, extending and moving from the body and intersecting the material architecture in a sequence of angles and distances. Source: Seth Riskin.



Figure 4.14: The circle smears into a curved sheet, a two-dimensional manifold experienced in three-dimensional perceptual space. Source: Seth Riskin.

In the first instance of the Light Dance performance (Figure 4.1), the circle is experienced as simply two-dimensional brightness. It has width and height, but no depth. The spacetime of

physical light has collapsed to low-dimensional brightness. With movement, the circle smears into a curved sheet. We begin to see spatiotemporal development. As it moves, the circle continuously changes in size, shape, acceleration, direction, and brightness intensity. A sheet of complex curvature generates in perception. Through such transformations (seen across Figures 4.2 to 4.14), the circle gives rise in perception to all manner of smooth-transition, curved surfaces, two-dimensional manifolds that include some bright points of tight transition—"singularities." (See Figure 4.15).



Figure 4.15: The performer sweeps out two-dimensional manifolds with bright points of tight transition—"singularities." Source: Seth Riskin.

Experience with the manifolds defines the global, three-dimensional perceptual space within

which they operate. Manifolds taken together in view become volumetric brightness structures. The brightness structure has an overall radial geometry that refers to the point origin on the body. We realize the brightness structure as a temporal expression of the circle-slice of the projected receptive field of vision. In other words, the global brightness structure is a time-trace of the “cone of vision”, geometrically reduced to the concentric conic shell seen in cross section as a circle.



Figure 4.16: Time-trace of the cone of vision. The circle-slice of the projected receptive field sweeps radially in a visible “seeing process” that embodies time in its global structure, evidenced by spacetime transformations, such as the shadow of the arm, elongated. Source: Seth Riskin.

The overall brightness geometry is seen from perspectives of the performer, viewer and light source. (See Figure 4.16). A global understanding of the Light Dance event comes into view: We collectively experience the dimensional development of the visible receptive field from a low-dimensional figure, the circle, to a multidimensional geometry. The circular slice of the projected receptive field is expressed as a volume in visual space *over time*. The conic volume concentrically cut from the “cone of vision” sweeps through the environment in a seeing process made visible, viewers and performer taking perspectives. The perspective of the light source on the circle, however, never changes. Relative to the light source, here equal to the eye, the receptive field remains fixed. The transformations and dimensionality of the brightness geometry seen by viewers and the performer diminish with increasing proximity to the light source to zero at the source. (See Figures 4.17 and 4.18).

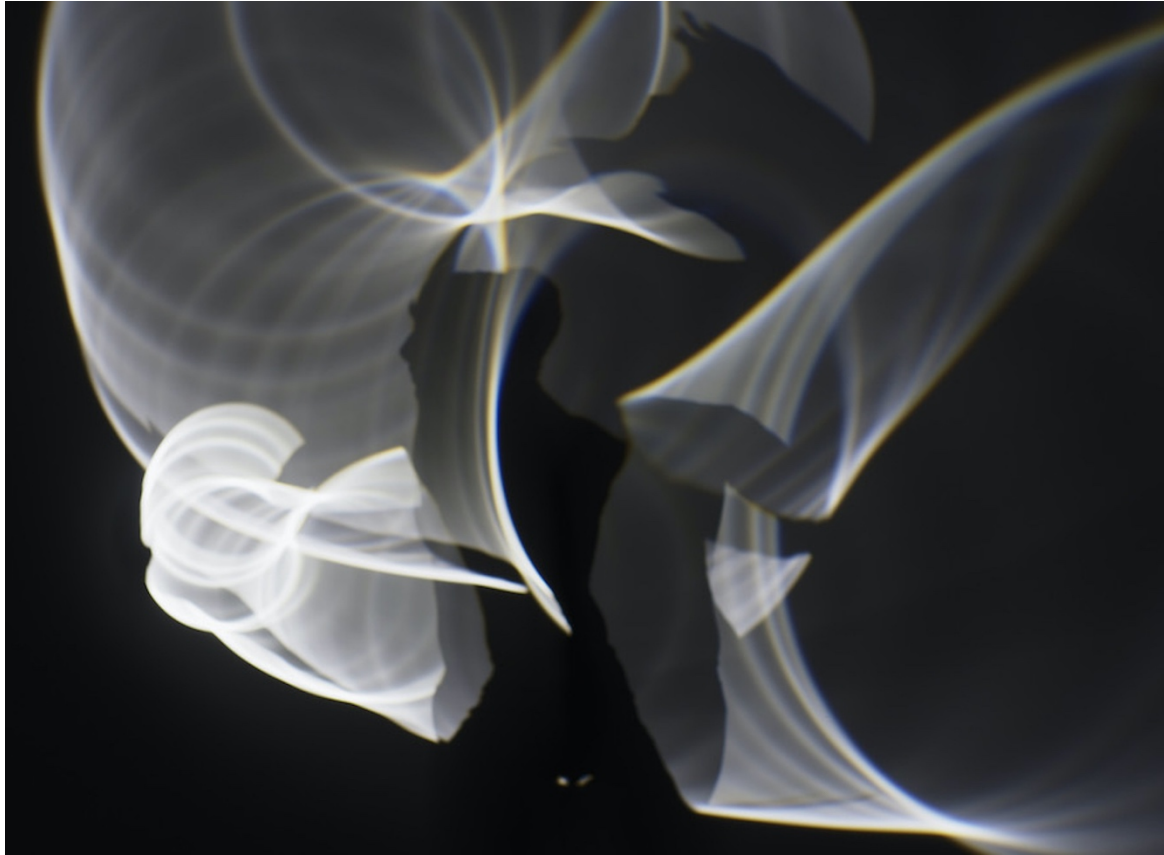


Figure 4.17: What it is like to see: a process of constant unfolding in the present about a locus of movement. My body is the center of an envelope, the shape of which is constant, the patterns of which change. Patterns flow through the present, located around me, making an envelope of early information. Source: Seth Riskin.



Figure 4.18: Light Dance demonstrates a principle of equivalence between vision and light. The projection, here the circle, is equal to a geometrically elemental portion of the projected receptive field, which, in itself, has no spatiotemporal information, rather is the receptive field of changing patterns of visual information from which perceptual spacetime is constructed. For the viewers and performer, the changing bright/dark patterns perceptually construct/are experienced as time-based volumes in visual space. The “cone of vision” sweeps through the environment in a seeing process made visible. Source: Seth Riskin.

4.3 Conclusion

Through precise, artistic work with light incorporating multiple inversions relative to the accustomed, hierarchical concept of light and vision, Light Dance re-presents elements of visual processing to perception. We are perceptually reminded of the moving present from which space and time construct; that multidimensionality is a process of synthesis across low-dimensional

views; that spacetime is curved, originating from and referring back to the point of origin; that the concreteness and extensivity of the visual world relies on cognitive integration, is a function of mind; that “light” and “vision” are two levels, conceptual and perceptual, of the same abstraction. “Light” is the invisible counterpart of physical spacetime, just as the “projected receptive field” is the invisible counterpart of visual spacetime. Through Light Dance experience it is recognized that the light geometry, familiar to the eye by the illuminated material environment, and the geometry of the projected receptive field are inversely ordered relative to the material ensemble, indicating their complementarity and continuity through a principle of equivalence.

Light Dance circumvents conceptual abstractions for perceptual experiences. It is the intention of the Light Dance work to bring the perceptual experiences in their foundational order back into productive reengagement with the conceptual abstractions, e.g., of “light” and “vision.” Building that bridge between the Light Dance perceptual experiences and conceptual formulation is the work of this dissertation. Based on the work achieved, the Conclusion identifies opportunities for further investigation. Specifically, the Conclusion looks at the current connection between visual art and vision neuroscience in historical context. Dissertation findings are used instrumentally toward advancing the conversation between visual art and vision neuroscience, from the current, one-way reduction to existing (neuroscience) knowledge, to collaborative generation of paradigmatically new knowledge, e.g., recasting the inverse optics problem.

CONCLUSION

Overview of Purpose

The purpose of this thesis is to contribute to theoretical knowledge by methodically and faithfully developing thought out of the practice of the Light Dance art form. Implicit in this work is the premise that the artwork, foremost the perceptual experiences it affords, contains new knowledge. Light Dance uses original technologies and methods for working with optical light to generate percepts that may be described as “early”: bright/dark edges, patterns, and pattern changes. Light Dance does this environmentally in performance with geometrically elemental light forms projecting from the artist’s body, articulated through his body movements. By constricting and casting a rudimentary element of the spherically propagating light, the performer makes visible radial and expanding structures that construct space and time in perception. Through this performance, Light Dance uses light to turn inside-out the seeing process, priming the visual mind to recognize a principle of equivalence linking light and vision. The purpose is to create perceptual experiences *prior* to high-level, conceptual abstractions that consistently and unconsciously impose upon, occlude visual perception, so called “top-down” influences. Light Dance thus endeavors to realize collective experiences of early visual processing, reflexively through light. If the light artwork of James Turrell affords “perceiving perception,” Light Dance affords perceiving perceptual construction, from early percepts such as bright/dark boundaries and low-dimensional patterns, to higher-dimensional structures incorporating perceptual space and time.

Below, I will summarize the methods and key findings of the chapters and then overview the contributions of the work. The final sections, titled “Contributions to New Knowledge, Part I” and “Contributions to New Knowledge, Part II,” will consider implications of the findings towards new knowledge in both future art practice and experiential research.

Research Questions and Summary of Findings

In pursuing the dissertation, the following research questions were posed:

1. Does art focused on visual perception work within the same knowledge paradigm as vision science, or can a case be made for experiential research in the manner of visual art leading to fundamentally new discoveries?
2. Visual art that takes optical light as a medium, Light Art, represents an area of inquiry where subjective method and objective phenomenon intersect. In this connection, is there anything to be learned from the history of Light Art? Does it evidence the prevailing distinction between subjective vision and objective light, or may evidence be found for an integrative approach?
3. What does Light Dance offer to this line of inquiry? Can Light Dance and relevant elements of history of the Light Art genre mutually inform experiential research of vision/light? Can Light Dance techniques be used to generate specific evidence of a new model of relationship between light and vision, specifically a principle of equivalence?

An account of the practice-based method executed in the foregoing dissertation is as follows.

Chapter 1 collects and builds upon primary thinking from Light Dance experiences, working from select notebook writings and drawings. Four postulates are developed, leading to a thesis concept. In Chapter 2, Light Dance equipment and methods are used in a series of experiments that test the postulates. The experiments are photographically documented and analyzed against the thesis claims. Chapter 3 takes insights from the Light Dance thesis into a study of the light art genre through select precedents of the Light Dance art form. This chapter builds art-historical context around the Light Dance artwork and thought and strengthens principal ideas of the thesis by example. A return to Light Dance imagery in Chapter 4 allows the claims underpinning the thesis to be visually explicated through the artwork, using a detailed series of photographs from a single performance.

I will now elaborate on the specific findings of each chapter.

Chapter 1 begins with a consideration of Light Dance as a reflexive study of vision. This inversion, framing artistic work with light as a firsthand vision study, signals the mindset and method of the artwork that will be carried through the thesis. The chapter proceeds to study the early perceptual experiences of the Light Dance event as captured in notebook entries, shaping the resident ideas into postulates:

Postulate 1: The experience of the elemental, geometric unit of light in Light Dance, e.g., a one-dimensional line in surrounding darkness, is otherwise spatially and temporally ambiguous, and therefore experienced as coincident with the viewer.

Postulate 2: Movement of the unit of brightness defines spatiotemporal structures in perception.

Postulate 3: The spatial and temporal order described by the unfolding unit of brightness in perception is the inverse of our ordinary visual perspective.

Postulate 4: The Light Dance elemental unit of brightness—spatiotemporally constricted, originating from the body, moved to acquire information—plays the role of a projected slice of the total receptive field, if it, and not the material environment, were visible.

This series of claims sets the arc of the work that follows. The claims begin with the fundamental Light Dance recognition of the perceptual equivalence of light and brightness sensation. Holding this experiential equivalence, further observations of the Light Dance event identify the perceptual construction of spatial and temporal dimensions through movement of the projected unit of brightness. Geometric features of the brightness structure unfolded in perception in the Light Dance experience are identified. The structure and rules of the unfolding brightness in Light Dance correspond with an according slice of the total receptive field extended into a volume of space over time. This sequence leads to the thesis statement: What we call “light” is

the cognitive projection of vision and therefore, inversely, what we call “vision” is preconceptual light.

This conception effectively sets physical light and visual experience into functional symmetry: one gives rise to the other in an expanded thought paradigm that drives, as it reflects, the Light Dance artwork.

Chapter 2 opens with a summation of the theoretical progress made in Chapter 1:

What we call ‘light’ does not exist in visual experience; the two—light and visual experience—do not exist simultaneously. Rather, in visual experience, ‘light’ is ‘brightness’, a sensation that has no spatial or temporal measure of its own, and is so defined only with reference to surrounding visual context. (Chapter 2, p. 101)

This statement orients and motivates toward experiments that test and detail the experiences borne of the Light Dance practice. Following the sequence of the postulates, the experiments proceed by way of the Light Dance method, eliminating ambient light and perceptual cues, and utilizing technology to project and manipulate elemental geometric units of light, a line or cross figure. Experiments are designed, mounted and refined. In these sessions, hundreds of photographs are produced. Select images and image series are chosen for study, annotation, testing and refinement of the postulates and the thesis concept. The experiment images visually explicate numerous aspects of the Light Dance phenomena and perceptual effects, in relation—often contradistinction—to the visual environment under ordinary ambient illumination. The experiments expand and detail the twofold, artistic approach to light stated at the outset of the dissertation: light conceived as a physical phenomenon separate from the perceiving subject and light perceived as a reflexive experience of vision.

Setting up Chapter 3 is a two-part question: can the twofold approach to light be detected in Light Art works and thought, and can according analysis of Light Dance precedents—artworks/related concepts—contextualize and inform the thesis argument?

Through the lens of the twofold artistic approach, *about* light and *through* light to reflexive experience of vision, Chapter 3 examines thought and practice in the Light Art genre. The Chapter begins by exploring thought about Light Art: Kepes, Sharp, Weibel, Lippard, among others. It then proceeds to examine Thomas Wilfred's *Lumia* art form as "well situated at the outset of the light art tradition and between traditional and technological media, abstraction and representation, pictorial and optical light, and "material" and "spiritual" purviews" (Chapter 3, pp. 154-155). *Lumia* manifestly demonstrates the dichotomy that runs through light art: "a profound disconnect between experience and thought" that frames the problem and opportunity of the Light Dance thesis.

Chapter 3 then proceeds to study precedent artworks and related concepts: *Light-Space Modulator* by László Moholy-Nagy and his concept of "Vision-in-Motion"; *Light Ballet* by Otto Piene and his concept of "Purity of Light" and three works by James Turrell: *Afrum I (White)*, *Prado (White)*, and *Perfectly Clear (Ganzfeld)* and his concept of "Perceiving Perception." These three studies serve to identify a tendency in Light Art that works toward the reflexive study of vision by application of light, therefore informing Light Dance practice and contributing to an inverse model of vision and light. These precedent artworks/concepts frame and inform Light Dance as part of a tradition that, in form, method, perception and thought, drive toward the

fundamental ambiguity of light and vision, showing how one converts to the other in experience, how one is embedded in the other in concept.

Chapter 4 collects and recites the chief claims of the thesis as prelude to correlating concepts with Light Dance visual evidence. The claims progress from perceptual observations to concepts, adhering to the purpose and method of the Light Dance thesis: “The dissertation is organized around the goal of drawing thought from perceptually rudimentary Light Dance experiences and building theoretical framework upon art perception.” The final chapter ties percepts and concepts, visual and verbal content for the most complete and cogent presentation of the thesis argument.

Using a detailed Light Dance image series from a single performance, *Circles*, that features fine circles of white light cast from the wrists, the thesis claims are correlated with visual evidence from the Light Dance performance. Chapter 4 concludes: “Through Light Dance experience it is recognized that the familiar visual perspective geometry and the geometry of the projected receptive field (a slice made visible in Light Dance) are inversely ordered relative to the material ensemble, indicating their equivalence.”

Chapter 4 establishes the position that one and the same light may be looked at or through; light may serve a dualistic paradigm based upon the fundamental separation of the perceiving subject and the physical phenomenon, and/or light may be applied to generating experiences within a unitary paradigm wherein the phenomenon we call “light” is recognized as a conceptually distant abstraction of a perceptually local visual process. The primary function of the Light Dance

artwork is to realize at the perceptual level collective experience of the equivalence of light and vision. This perceptual experience motivates and guides conceptual development, the effort of this dissertation.

In the next section, I will trace an historical thread: the use of science to explain art, informing the character of the contemporary connection between visual art and vision neuroscience and the countervailing potential Light Dance holds for expanding the relationship to a true collaboration, generating new knowledge between fields.

New Vision: Reimagining the Conversation between Visual Art and Vision Neuroscience

At M.I.T. several years ago I began a dialogue with vision neuroscientists that continues as collaboration and co-teaching. The foundation of common interests remains the insights provoked by two angles and methods on the study of vision. Visual art and vision neuroscience both penetrate to “early visual processing,” divergently and convergently reflected in scientific models and artworks. The idea that art can reflect structure and functions of the brain is not new. The “beholder’s involvement,” the viewer’s psychological completion of the artwork, goes at least as far back as the work of the art historian Alois Riegl, whose work was built upon by Ernst Kris and Ernst Gombrich (who adjusted the term to “Beholder’s Share”), as described by neuroscientist Eric Kandel (2012, p. 192): “Thus just as the artist creates a work of art, so the viewer re-creates it by responding to its inherent ambiguity.” Art historians adapted contemporaneous psychology to art criticism to better address questions of visual perception. The effort to give art criticism psychological basis and, the later psychology of art, scientific

basis, is pronouncedly reflected in the work of the art theorist Rudolf Arnheim. Arnheim studied with Max Wertheimer and Wolfgang Köhler, founders, with Kurt Koffka, of Gestalt psychology. *Art and Visual Perception: A Psychology of the Creative Eye* (1954), considered Arnheim's magnum opus and a cornerstone in the field, shaped art history and psychology, especially in the United States. The basic premise of Arnheim's approach: visual process in the creation, or viewing, of artworks accords with definite psychological laws. Arnheim worked, through his career, from notional ideas to discrete principles, as the psychology of art advanced with input from adjacent fields such as cognitive psychology. In the preface of the 1974 new version of *Art and Visual Perception*, Arnheim states a lead objective for the update: "...I endeavor to show that the tendency toward the simplest structure, the development by stages of differentiation, the dynamic character of percepts, and other fundamentals apply to each and every visual phenomenon" (pp. ix-x). Arnheim's aim reflects both the character of his past efforts and that of future efforts, drawing from science to understand art.

Arnheim's "tendency toward simplest structure" is reflected in *Kandel's Reductionism in Art and Brain Science: Bridging the Two Cultures* (2016). Kandel (p. 5) sees "reductionism" as applicable to both artistic abstraction and science—different aims, but "analogous," forming the basis of his study: "Thus scientific reductionism can be applied to the perception of a single line, a complex scene, or a work of art that evokes powerful feelings."

Neuroscience exemplifies reduction, with tools and questions aimed at the structures and functions of single cells of the brain. In the 1950s, Stephen Kuffler correlated movements of a light point over the receptive fields of retinal cells and found they responded specifically to

luminance contrast, or edges. David Hubel's invention of a tungsten microelectrode for detecting single-unit neuronal electrical activity led to discovery, with his collaborator Thorsten Wiesel, that neurons of the visual cortex of a cat respond to linear luminance contrast and its orientations and directions of movement, presumably tuned to detect luminance edges and oriented structure in the environment.

Hubel and Wiesel mapped the receptive fields in visual centers of feline and primate subjects, revealing columns of cells, striate architecture, in the visual cortex, linking anatomical structure and function. This work opened the concept that neuronal sequence over a few synapses, retina to cortex and within cortex, could represent stages of visual processing. "They showed how the pointillism of the retina is transformed into the orientation sensitivity in cortex" (Wurtz, 2009, 2819).

Spatial contrast structure of receptive fields provided David Marr and Ellen Hildreth (1980, pp. 187-217) a primary vehicle for new computational models of visual processing and algorithmic design in the late 1960s and 1970s. In recent decades, technologies such as magnetic resonance imaging of the brain have increased momentum of correlative discoveries between brain structure/functions and features of the physical world, e.g. "edges."¹ This and many other details of cellular decoding of luminance and color patterns on the retinae have revealed to vision scientists that artworks (chiefly drawings and paintings) can be reflections of early visual processing, e.g., line considered an artistic "invention" reflecting and effecting edge detection.

¹ See Szymkowicz et al. (2017): "they help to reduce the amount of data that needs to be processed via filtering out irrelevant information and preserving necessary structural elements of the image."

Over the past two decades, the trend of vision neuroscience research into, and communication about, visual art has grown.

I've gone to some length describing efforts to draw from science to think about art, as well as neuroscience developments that have intensified the trend, as background to the current "conversation" between visual art and vision neuroscience that bears upon the situation and significance of this dissertation. The "conversation" is largely a one-way affair that characterizes artists as working in the neuroscientist's territory, introspectively and naively coming to corroborating evidence. Generally, art practice and works are interpreted within, or reduced to, science:

Semir Zeki (2001, p. 51): "Visual art ... obeys the laws of the visual brain, and thus reveals these laws to us."

Patrick Cavanagh (2005, p. 301): "In discovering these shortcuts [deviations from true physics] artists act as research neuroscientists... Art in this sense is a type of found science — science we can do simply by looking."

Eric Kandel (2016, p. 7): "The new, biological science of mind aspires to a deeper understanding of ourselves by creating a bridge from brain science to art... If successful, this endeavor will help us understand better how we respond to, and perhaps even create, works of art."

Artists have been line-drawing for a long time. “Paintings and drawings are a 40,000-year record of experiments in visual neuroscience, exploring how depth and structure can best be conveyed in an artificial medium. [...] We can look at their work to find a naive physics that uncovers deep and ancient insights into the workings of our brain,” says Patrick Cavanagh (2005, p. 306). I think he is half right. Artistic practice does penetrate deep into the workings of the brain, manifesting evidence in the form of artworks. However, art is art, not neuroscience. The methods, manner of insights, the motivating principles and the paradigmatic order of knowledge expressed through art need fuller comprehension, articulation and connection with the knowledge of adjacent fields. Contemporary research methods and technological means have made this prospect both more immediate and distant—immediate for the available information and shifting/dissolving disciplinary boundaries; distant, because the success, momentum and mindset of the specializations are strong and tend to frame, and therefore limit, art. Yet if Cavanagh is suggesting that, by newfound awareness and evidence, art and neuroscience may jointly, with mutual growth, fill the space of unknown that lies between them with knowledge, I avidly agree.

To consider how visual art and vision neuroscience might collaborate and Light Dance’s role, I want to return to Alva Noë, a philosopher of mind, whose research and teaching focus on perception, consciousness and the philosophy of art. He opens his book *Strange Tools* (2015, p. xi) by recounting his words to an artist concerning the key question of the science of visual perception: “How do we see so much on the basis of so little [the paucity of retinal information]?” The artist responds: That’s not the question we should ask. [...] Why are we so blind, why do we see so little, when there is so much around us to see?”

Noë (2015, p. xi-xii) reflects:

The artist was right.” Science and philosophy, to the extent that they concern themselves with art, tend to do so from on high. They seek to explain art, to treat art as a phenomenon to be analyzed. Maybe we’ve been overlooking the possibility that art can be our teacher, or at least our collaborator. Not because art is cryptoscience, but because it is its own source of knowledge.

Strange Tools focuses on this possibility and its significance: “What is the character of this new knowledge? What can it contribute to our understanding of the world and ourselves?” Elsewhere, Noë (2004) has advanced the understanding of perception as “enactive,” not as something that happens in our brains, but something we do, make, or achieve. We can fail to see, and, equally, we can cultivate greater seeing. Art can be practice and product of greater seeing. Art may therefore be in a position to introduce not only new evidence, but new knowledge and, implicitly, new ways of interpreting knowledge, to fields such as science and philosophy.

Light Dance has long been methodically developed as an artistic experiment in seeing by cultivating techniques and technologies and the intellectual environment/interdisciplinary exchange around the work. This dissertation has sought to go deeper into the practice-based thinking process, precisely because I see that, while neuroscience informs art, the artist’s voice, interpretation of knowledge embodied in the artwork, is all but absent. The discussion between art and neuroscience, from research to popular literature, is conducted as if the neuroscience findings are physical facts, instead of what they are: points of departure for evolving interpretation.

In my experience, artistic practice originates, engages, evidences a distinct approach to the study of vision, one from *within* the experience, which may be considered the inverse of reduction. If visual art expression is similar to vision neuroscience evidence, it is an opportunity for symmetrical expansion of knowledge and not subordination of the art. In Chapter 3, I explored linked visual and conceptual expressions of direct precedents of the Light Dance art form as prototypal thought/practice. Art *is* a form of thought manifest, not in the sense of material expression, but manifestation of a state of *physical/perceptual oneness* that, in my view, is intrinsic to perceptual experience and, in its study, ineluctable.

Light Dance originates in, and expresses, the *bodily* experience of seeing, what it *is* to see, not what we think about seeing. What it is like to see: a process of constant unfolding in the present about a locus of movement. My body is the center of an envelope, the shape of which is constant, the patterns of which change. Patterns flow through the present, located around me, making an envelope of early information. Space and time construct around the center, issuing from the continual present. Earliest time and space experience coincide with the locus of my self-experience. I am the origin of space and time that construct away from the present and place of my experience. Space and time are not something I see but are generated from the seeing. The seeing experience itself is continually, firstly, spatially and temporally immediate, located at the “me-experience/center.” From the center’s local, simple information, what we see grows more spatiotemporally complex and extensively “away” as percepts are integrated into concepts that layer into and inform early visual processing. Against the present, local experiential order of seeing, the cognitive structuring of space and time across local “memories” of the eye becomes clear. In the seeing experience—radial order issuing from the central perceiver—there is no

“light,” but as a distant concept constructed upon a chain of experiences that spatiotemporally extend the world-in-mind beyond the curvature of its immediate experience until that perceiver-origin becomes a point in a vast, autonomous world of distant origin that originates “light” in its essential function of connecting widely separated things, including the viewer, and causing vision. In “light” we are dealing with the conceptually distant abstraction of a perceptually local/immediate visual sensation. Spacetime is in-between and can be looked at as both curved and coming from the seeing and/or independently existing, extensive, containing and causing the seeing.

Contributions to New Knowledge, Part I: The View from Light Dance on the Inverse Optics Problem

The above text represents thinking *from*, not about, seeing, as relevant to Light Dance practice and this dissertation. In this work I have developed evidence and thought from the Light Dance practice, itself a form of thinking from seeing. It has led to the thesis concept of equivalence between “light” and “vision,” bifurcated in two abstractions at perceptual and conceptual levels.

We are now in a position to answer the third and final set of research questions: “Can Light Dance and elements of history of the Light Art genre mutually inform experiential research of vision/light? Can Light Dance techniques be used to generate specific evidence for an integrated vision/light model?” In “light” and “vision,” I believe we are dealing with two perspectives on a single order divided as “physical” and “experiential.” These are associated with, and ultimately distinguished by, inversely proportional spacetime structures. As seen in Light Dance, experiential order spatially and temporally continually unfolds from the location of the viewer in

a geometry that references the perceiver. It can be seen from this perspective that further distance is not seen in terms of reception of information but constructs and extends in the mind *as concept*. In this order, “visual space” (visual perspective geometry) is primary and generative of “physical-space” concept. ” In contrast, physical order (the accustomed concept) is considered independently existing and spatiotemporally extensive, surrounding and situating the viewer at the end of the causal chain of “light.” Physical order is the accustomed space of Euclidean measure within which the viewer is considered to see visual space by the “distorting” function of the receiving eye within a field of rectilinearly propagating light.

In view of these two paradigms, it may now be seen that “visual perspective” actually represents two different orders: material structure seen by way of light and “light” (the projected receptive field) seen by way of material. The inversions of the Light Dance method show the eye the conceptual ambiguity of light/brightness in the spatiotemporally extended form of “visual space.” Visual Space, like “light” and “brightness,” is conceptually bistable, applies to two conceptual structures, perceptual and physical.

I intend that this Light Dance dissertation reveals character of method and knowledge intrinsic to visual art by example. Light Dance knowledge of the light/vision relationship is foundationally and paradigmatically complementary to existing analytical models. Problems of light/vision go to the origin of not only western science but western thought itself. Analytical methods have brought great progress, of course, but at what expense? At question concerning method is not whether the right path, but whether the whole picture. Knowledge left behind perhaps equals knowledge gained; the count depends on the concern.

The inverse optics problem from the study of vision provides a lens on the character and potential of the new knowledge produced by Light Dance. “Inverse optics” implies 1. a causal chain, light information to vision, and therefore 2. the necessity of the brain’s reverse modeling. Retinal images are fundamentally ambiguous relative to their physical causes. For any given pattern on the retina, the number of possible causes is infinite; object size, distance, orientation conflate in the 2D retinal image.²

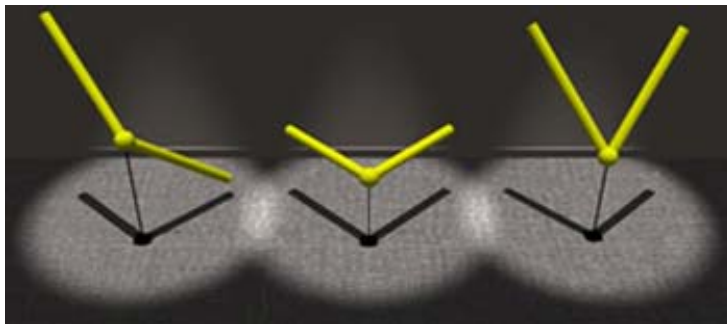


Figure 5.1: A given angle projected on the retina may come from various objects at various angles, of varying lengths, and with varying orientations in space. Source: Purves et al. (2001).

The problem and attempted solutions have a significant history at the core of vision science (Pizlo, 2001). Although widely accepted today that visual perception is constructive, the prevalent conception of the generative function of vision does not violate the light/vision causal chain, thus, the inverse optics problem: How does the eye fill the information gap with such demonstrated accuracy and consistency? The problem remains intact and intractable. For example, applications of Bayesian probability to the computational problem of constructing 3D from 2D have not answered how the brain achieves consistent, accurate interpretations. Pizlo

² In addition to Figure 5.1, see Purves et al. (2001).

(2001, p. 3159): “We are still far from understanding the nature of the processes that allow our precepts to be veridical.”

The fundamental Light Dance experience of light/brightness equivalence subverts the conventional, hierarchical concept of light and vision. In the perceptually primitive environment of Light Dance, space and time are experienced to “collapse” as the object light is perceived as equal with brightness sensation and therefore coincident with the subject/observer. From here, perceptual spacetime develops as primary, revealing physical spacetime as derivative. Whereas visual space is ordinarily considered the subjective counterpart of the physical space of objects, in Light Dance, “physical space” concept holds a trace of perceptual construction and therefore “owes,” in some degree, to visual space. Does this offer any new light on the inverse optics problem?

The Light Dance experience of equivalence between light and brightness is also an experience of the constructive function that builds one-dimensional brightness into higher dimensional brightness structures. By examining the geometry and rules of the perceived Light Dance brightness structures, we see how low-dimension brightness extends into volumes of projected receptive field space, thereby extending the equivalence connection to the inversely proportional spacetime structures associated with light and brightness in the Light Dance experience. The Light Dance illumination inversion, seeing light via material surfaces, perceptually foregrounds perceptual construction. Light Dance is like a visual abstraction that lifts perceptual construction from the conceptual paradigm of inverse optics and lets us study it relatively free of high-level, cognitive models. In Light Dance, spatial dimensions are not experienced as strictly physical; they exist between memory and physicality. This allows us to see a tradeoff: Light Dance shows

the necessity of *seeing through* the perceptual construction of spatial dimensions *to have* the experience of solid, three-dimensional physical world; three-dimensionality in experience is achieved by the *transparency* of perceptual construction. By revealing this tradeoff, a kind of bistability between perceiving perceptual construction and perceiving the third dimension, Light Dance gives us perspective beyond the strict, one-way causal conception of inverse optics to imagine a two-way model of light and vision.

In the Light Dance experience, the visual world is not simply “there,” rather continually unfolds from the point of spatial origin and temporal present, the light source on the body. From a line of brightness, the Light Dance world dimensionally constructs in the mind. The fleeting, fluid world of perceptual construction is put before the eye. The geometry of that world extends, curved in inverse perspective order from the point of perceptual spacetime origin. The spatial dimensions and change (time) are comprised of brightness, i.e., sensation patterns/structures. Physical light is revealed as continuous with perceptual “light” or brightness; physical space and time are revealed as continuous with perceptual space and time.

Light Dance is a world inverted about the pivot of light/brightness. The physical-world experience is reduced to a single dimension from which the perceptual world expands with inverse spatial and temporal order. By showing the eye the spacetime constructive function of perception, lifting it from its ordinary entanglement in conceptual structures of physical-world experience, Light Dance reveals the physical-world experience as a world of past constructions. When the past constructions (perceptual contributions) are invisible to perception and the world is considered “there”, “solid”, the problem of vision is framed as one of reconstructing the world—the inverse optics problem in full force. In creating an experience of equivalence

between light and brightness, Light Dance lets us look beyond a strict dualistic and causal interpretation, to light/brightness interdependence and conceptual continuity.

Yet we must remember that in the Light Dance world, process and structure are inverted. The world continually unfolds from the spatial location and the temporal present of the brightness unit, e.g., line or circle. As the brightness is coincident with the viewer in experience, the viewer is source and center, and the world expands from that source radially. This world is the inverse of the physical; there are no “inverse optics,” rather a forward process of perceptual construction upon spatiotemporally evocative brightness sensations.

Contributions to New Knowledge, Part II: Visual Art, Vision Neuroscience and the Receptive Field

The general state of the conversation between visual art and vision neuroscience is such that neuroscience looks at line drawings and paintings up to mid-twentieth century for luminance and color effects corroborating, or indicating potential for, early visual processing theories. Through the conscious practice of vision, namely artistic practice, the artist is able to penetrate to early vision, and thus sees the world “primitively.” Light Dance offers an opposite account and the possibility of a fundamentally different conversation: the artist performs an epistemic inversion, sees the primacy of perception ahead of conceptual structures. Light Dance is a *vision-first world*. The Light Dance artist does not “read” the material world but sees through to underpinning perceptions. We are reminded of Galison’s “concrete abstraction,” the notion that artistic abstraction can penetrate into the truth of the physical, revealing underlying order. In this

view, Light Dance “abstractions” of light are specific to revealing fundamental, perceptual truths to the eye, while cutting through obscuring conceptual abstractions of “light” and “vision.”

From the beginning of this dissertation, I have distinguished between the physical events and perceptual events of Light Dance. I have sought to demonstrate and detail structure and dynamics of the Light Dance *experience* relative to those of the perceived physical event, revealing two orders intersecting at the conceptual bistability of “light” and “brightness” and associated spacetime structures. The Light Dance experience of brightness is simple, local, and originating from one-dimensional luminance contrast, a line of brightness. The Light Dance experience is movement-based, constantly unfolding in low-dimensional curved surfaces that incorporate both space and time. In its handling of physical light, Light Dance treats light as a unit of experience. Through changes of direction, speed, orientation, intensity and combinations of these, Light Dance sweeps out in perceptual experience curved and transforming planes—two-dimensional manifolds embedded in, and informing, three-dimensional perceptual space.

How does this serve as an example of Light Dance giving us a way to investigate vision in terms of what we know about light? Where in the knowledge of early visual processing is such spatiotemporal unfolding seen? The answer, I believe, is the concept of the receptive field extended into a spatiotemporal volume. Rather than ask how signal patterns add up to complex representations accurate to “physics,” the artist asks: what kind of a world do the discharge patterns construct? The answer should relate to what we see in Light Dance, where linear luminance contrast, moved at different orientations, directions, speeds, generates in perception two-dimensional manifolds that incorporate movement and therefore time; as spacetime percepts, the manifolds show not what we see, but *how we see*.

I will conclude this dissertation by drawing a few connections between the Light Dance experience and knowledge of receptive fields in the visual system. I do so as a sketch of the called-for conversation between visual art and vision neuroscience, a sketch that applies the Light Dance light/vision equivalence principle and therefore indicates a new kind of relatedness and resulting productivity between physical light and vision theories. Though, in common consideration, Light Dance works environmentally with optical light and receptive fields concern electrical discharge patterns across mutually antagonistic excitatory and inhibitory retinal regions, it may be considered that the Light Dance experience “collapses” to low-dimensional brightness patterns, effectively “discharge patterns” in perception.

The line of light in Light Dance is similar to the “slit” of light swept by Hubel and Wiesel (1959) in varied orientations, directions and speeds across a cat’s retina, either directly by ophthalmoscope or by way of a screen opposite the cat’s eye. In their groundbreaking experiments, Hubel and Wiesel found that figures of isolated and delimited luminance contrast, e.g., a thin bar of light, was an effective tool for exploring and mapping the anatomical and functional organization of receptive fields of the cat’s retina. “The form and size of the most effective light stimulus was given by the shape of a particular region. The forms of stimulus used in these studies were usually simple, consisting of slit-shaped spots of light and boundaries between light and darkness” (Hubel and Wiesel, 1959, p. 587). Hubel and Wiesel developed spatial maps of receptive fields. They moved light spots and lines across receptive fields, noted correlated cell-unit firing and thereby mapped receptive fields organization in single cells and cell hierarchies, e.g., “simple” to “complex.” By such method they discovered features such as

orientation tuning in single neurons and the functional organization of cells in columns in the primary visual cortex.

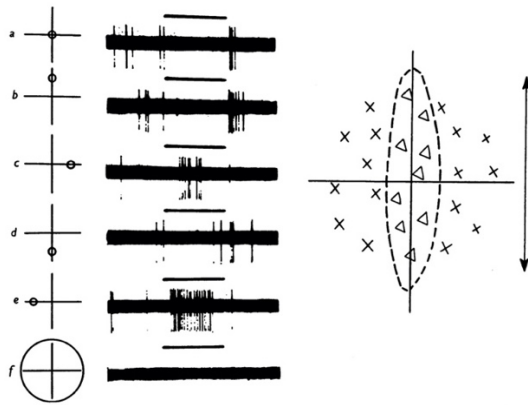


Figure 5.2: Responses of a cell in the cat's striate cortex to a 1° spot of light. At left, the field location of the spot and electrical responses; at right, the complete map showing areas of excitation (x) and inhibition (Δ). Source: Hubel and Wiesel, 1959, p. 577.

Stephen Kuffler's seminal contributions to the knowledge of vision and neural coding were advanced through Hubel and Wiesel's application of cellular techniques to the visual cortex, in turn, extended by information-rich models achieved through quantitative methods of receptive-field mapping that captured dynamic, or temporal, aspects. Where Kuffler, Hubel and Wiesel had studied how responses varied with size, shape, speed and contrast of stimuli, Robert Rodieck and Jonathan Stone (1965) quantitatively studied the spatial distribution of on- and off-influences on a cell *in relation to* how parts of the receptive field interact when stimulated simultaneously or sequentially. Such work led to the notion of integral spacetime in neuronal response.

The "spatiotemporal energy model" of Edward Adelson and James Bergen (1985) proposed *spatiotemporal orientation* as a means of motion-information extraction in low-level vision. The "spatiotemporal energy model" consists of a single pattern in $x-y-t$ space where motion velocity corresponds to three-dimensional orientation in the space. Change of the spatial phase as a

function of time is represented as receptive field slant along an oblique axis in spacetime: “In this space, a moving stimulus is one that is sheared in time, so that its representation is slanted. The problem of detecting motion is then entirely analogous to the problem of detecting orientation in space; the orientation exists in spacetime rather than just in space” (Adelson and Bergen, 1985, p. 296). This model encoding movement (time) in terms of space bears analogue with the Light Dance experience of manifolds incorporating movement in terms of space.

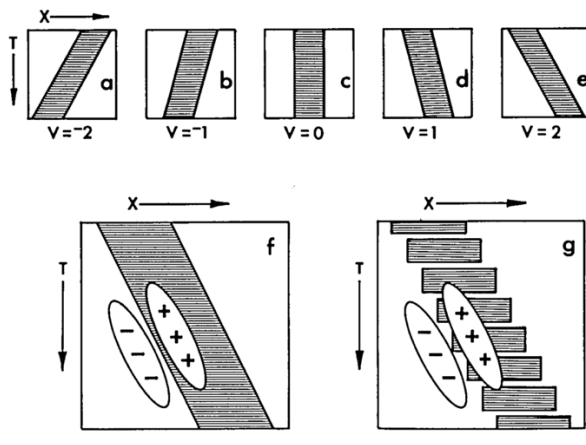


Figure 5.3: a-e: X-axis, time (x, t) plots of bars moving left or right at various speeds. f: Motion is like orientation in (x, t), and a spatiotemporally oriented receptive field can be used to detect it. g: The same oriented receptive field can respond to sampled motion just as it responds to continuous motion. Here, constant velocity plots as a straight line, while accelerated movement would result in a curved line. Source: Adelson and Bergen, 1985, p. 288.

While the concept of the receptive field as a spatiotemporal entity has been instrumental in advancing knowledge of receptive field function, it has also presented complex problems concerning visual processing (Ringach, 2004). How does the brain deal with the visual “distortions” (Concetta Morrone et al., 2010, p. 2) that spatiotemporal events entail, e.g., “...mislocalization of spatial position, misjudgements of temporal duration and order of stimuli presented...”? From the earliest mapping of receptive fields in mammalian retina, Stephen Kuffler (1953, p. 61) saw the “flexibility and fluidity of the discharge patterns” and the challenge of conceiving a model:

The most outstanding feature in the present analysis is the flexibility and fluidity of the discharge patterns arising in each receptive field.... Stability [...] disappears when one or more of several parameters, such as the adaptation level, stimulus intensity, and area of illumination, are changed singly or in combination. In the absence of a fixed pattern from the whole receptive field, it does not appear accurate enough to speak of “on,” “on-off” or “off” fibers in the cat’s retina.

“Sixty-five years later, we are still grappling with the difficulty of capturing concisely and completely how the visual world is encoded in the firing patterns of retinal ganglion cells” (Wienbar and Schwartz, 2018, p. 102). The inverse-optics approach characterizes the ongoing effort to relate the “distorted” discharge patterns to the “existent” visual world. “Both space and time are grossly distorted during saccades” (Cicchini and Burr, 2009, p. 13147). Here, the framing of the problem and hypothetical paths to solution implicitly portray a rigid, existent physical world within which the derivative vision process generates space and time “distortions,” the undoing of which must be part of processing. “If our perception of the world is to remain stable, the visual directions associated with retinal sites, and others they report to, must be updated to compensate for changes in the point of gaze” (Ross et al., 1997, p. 598). Physical space and time and early perceptual space and time are seen to be of different orders. How does the brain fill the gap from the receptive-field distortions to the consistently ordered visual world? The question may not require an answer so much as recasting, in view of developed conceptions of space and time originating from physical light theory.

“Spacetime” originates in physics with the work of Hermann Minkowski (1909) concerned with the geometric formulation of the special relativity theory. “Henceforth, space for itself, and time for itself shall completely reduce to a mere shadow, and only some sort of union of the two shall preserve independence” (Minkowski, 1909, p. 1).

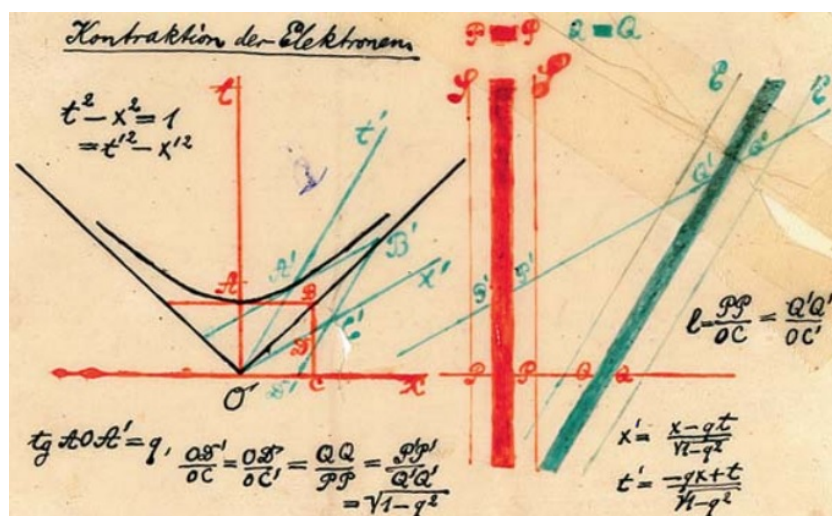


Figure 5.4: Geometric interpretation of spacetime. Source: Hand-colored transparency presented by Minkowski in his 1908 *Raum und Zeit* lecture.

In Albert Einstein's special relativity, space and time show inversely proportional transformations, length contractions and time dilations, as measured across reference frames, under the universal constant of the speed of light and the relativity postulate: all laws of physics are the same for all inertial reference frames. The spacetime continuum, and measurements within it that result in relative transformations of space and time across reference frames, follow from physical light theory, e.g., light speed constancy, rectilinear propagation. Relativistic spacetime/transformations and those of the spatiotemporal receptive field couldn't be further apart in the broad picture of our current understanding. Relativistic spacetime concerns physical entities at astronomical-scale space, time and speeds, while receptive-field spacetime concerns biological discharge patterns at single-cellular scale in the range of 100 milliseconds. Nevertheless, we have a situation where knowledge in these areas show similarities:

In conclusion, many complex perceptual localization phenomena have been predicted by a simple model that simulates the space-time transformations that occur in the receptive fields of many visual neurons at the time of saccades. This line of reasoning shares many analogies with the physical case where the observer and the phenomenon to be measured are in different inertial frames of reference that move at different velocities (Special Relativity) and the analogy may be useful to elucidate the phenomenon of perisaccadic distortion of visual perception. (Cicchini and Burr, 2009, p. 13156)

Beyond mechanical analogues, there exists no knowledge framework relating these two domains/scales of relativistic spacetime and receptive-field spacetime. We see here a potential point of connection between physical light theory/spacetime and knowledge of the spatiotemporal receptive field. While the analogues may be pursued at a procedural level, as in the work of Burr and others, there perhaps is something to be gained by exploring a theoretical model that would show these two vastly different spacetime realms as cognate. Here Light Dance practice/thought may contribute.

As a further suggestion of how Light Dance may connect to this general field of early vision spacetime study, I would like to point out the work of Joshua Tenenbaum (1997) on non-linear dimensionality reduction as a visual perception model. This work concerns an algorithmic approach to isometric reduction from a high-dimensional data set to a low-dimensional, but perceptually meaningful, structure such as a two-dimensional manifold. Views of a face provide an example. “The set of views of a face from all possible viewpoints is an extremely high-dimensional data set (...) The perceptually meaningful structure of these images, however, is of much lower dimensionality [i.e., a two-dimensional manifold]” (Tenenbaum, 1997, p. 682). Here, a set of images of a face from a single point of view lie on a two-dimensional manifold. “A perceptual system that discovers this manifold structure has learned a model of the appearance of this face that will support a wide range of recognition, classification, and imagery tasks [...] despite the absence of any prior physical knowledge about three-dimensional object geometry, surface texture, or illumination conditions” (Tenenbaum, 1997, p. 682). In other words, here we have a bottom-up, data-rich model that informs how early perceptual construction begins to fill the inverse-optics gap. Within the field, manifolds are considered fundamental to perception as a

bottom-up model for finding information-rich, low-dimensional structures hidden in high-dimensional observations (Tenenbaum et al., 2000, p. 2319). We see a correlation with the Light Dance method and experience that, from the opposite processing direction, reveals the function of two-dimensional manifolds as a link between early visual processing (brightness) and high-level concepts such as “light.”

Here again, we have an interesting parallel, in terms of spacetime, between an early visual perception processing model and Light Dance method and experience. Light Dance works with low-dimensional units of brightness and studies experiences of perceptual construction of higher-dimensional brightness structures, specifically two-dimensional manifolds embedded in three-dimensional perceptual space, on the way to “light” concept. These are generated out of the Light Dance units of brightness (geometrically-reduced, projected light originating from a point in space) interacting with complex material-surface geometries, producing two-dimensional manifolds. This is, in other words, “low-dimensional Euclidean embedding” (Tenenbaum 1997, p. 688). Based upon the thesis of equivalence between light and brightness (physical and biological) in the Light Dance experience, the Light Dance manifolds provide a projected window on receptive-field spacetime structuring. In context of the above examples posing parallels between physical and biological spacetime, the inversions of the Light Dance method make visible the possibility of a paradigmatically new model revealing physical and biological spacetime contiguity, shedding new light on the inverse optics problem.

“Through Light I See Vision”

I believe that knowledge of the physical world, and acutely knowledge of the interface between the physical world and human mind as represented in the study of vision, faces the necessity of turning physical fact to evidence of a subjective element in the context of objective knowledge. I phrase it this way because I believe it is not a matter of a new discovery, but seeing differently. This is the specific function of art in relation to fields such as neuroscience and physics. Light Dance works with light as a medium for the reflexive study of vision—it sees vision through light. This is the major, mental shift embodied in the practice and artworks. Light Dance does not look upon light as a physical phenomenon for study, but *through light* to the study of the visual experiences inherent in it. The effort to probe and refine these visual experiences for what they offer to this inverted knowledge results in the specific Light Dance techniques and equipment. Light Dance is specifically concerned with the application of light to the study of early perceptual spatial and temporal structures and transformations.

The mental shift embodied in the Light Dance experience allows us to see light for material, and then brightness for light. Seeing light, studying its qualities and changes, is to realize that, to some extent, one is looking at vision itself, and that the light can be refined and controlled to bring out increasingly more detail of vision. This is a critical element of what is evidenced in art, e.g., Light Art extending into the history of visual art. Light Dance reveals the principle upon which visual art reflects the visual brain, a fundamental equivalence of light and vision, exemplified by works of James Turrell, recognized and built upon through artistic methods for the purpose of presenting vision to itself and the knowledge resulting from this encounter. With this

mental shift that recognizes continuity, and therefore interconvertibility, between light and vision, knowledge of the physical and biological may be looked upon for how they form a whole.³ Thereby physical light can be understood as a function of vision and the theoretical model that structures knowledge of one can be applied to the other.

In the seeing experience there is no “light,” but as a distant concept constructed upon a chain of experiences that spatiotemporally extend the world-in-mind beyond the curvature of its immediate experience. My body is the center of an envelope, the shape of which is constant, the patterns of which change. Patterns flow through the present, an envelope of early information. Issuing from the continual present, space and time construct around the center, Earliest spacetime experience and my self-experience coincide. I am the origin of space and time that construct away from the present and place of my experience.

The world in space-time extension is constructed in concept upon the unknowing of light, and the greater the knowing of light as an object in that world, the more that knowing undermines the space-time extension and the distance between the observer and the object that is essential to the objectivity of the world.

³ “Our organs are not instruments; on the contrary, our instruments are added-on organs. Space is not what it was in the *Dioptrics*, a network of relations between objects such as would be seen by a third party, witnessing my vision, or by a geometer looking over it and reconstructing it from outside. It is, rather, a space reckoned starting from me as the null point or degree zero of spatiality. I do not see it according to its exterior envelope; I live it from the inside; I am immersed in it. After all, the world is around me, not in front of me. Light is found once more to be action at a distance. It is no longer reduced to the action of contact or, in other words, conceived as it might be by those who cannot see” (Merleau-Ponty, 1964, p. 138).

Light does not begin vision but completes it, a conceptual closing of the circle back to the point of origination. In this respect, light is the completion of a perceptual-construction process that relates the world back to the eye.

By examining the geometry and rules of the perceived Light Dance brightness structures, we see how low-dimension brightness equates with a slice of the total receptive field extended into a volume of space over time, thereby extending the original Light Dance equivalence experience of light/brightness to inversely proportional spacetime structures.

The phenomenon we call “light” is recognized as a conceptually distant abstraction of a perceptually local visual process. Through the Light Dance perceptual environment, we conceive equivalence between “vision” and “light” as abstractions, perceptual and conceptual, bifurcated from deeper, unitary order.

In the Light Dance experience, light in the physical world, and the receptive field projected into the perceptual world are superimposed, revealing to the eye that they play the same role, derived from “light” and “brightness,” a single entity experienced at perceptual and conceptual levels.

Light Dance recognizes in perception of light reflexive experience of vision, and therefore uses light to reveal the early visual process to itself, ultimately informing the nature of “light” in concept. As the artist works not with the material order, but light order, the world generated is spatially and temporally inverted, issuing dimensionally-simple and temporally local, before growing in spatial and temporal complexity *in mind*. Visual art shows us a world epistemically

inverted about light/vision; not vision derived from light information (inverse optics), but light phenomena as conceptual vestiges of visual processes. Vision is posed as a forward problem, relative to which physics is the inverse problem. This is the new knowledge we are posed to learn: *Light Dance gives us a way to think about and investigate vision in terms of what we know about light.*

APPENDIX I: GLOSSARY

Ambient illumination: Overall, diffuse illumination as opposed to articulated illumination of the Light Dance performance. After James Gibson: Reverberating flux of light in an environment brings about condition of illumination such that there is at any point ambient light, light coming to the point from all directions. See “full-field illumination.”

Ambiguity: Uncertainty in the experiential coordinates (orientation, size, shape) of light information. Makes reference to ambiguous 2D figures with two or more possible interpretations or figures such as the Necker cube that exhibit perceptual reversals in 3D orientation. The Light Dance thesis extends ambiguity into the conceptual realm, e.g., “light”/“brightness” interpretations and attendant conceptual structures.

Brightness structure: A perceptual structure based upon the Light Dance low-dimensional unit of brightness that, with movement, incorporates higher spatial and temporal dimensions.

Cognitive integration: The processing of perceptions into higher-order, mental constructions.

Concept: A complex structure ideated by cognition, generated by perceptions, and habituated through a given knowledge paradigm.

Cone of vision/Slice of the cone of vision: Refers to the eye’s total receptive field extended into a volume of space. In the Light Dance experience, light is equated with brightness and therefore the receptive field and therefore the Light Dance projections are experienced as geometric, linear

portions of the cone of vision, e.g., a bisecting plane seen as a line when it meets material surface.

Curvature (conceptual): Refers to (often unknown) subjective element in knowledge that “bends” the advance of knowledge toward the subject of the knowing. For example, in Light Dance, light is considered ultimately inseparable from the perceiving subject. Advancing knowledge of physical light will therefore reveal curvature with regard to its implication of the subject.

Direct perception: Of or pertaining to percepts relatively free of higher-level cognitive processes and influences. See “early vision.”

Early vision/early visual processing: Transduction of light into neuronal signals, fundamental proximal stimuli such as bright/dark boundaries and patterns, conscious or not. Our conscious access to early vision is perpetually occluded and/or mediated by higher-level cognitive functions, regardless of semantic construction.

Elemental unit of brightness: In the context of the Light Dance experience, a delimited, equiluminant, low-dimensional light figure, such as a line, that serves as the basis of the Light Dance experience. See too “unit of brightness.”

Epistemic inversion: Reversal achieved in the Light Dance experience of the basic coordinates of light and the function of perception. In Light Dance, “light” concept holds an element of

perceptual construction and therefore perception may be experienced as primary and constructive of “light.”

Epistemic paradigm: A conception of information flow and/or learning order. For example, western, post-Enlightenment conception of the relationship between external phenomena and inner experience that centers a perceiving subject capable of apprehending the world through information gleaned through sensory organs. In the context of vision, a model that holds seeing as apprehending light.

Equiluminant: Refers to a light field with equal-luminance value throughout, whether filling the visual field (see “ganzfeld”) or constricted, as in the Light Dance unit of brightness.

Equivalence/principle of equivalence: Coextensive, coterminous in structure. Used in context of the Light Dance experience to describe the mutually constitutive relationship between light and vision. Light Dance thesis: what we call “light” and what we call “vision” are in some degree equivalent and may be described by a unitary model.

Ganzfeld: A visual field of unstructured, uniform brightness resulting in hallucinations, reported since ancient times; associated with the studies of Wolfgang Metzger and Gestalt Psychology; associated with the equiluminant light fields of artist James Turrell.

Geometrically elemental: Of or pertaining to simple Euclidean structures. In the context of Light Dance, referring to the simplest geometric reductions of spherically propagating light, e. g.,

a radial line, a section of a diametral circle, or a spherical sector (cone).

Global spatiotemporal structure/global structure: With movement, the Light Dance unit of brightness constructs in perception a “brightness structure” that incorporates space and time. The overall view of this, whether in mind or photograph, is the “global spatiotemporal structure.”

Interconvertibility: Based on the Light Dance principle of equivalence between light and vision, the instance between them of “conceptual ambiguity,” that one can convert to the other, depending on conceptual interpretation.

Inverse optics problem: The question of how the brain fills the gap between retinal information and physical cause, based on the concept of vision deriving, in the first instance, from light information and therefore the necessity of the brain’s reverse modeling. Information on the retinae is coarse, two-dimensional and fragmentary. Size, orientation and distance conflate, making the mapping of retinal patterns to physical cause uncertain.

Inverse visual perspective: In the Light Dance experience, refers to the inversely proportional geometric order effected in perception by the movement of the unit of brightness, relative to ordinary visual perspective.

Inversion/inversions: Refers to the multiple ways that Light Dance reverses, or turns upside-down, the way light is used and is thought about. For example, the Light Dance illumination function of light is inverted relative to ordinary experience and thought: instead of using light to

illuminate material surfaces, Light Dance instruments shape light into tightly delimited figures, a line or circle, that themselves become visible through interaction with material surfaces.

Light construct: Refers to light stimulation of perceptual construction in context of the Light Dance experience, e.g., the movements of the units of brightness effect perceptions of space and time that constitute a “light construct.”

Light figure: Light shaped, bounded, and articulated as a low-dimensional object of perception in the Light Dance experience. The low-dimensional light figure can see further articulation with movement, e.g., as a two-dimensional light plane in perception or as a complex three-dimensional object or space (“light structure”) in the Light Dance experience.

Light form: Refers to the Light Dance experience of a higher-dimensional perceptual construction, a “form,” from the low-dimensional unit of brightness, e.g., line effecting in perception a two-dimensional manifold with complex curvature, a “light form.”

Light line: Light shaped, bounded, and articulated as a one-dimensional light figure in perception in the Light Dance experience, which through movement can see further articulation as a two-dimensional light plane; also used in the context of the experiments in Chapter 2 to evidence isolation of light as object of perception.

Light object: Light shaped and bounded such that it is visible upon interacting with material and appears in a darkened environment as an “object,” a self-contained (complete and separate)

“thing” in the world in perception. See too “light figure,” “light form,” “light structure,” and “object of perception.”

Light structure: In context of the Light Dance experience, perception of a higher-dimensional brightness that incorporates movement (time) and therefore is described in terms of spacetime. See too “light form,” “light figure,” “light object,” and “object of perception.”

Manifold: In context of the Light Dance experience, a two-dimensional surface that constructs in perception through movements of the one-dimensional unit of brightness. The manifold is experienced as a smoothly curving plane, occasionally with “singularities, points of tight curvature.

Material environment: Physical space, coordinates, and parameters as defined by material objects which in the accustomed epistemic paradigm are illuminated by light.

Objective: Used with reference to physical objects, phenomena or world-experience; used here to bring out assumptions that go beyond objectivity as a property of various aspects of science, specifically ontological independence with regard to the human perceiver.

Object of perception: A defined entity in perceptual experience. In the Light Dance experience, the use of light such that it is perceived as a figure or form that moves, changes size, shape, speed, etc., and in so doing, reveals characteristics such as spatial dimensionality.

One-dimensional brightness: A line of light, bearing, e.g., height, but no width or depth. In the Light Dance experience, a fundamental unit of the practice that, with movement, takes on higher dimensions in perception.

Opponency: Relative difference providing elemental distinction in early vision, here applied specifically to brightness/darkness, e.g., a bright/dark boundary or edge. Fundamental visual sensation relative to its absence; rudimental unit of early visual processing.

Ordinary visual perspective: The familiar structure and rules of material objects as appear in visual space as distinct from physical space. For example, objects appear to get smaller with distance toward the horizon.

Percept: Generally used to identify a basic, primitive (or “pre-conceptual”) element of perception, relatively free of higher-level cognitive influences. See also “direct perception” and “sensation.”

Perceptual collapse: Used in context of the Light Dance experience; when the Light Dance elemental unit, e.g., a line of brightness, it is experienced as a one-dimensional percept. The perceived unit has extension only along one axis. This percept in the context of the ordinary, three-dimensional visual scene appears as a dimensional “collapse.” The unit is perceived coincident with the perceiver, even as other objects in the dimly lit environment appear in depth.

Perceptual construction: Refers to the early, “bottom-up” visual process of building higher-

order percepts from sensory inputs; generally considered operating prior to cognitive influences.

In Light Dance, the perception of a two-dimensional plane of brightness from input of a line of brightness in movement is an example of perceptual construction.

Perceptual experience: Refers to visual experience at the level of perception, as free as possible from influences of higher-level concepts and cognitive processes. For example, visual art practice may cultivate the ability to see naively, or primitively, to consciously access early perceptual experiences. See also “direct perception”

Perceptual spacetime: In the Light Dance experience, the one-dimensional unit of brightness moves and transforms, eliciting higher-dimensional percepts—“brightness structures”—that incorporate time, and are therefore described in terms of spacetime. A connection is intentionally made here to the physics concept.

Physical space: The objective space of physical objects that is considered, at human scale and for practical purposes, Euclidean in its metric. We typically look through visual space and see physical space, i.e., we unwittingly do the transformations to get from visual space to physical space experience.

Receptive field/projected receptive field: Receptive field is a delimited area in a biological medium, e.g., a cell, where physiological stimuli can evoke sensory neuronal response. A visual receptive field may be considered as the volume of space comprising all the visual directions from which light will alter the firing of the cell. Therefore, “projected receptive field” is the

volume of space, the “cone of vision” of neuronal response as it constructs into multi-dimensional space.

Sensation: Denotes the eye’s response to sensory input, typically distinguished from conscious awareness. In the context of Light Dance, “sensation” is used to identify “raw” percept, e.g., of brightness sensation.

Spacetime: Used in referring to unification of dimensions of space and time, whether physical or perceptual.

Spatially and temporally ambiguous: Refers to dimensional ambiguity of brightness percepts. For example, the original unit of brightness in the Light Dance experience is perceptually defined in one dimension, but undefined, or ambiguous in other dimensions. The one-dimensional brightness is experienced as coincident with the perceiving subject as it indicates no depth.

Spatiotemporal construction: Refers to the perceptual construction of dimensional experiences in the Light Dance experience. For example, the Light Dance one-dimensional brightness is perceived to develop into higher spatial dimensions incorporating time, therefore described as “spacetime” or “spatiotemporal.”

Speed differential: Comparative difference in speed in perception.

Subjective: In the Western epistemic paradigm, that which refers to the inner experiences of the autonomous individual.

Transformation: Alterations in the attributes (shape, size, speed, luminance) of a light figure or unit of brightness in the Light Dance experience. For example, the line of brightness grows in length and speed as it moves. These are “transformations” relative to the original light figure/unit of brightness.

Transparency: refers to seeing through specific percepts or concepts. For example, in context of ordinary experience, we see through early percepts to concepts of invariant, physical objects. In Light Dance, we see through the habitually-invoked concept of physical light to relatively direct perceptions of low-dimensional brightness.

Unfolding: The self-articulation and spatiotemporal development of a unique pattern from a light figure or structure in Light Dance perception.

Unit of brightness: “Direct perception” experience of low-dimensional light projection, such as a line, in the Light Dance experience. See too “elemental unit of brightness.”

Vision structure: The implicit space that counterparts material objects in the ordinary visual perspective scene in perception; specifically used to describe the world experienced in the Light Dance event, one created in the perception of viewers and performer by the movement of the light projection from the body.

Visual perspective/visual perspective order: The structure and rules of visual space, i.e., space seen by the eye as opposed to the space of physical objects. Visual perspective is related to linear, or graphical, perspective, e.g., one-point perspective, vanishing point and the associated distortions (foreshortening, size diminution with increasing distance, etc.) of objects in the scene presumably due to the point reception of the eye within a field of rectilinearly propagating light.

Visual spacetime: An extension of “visual space.” Visual space is used to distinguish the structure and rules of objects and associated space as they appear to the eye as opposed to the physical space. “Visual spacetime” indicates that the dimension of time is incorporated into higher-dimensional spatial percepts such as a three-dimensional object, as multiple views, i.e., movement/time, must be perceptually integrated into the 3D percept.

SELECTED BIBLIOGRAPHY

Adelson, E. H. and Bergen, J. R. (1985). Spatiotemporal energy models for the perception of motion. *Journal of the Optical Society of America A*, 2 (2), 284-299.

Albright, T. D. (2012). On the Perception of Probable Thing: Neural Substrates of Associative Memory, Imagery and Perception. *Neuron Journal*, 74, 227-245.

Arnheim, R. (1974). *Art and Visual Perception: A Psychology of the Creative Eye*. Berkeley: University of California Press.

Boccioni, U. (1966). Technical Manifesto of Futurist Sculpture. In Frank Popper (Ed.), *Kunst Licht Kunst*. Stedelijk van Abbe Museum. (Original work published 1912).

Boehme, H. (1993). *The Philosophical Light and the Light of Art*. Parkette.

Borgen, M. (2017). Lumia and Postwar Art: Space, Time and Drama. In Keely Orgeman (Ed.), *Lumia: Thomas Wilfred and the Art of Light* (pp. 49-62). New Haven: Yale University Press.

Bridgman, P. W. (1927). *The Logic of Modern Physics*. London: MacMillan.

Burnham, J. (1968). *Beyond Modern Sculpture: The Effects of Science and Technology On The Sculpture Of This Century*. New York: George Braziller.

- Burr, D. and Morrone, C. (2006). Time Perception: Space-time in the brain. *Current Biology* 16(5), 171-173.
- Cavanagh, P. (2005). The Artist as Neuroscientist. *Nature*, 434, 301-307.
- Cicchini, B. & Burr, M. (2009). Spatiotemporal Distortions of Visual Perception at the Time of Saccades. *The Journal of Neuroscience* 29(42), 13147–13157.
- Clarke, A., Taylor, K., Devereux, B., Randall, B., and Tyler, L. (2013). From Perception to Conception: How Meaningful Objects Are Processed Over Time. *Cerebral Cortex*, 23(1): 187–197.
- Das, A. (2015). *Guide to Signals and Patterns in Image Processing: Foundations, Methods, Applications*. New York: Springer International.
- Delaney, B. (2018, January 25). Blinded by the light: James Turrell obliterates the senses in stunning new Mona wing. *The Guardian*.
- Felver, C. (Director). (1998). *Donald Judd's Marfa, Texas*. MVD Entertainment Group.
- Florensky, P. (2002). *Beyond Vision: Essays on the Perception of Art* (Wendy Salmond, Trans.). Ed. Nicoletta Misler. London: Reaktion Books.

Galison, P. (2013). Concrete Abstraction. In Leah Dickerman (Ed.), *Inventing Abstraction, 1910-1925: How A Radical Idea Changed Modern Art* (pp. 350-357). The Museum of Modern Art.

Gibson, J. (1978). The Ecological Approach to the Visual Perception of Pictures. *Leonardo* 11(3), 227-235.

Giménez, C. & Trotman, N. (2013). *James Turrell Early Works* [Exhibition Catalogue]. Exhibited at Guggenheim Museum.

Govan, M. (2013). Inner Light: The Radical Reality of James Turrell. In *James Turrell; A Retrospective* [Exhibition Catalogue]. Exhibited in Los Angeles County Museum of Art May 26 2013-April 6 2014.

Heidegger, M. (1996). *Being and Time*. (J. Stambaugh, Trans.). State University of New York Press. (Original work published 1927).

Hubel, D. & Wiesel, T. (1959). Receptive Fields of Single Neurones in the Cat's Striate Cortex. *Journal of Physiology*, 1(48), 574-591.

Irwin, R. (1998-1999). *Prologue: $x 18^3$ and Excursus: Homage to the Square*³ [Exhibition catalogue]. Exhibited at Dia Art April 12-June 14 1998 and September 13 1998-June 13 1999.

James, W. (1890). *The Principles of Psychology, Vol. II*. Dover.

Jewell, E. A. (1939, September). Of Space, Time and the Fine Arts: Contemporary American Painters at the Two Fairs. *The New York Times*.

Jones, J. (2010, November 17). Warning: Art that will blow your Mind. *The Guardian*.

Kandel, E. (2012). *Age of Insight: The Quest to Understand the Unconscious in Art, Mind, and Brain, from Vienna 1900 to the Present*. New York: Random House.

Kandel, E. (2016). *Reductionism in Brain Science and Art: Bridging the Two Cultures*. New York: Columbia University Press.

Kandinsky, W. (1947). *Point and Line to Plane: Contribution to the Analysis of the Pictorial Elements*. Solomon R. Guggenheim Foundation for the Museum of Non- Objective Painting. (Original work published 1926).

Kepes, G. (1967). Inaugural Catalogue. MIT Center for Advanced Visual Studies. Cambridge: The MIT Press.

Kepes, G. (1944). *Language of Vision*. Chicago: Paul Theobald.

Kepes, G. (1965). *Light as a Creative Medium* [Exhibition catalogue]. Exhibited at Carpenter Center for Visual Arts, Harvard University.

Kirkpatrick, D. (1988). Time and Space in the Work of László Moholy-Nagy. *Hungarian Studies Review*, 15(1), 63-76.

Kuffler, S. W. (1953). Discharge patterns and functional organization of mammalian retina. *Journal of Neurophysiology* (16), 37-68.

LACMA. (2013, December 9). *Art + Technology Lab Renovations* [Press release].

Lifson, E. (2013, September 7). James Turrell Experiments With the “Thingness of Light Itself.” *NPR*.

Lippard, L. (1967). Notes on a Total Light. In Richard Bellamy, et al. (Ed.), *Focus on Light* [Exhibition catalogue]. Exhibited at the New Jersey State Museum, 1967.

Livingstone, M. S. (2002). *Vision and Art: The Biology of Seeing*. London: Abrams.

Magnus, R. (1949). *Goethe as a Scientist*. Henry Schuman.

Marcoci, R. (2012). Gallery label. *The Shaping of New Visions: Photography, Film, Photobook*.

Exhibited at Museum of Modern Art, April 16, 2012–April 29, 2013.

Marr, D. (1982). *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information*. New York: W. H. Freeman and Company.

Marr, D. & Hildreth, E. (1980). Theory of Edge Detection. *Proceedings of the Royal Society of London B*(207), 187-217.

Marx, P. (1968, July 18). *Interview with Thomas Wilfred* [Radio broadcast]. NPR.

<https://www.wnyc.org/series/patricia-marx-interviews>

Matisse, H. (1973). Notes of a Painter. In Jack D. Flam (Ed.), *Matisse on Art*. Phaidon Press Limited. (Original work published 1908).

Merleau-Ponty, M. (1964). Eye and Mind. In James E. Edie (Ed.), *The Primacy of Perception: And Other Essays on Phenomenological Psychology, the Philosophy of Art, History and Politics* (pp. 159-192). Northwestern University Press.

Minkowski, H. (1909). Raum und Zeit. In *Jahresbericht der Deutschen Mathematiker-Vereinigung* (pp. 1-14). Leipzig: B.G. Teubner.

Moholy-Nagy, L. (1947). Abstract of An Artist. In *The New Vision and Abstract of An Artist*. (pp. 65-88). George Wittenborn. (Original work published 1925-28).

Moholy-Nagy, L. (1923, March). Light—A Medium of Plastic Expression. *Broom: An International Magazine of the Arts*, 4(4), 283-284.

Moholy-Nagy, L. (1930). *Light Prop for an Electric Stage (Light-Space Modulator)* [Gallery Text]. Exhibited at Harvard Art Museum.

Moholy-Nagy, L. (1945, December 1). In Defense of Abstract Art. *Journal of Aesthetics and Art Criticism*, 4(2), 74-76.

Moholy-Nagy, L. (1969). Untitled Poem. In Sibyl Moholy-Nagy, *Moholy-Nagy: Experiment in Totality*. Cambridge: The MIT Press. (Original work published 1917).

Moholy-Nagy, L. (1947). *Vision in Motion*. Chicago: Paul Theobald.

Morrone, M. C., Ross, J. & Burr, D.C. (2010). Keeping Vision Stable: Rapid Updating of Spatiotopic Receptive Fields May Cause Relativistic-like Effects. In R. Nijhawan & B. Khurana (Eds.), *Space and Time in Perception and Action* (pp. 52-62), Cambridge: Cambridge University Press.

Nagel, T. (1980). The Limits of Objectivity. In S. M. McMurrin (Ed.), *The Tanner Lecture on Human Values*, Vol. I. Cambridge: Cambridge University Press.

Nagel, T. (2012). *Mind and Cosmos: Why the Materialist Neo-Darwinian Conception of Nature is Almost Certainly False*. Oxford: Oxford University Press.

Noë, A. (2004). *Action in Perception*. Cambridge: The MIT Press.

Noë, A. (2015). *Strange Tools: Art and Human Nature*. New York: Hill and Wang.

Orgeman, K. (2017). A Radiant Manifestation in Space: Wilfred, Lumia and Light. In Keely Orgeman (Ed.), *Lumia: Thomas Wilfred and the Art of Light* (pp. 21-48). New Haven: Yale University Press.

Piëne, O. (1990). Flying People: Goethe-Institut talk. Boston, MA.

Piëne, O. (1965). *Light Ballet* [Exhibition catalogue]. Exhibited at Howard Wise Gallery November 4-20 1965.

Piëne O. (1960). *Ölbilder, Rauchzeichnungen, Lichtmodelle, Lichtballet* [Exhibition Catalogue]. Exhibited at Galerie Diogenes, November 1960.

- Piense, O. (1973). On the Purity of Light (H. Beckman, Trans.). In Otto Piense and Heinz Mack (Eds.), *ZERO*. Cambridge: The MIT Press. (Original work published 1961).
- Piense, O. (1973). Paths to Paradise (H. Beckman, Trans.). In Otto Piense and Heinz Mack (Eds.), *ZERO*. Cambridge: The MIT Press. (Original work published 1961).
- Piense, O. (1988). Story of Light Art—Night and Day Ad Infinitum? In *Lights OROT* [Exhibition catalogue]. Exhibited at Yeshiva University.
- Pizlo, Z. (2001). Perception as an Inverse Problem. *Vision Research* 41, 3145-3161.
- Popper, F. (1966). *Kunst Licht Kunst*. Eindhoven: Stedelijk van Abbe Museum.
- Pritchard, R. M. (1961). Stabilized Images on the Retina. *Scientific American*, 204(6), 72–78.
- Purves, D., Lotto, R. B., Williams, S.M., Nundy, S. & Yang, Z. (2001). Why We See Things the Way We Do: Evidence for a Wholly Empirical Strategy of Vision. *Philosophical Transactions of the Royal Society of London, B* 356(1407): 285–297.
- Reichenbach, H. (1942). *From Copernicus to Einstein*. (R.B.Winn, Trans.). New York: Philosophical Library.

- Ringach, D. (2004). Mapping Receptive Fields in Primary Visual Cortex. *Journal of Physiology* 558(3), 717-728.
- Rodieck, R. W. & Stone, J. (1965). Analysis of Receptive Fields of Cat Retinal Ganglion Cells. *Journal of Neurophysiology* 28(5), 833-849.
- Ross, J., Morrone, M.C. & Burr, D. (1997). Compression of Visual Space Before Saccades. *Nature* 386: 598-601.
- Sharp, W. (1967). Luminism: Notes Toward an Understanding of Light Art. In *Light, Motion, Space* [Exhibition catalogue]. Exhibited at Walker Art Center, 1967.
- Smith, A. M. (2015). *From Sight to Light: The Passage from Ancient to Modern Optics*. Chicago: University of Chicago Press.
- Szymkowicz, S.M., Nissim, N.R. & Woods, A.J. (2017). Edge Detection. In J. Kreutzer, J. DeLuca & B. Caplan (Eds.), *Encyclopedia of Clinical Neuropsychology*. New York: Springer.
- Tenenbaum, J. (1998). Proceedings of the 1997 conference on Advances in neural information processing systems. Cambridge: The MIT Press.

- Tenenbaum, J., De Silva, V., & Langford, J. (2000). A Global Geometric Framework for Nonlinear Dimensionality Reduction. *Science* 290 (5500): 2319-2323.
- Turrell, J. (1993). Early Flight. In Mark Holborn (Ed.), *Air Mass*. South Bank Centre.
- Turrell, J. (2013). *Early Works* [Exhibition Catalogue]. Exhibited at Guggenheim Museum June 21-September 25 2013.
- Turrell, J. (1985). *Occluded Front*. Culver City: Lapis Press.
- Von Senden, M. (1960). *Space and Sight: The Perception of Space and Shape in the Congenitally Blind Before and After Operation*. (Peter Heath, Trans.). London: Methuen & Co.
- Wagley, C. (2013, May 16). Escaping the Corporate Frame. *Art21 Magazine*.
- Weibel, P. (2006). *Light Art from Artificial Light: Light as a Medium in 20th and 21st Century Art*. Berlin: Hatje Cantz.
- Wienbar, S. & Schwartz, G. (2018). The Dynamic Receptive Fields of Retinal Ganglion Cells. *Progress in Retinal and Eye Research* (67), 102-117.

Wilfred, T. (1948). Composing in the Art of Lumia. *Journal of Aesthetics and Art Criticism* 7(2), 79-93.

Wurtz, R. (2009). Recounting the Impact of Hubel and Wiesel. *The Journal of Physiology* 587(12), 2817–2823.

Zeki, S. (2001). Artistic Creativity and the Brain. *Science* 293(6), 51-52.

Zeki, S. (2020). “Can the Brain Explain Art?” [Interview]. *Closer to Truth: Neuroesthetics: How the Brain Explains the Arts*. PBS. <https://www.closetotruth.com/interviews/78422>