EXPERTISE IN ARTISTIC PHOTOGRAPHY

by

JOANNA SERAFIN

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The Graduate Center of the City University of New York

2013

This manuscript has been read and accepted for the
Graduate Faculty in Psychology in satisfaction of the
Dissertation requirement for the degree of Doctor of Philosophy

Aaron Kozbelt, Ph.D.

_____	_____
Date	Chair of Examining Committee

Maureen O'Connor, Ph.D.

_____	_____
Date	Executive Officer

Elisabeth Brauner, Ph.D.
Benzion Chanowitz, Ph.D.
Laraine McDonough, Ph.D.
David Owen, Ph.D.
Pablo P. L. Tinio, Ph.D.

Supervisory Committee

THE CITY UNIVERSITY OF NEW YORK

Abstract

Expertise in Artistic Photography

by

Joanna Serafin

Adviser: Aaron Kozbelt

Empirical literature on the psychological processes involved in professional and artistic photography is extremely scarce. This dissertation project attempted to integrate relevant information, taken from several disparate literatures, to derive a sense of the likely nature of creativity and expertise in artistic photography. We argued that superior performance in photography can likely be understood as a function of principles of expertise operating in other domains, especially those with a strong creative and perceptual-motor component. Educational guidelines and noteworthy photographers' own accounts of their creative processes provide a rich supplementary set of ideas to help define and understand the nature of creativity and expertise in artistic photography. Consolidating this information, we tested a series of hypotheses and empirical research methodologies. The tasks looked at both routine (Study 1) and creative (Study 2) aspects of photographic expertise. The routine aspects were assessed by examining both groups' ability to identify photographic flaws, whereas the creative aspects were observed through tasks involving image capture under spatially or temporally constrained conditions and later selection of best images. The dependent measures were quality ratings of the resulting images obtained from another group of experts and non-experts. In Study 3, we compared experts' and novices' aesthetic judgment criteria pertinent to photography. We found that expert

photographers outperformed novices on both routine and creative tasks. Both groups were differentially sensitive to four types of photographic flaws, with photographers outperforming non-photographers in flaw detection. Specifically, identifying lighting and lens flaws was easier than identifying subject and composition flaws. In addition, in the creative tasks in Study 2, selection of best images affected the quality ratings. This suggests that expertise in photography is a combination of technical skills and creative ability. Finally, experts and novices showed similarities and differences in their aesthetic judgment criteria. Both groups showed a complex first factor with strong loadings of pleasantness, content and overall quality. The second and third factors represented familiarity and dynamism. The main difference was on the fourth factor, which for novices was overall quality as associated with technical quality. Experts' factor patterns were also more coherent and explained more total variability.

Acknowledgements

There are many people I would like to thank. Without their support and friendship this dissertation would not be possible. First, I would like to thank my adviser, Dr. Aaron Kozbelt, for being immensely supportive, motivating, and patient, and for teaching me how to be an academic. There are many other mentors who helped me along the way. Dr. Arthur Reber has encouraged me since my first year in college, when I took his introduction to psychology course. He later urged me to apply into the doctoral program. Dr. David Owen has been a great source of wisdom, both the statistical and the everyday life kind. I extend my thanks to my wonderful Dissertation Committee: Dr. Elisabeth Brauner, Dr. Benzion "Buzzy" Chanowitz, and Dr. Laraine McDonough, and Dr. Pablo P.L. Tinio.

Graduate school would not be the remarkable experience it was without my graduate school friends: Katherine Nutter-Upham, Natasha Nadler, Melissa Dolese, Gabriella Brick Larkin, Kendall Eskine, Yana Durmysheva, Michael Brown, Karla Felix, Janina Scarlet, Angelika Seidel, and all the other wonderful graduate students. The great psychology staff, especially Maureen Ghans, brightened many of my days. I am grateful to have been a part of the Brooklyn College community since 1999, both as a student and as an instructor. Brooklyn College students helped me learn about teaching.

My wonderful bosses and coworkers: Florence Kempner, Louise Hainline, Lori Sims, Niki Jones, Elizabeth Aquino, Mila Gabriel, and others in the CASE office provided exceptional support, training, friendship, and flexibility—especially when I needed to do my homework or write my dissertation.

Finally, I would like to thank my dearest family and friends. My friends Sarah Py-Noack, Christopher Anc, samba teacher Danielle Lima, and all my friends who gave me valuable advice, emotional support, and opportunities to recharge my batteries. My mother, my biggest support and confidante, my wonderful sister Bernadette, my amazing siblings in Poland, Marzena, Kasia, and Damian, and my aunt Maria have always been proud of me, and encouraged me along my journey to the doctoral degree. Finally, I would like to express my thanks to my dear boyfriend Stephen for listening and supporting me in the final steps of the dissertation process. I am blessed to know so many wonderful people in my life.

Table of Contents

Lists of Tables

Lists of Figures

CHAPTER 1

LITERATURE REVIEW

Motivation and Theoretical Background

With the arrival of digital technology photography has become perhaps the most widespread artistic activity in the modern world. The mechanical process involved in capturing photographs allows virtually anyone to produce a visually sound image. Moreover, a great selection of digital photo editing tools and online display galleries such as Instagram allows virtually anyone to enjoy the experience of creating and exhibiting their work. Outside of personal, commercial, and purely artistic uses, photography is also emerging more and more as a method for addressing social (Briski & Kauffman, 2004; Help-portrait, 2010; Traub, Heller, & Bell, 2006) and psychological issues (Dennett, 2009). In light of the multiple applications of photography, including as a means of artistic expression, it is important to understand the psychological processes underlying the production of photographs. For example, vast individual differences in performance appear to be evident between eminent artistic photographers and the throngs of people who take photographs in a casual way. Strangely, however, the nature and basis of a superior, expert level of performance in photography has not been extensively examined by psychological researchers. It is therefore an open question which psychological mechanisms enable a consistently high level of performance, where a person can produce visually strong, interesting, and creative photographs—in contrast to lower levels of performance by persons who lack the requisite expertise. This doctoral dissertation project attempts to provide some initial insights on these issues.

In the scarcity of empirical studies specifically addressing expertise in photography, the most relevant information comes from two bodies of psychological research literature: the first, on artistic creativity; the second, on high-level performance and expertise, specifically perceptual-motor expertise, as they apply to other visual art forms. Complementing this psychological research are discussions by photographers themselves of what they do and how they think they do it. As in the study of painters, much intuitive wisdom can likely be garnered by examining the writings of eminent practitioners in a domain, as well as 'how-to' books on the topic (see, e.g., Kozbelt & Seeley, 2007).

The primary purpose of this research project is to understand the nature of artistic photographers' activities and goals, and to understand what kinds of psychological mechanisms, abilities, and domain-specific knowledge contribute to the high-level performance of expert artistic photographers. Synthesizing the literatures on creativity and expertise, plus photographers' own comments, is not necessarily easy or straightforward. Unlike 'classic' and well-defined domains of expertise (such as chess), where the rules are very clear, producing photographs involves a more fluid and less predictable ill-defined dynamic. Thus, photography like many artistic domains, lies in the less well understood realm of adaptive expertise (Crawford, 2007; Pandy, Petrosino, Austin, & Barr, 2004) where the stress in not on efficiency and speed of performance but rather on the creative solutions that some experts are capable of producing, which set them apart from novices.

Ideally, the study of other visual artistic domains can inform the nature of expertise in photography, since these are all by nature ill-defined domains (Mumford,

Reiter-Palmon, & Redmond, 1994). However, photography also differs from those domains in important ways. For instance, as an invention of the modern age where mechanical reproducibility lies at the heart of the process (Benjamin, 1936), photography may require a somewhat different set of perceptual or perceptual-motor skills than, say, drawing or painting. Also, photography may be temporally more constrained than these other domains, since having a good sense of timing (i.e., exactly when to click the shutter) appears to be critically important for taking a good photograph (Hurn & Jay, 2008). In light of the ensuing discussion on these topics, a set of testable predictions to identify aspects of adaptive expertise in photography will be proposed.

Photography as a Creative Domain

Photography is a complex and multifaceted medium. It encompasses qualitatively varied types of work, and it can be subdivided into about four large categories: documentary, fashion or advertising, portraiture, and art (Jaeger, 2007). These categories are determined by their purposes: documentary serves the mass media, fashion and advertising are commercial, portraiture is usually for documenting personal information, and art is chosen by galleries and museums to display as aesthetic objects.[1]

In other words, many aspects of photography have the potential for high levels of creativity. We begin by describing some current views of the phenomenon of creativity, in order to gain some traction on understanding how creativity plays out in the domain of photography.

[1] When describing the process of creating photographs, all great photographers share the same devotion to the medium; they 'make' rather than 'take' their images. Therefore, it is hard to categorize photography. One should keep in mind that there are overlaps between fine art and other categories in photography (e.g., the hauntingly beautiful photographs by a documentary photographer Sebastiao Salgado). However, possibly similar cognitive processes apply to creating various types of photographs.

‘Chance’ Views of Creativity

Some guidance on the nature of creativity and the creative process in photography and other arts can be informed by determining what creators are trying to achieve, and how they might achieve it. One of the most elaborate accounts of this dynamic was described by Martindale (1990, 1994, 2009), who emphasized the constant pressure on artists to produce novelty, in order to attract attention and patronage. For Martindale, this dynamic is set into motion wherever and whenever a domain is raised to the status of an ‘art form’ and dedicated practitioners develop the tradition and compete for critical recognition. Martindale explored and expanded the nature of this dynamic as an active “intensifying perception or arousing attention” (1994, p. 160) —in other words, raising the arousal potential (AP), or impact of artworks on viewers (see also Berlyne, 1971). Doing so attracts critical attention and recognition for the creator, and as a result, the art form develops and changes in particular predictable ways over historical timescales.

Martindale argued that painters, poets, and composers (and, presumably, artistic photographers) can increase arousal potential by modifying several aspects of their works. These include “collative properties (e.g. novelty, complexity, surprise, unpredictability), ecological properties (signal value or meaning), and psychophysical characteristics (e.g., stimulus intensity)” (Martindale, 1994, p. 161). Psychophysical impact can be increased by manipulating the physical intensity or sense of presence of works (e.g., bigger, brighter, or more saturated images). However, there are physical limits to how far psychophysical properties can be pushed. Ecological properties include the manipulation of a communicative and conceptual value of a work. For instance, presenting a topic that is highly relevant within a specific context or one that generally

appeals to the intended audience would increase the signal value or meaning of a work and help garner attention. However, like psychophysical properties, increasing arousal potential by increasing meaningfulness has limitations. It is susceptible to ceiling effects—for instance, in religious paintings, virtually every object already has maximal symbolic meaning; moreover, people vary widely in what is meaningful to them.

According to Martindale, most important for creativity are collative properties, which drive the novelty aspect of art. Martindale (1994) described collative properties in the context of a distinction between primary and secondary cognition. Collative value is mostly driven by the primary (primordial) cognitive process, which is concrete, irrational, and free-associative—like the kind of thinking in dreams and reveries. According to Martindale, primary process cognition marks the ideational stage within the process of creation. Secondary cognitive processes, on the other hand, are conceptual, deliberate, logical, and abstract, and they allow a creator to more consciously elaborate the newly created associations into finished works. Both phases are necessary for the production of creative works. Creative ideas may be produced in two ways on this continuum of primary and secondary cognition: (a) elaborating through deeper regression into primordial thought and forming remote conceptual connections or (b) by lowering elaboration through a stylistic change. Martindale's framework privileges the ideational phase as the essential engine of creative thought and creative productivity. What is more, Martindale asserts that artists usually opt for using primordial, free-associative cognition until the produced novel connections become uncommunicative, at which point a new style typically emerges (Martindale, 1990, 1994).[2]

[2] Martindale argued that the level of arousal potential and the hedonic or primordial value of art works keep increasing as artistic styles are explored, until it hits a ceiling where viewers can no longer appreciate

Undeniably, artistic photographers actively seek to impact their viewers. Therefore, as Martindale (1994, p. 163) asked of poets, we might paraphrase and ask for photographers: "how do successive [photographers] produce [photography] that becomes more and more novel, original, or incongruous over time?" Along the lines of Martindale's theory, photographers likely manipulate arousal potential properties in various ways, in order to achieve a strong response in viewers. For example, some curators have noted that contemporary works in art photography have increased in size (Jaeger, 2007) —consistent with the predicted change in psychophysical characteristics. A good, contemporary example of works where the photographer manipulated the psychophysical properties are the large-scale and razor-sharp close-up portraits by Martin Schoeller. The artist used a fairly simple studio setup and relied on the size and sharpness of the photographs to impact viewers (Wilton, 2008; see Figure 1).

Figure 1. Portraits of George Clooney and Meryl Streep by Martin Schoeller.

---

and/or understand it, which usually is marked by a stylistic change with increase in novelty. This fluctuation, which Martindale and others explain in terms of chance processes or hedonic and social selection forces, has been observed in many domains, for instance in poetry (Martindale, 1990, 1994).

Or, take for instance the seminal photograph of the "Migrant Mother" (1936) by Dorothea Lange (Lange, 1936) where the photographer took advantage of another arousal potential property related to ecological value or meaning to affect the emotions of viewers. The photo movingly portrays the post-great depression America by showing a destitute, fatherless family, a worried 32-year old woman, looking too old for her age and her children, with their faces turned away from the camera (see Figure 2)[3].

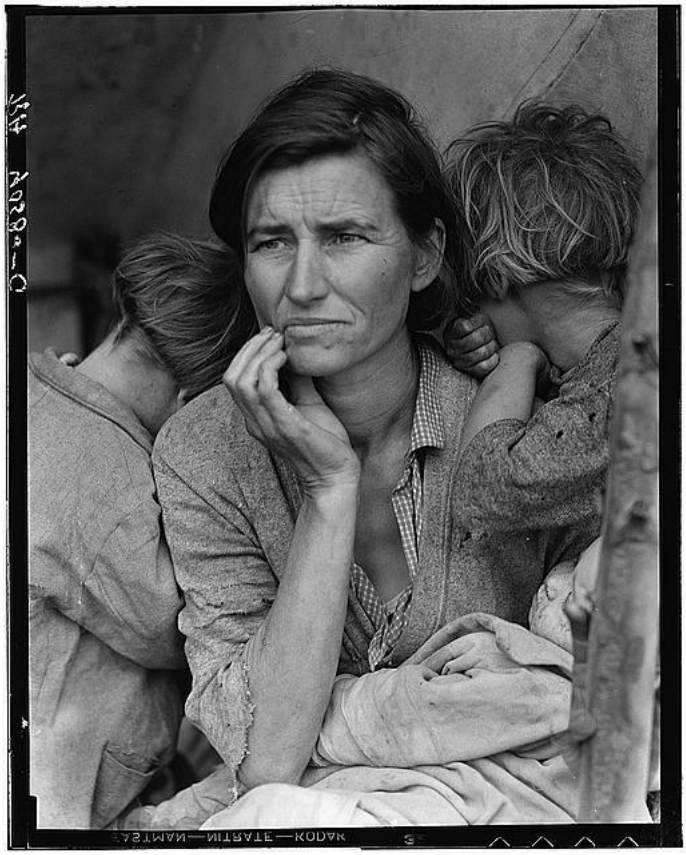


Figure 2. Migrant Mother by Dorothea Lange (1936).
Destitute peapickers in California; a 32 year old mother of seven children.
February 1936.

[3] Tinio and Leder (in press) presented a possible alternative explanation of the artistic process underlying photographs like the *Migrant Mother* (1936). This process could be understood as a peak-shift which involves exaggerating particular characteristics of photographed objects. Peak-shift effects are important to explaining "human fascination for art. This effect also corresponds specifically to neural response patterns: amplification of form leads to a corresponding amplification of neural responses to such form" (Tinio & Leder, in press, p.17).

The remaining arousal potential collative properties concern the novelty or surprise level in artistic works. One might assume that using collative properties to increase arousal potential in photography may be implausible since the medium is, at least on the surface, concerned just with the objective portrayal of reality. In addition, it may arguably be difficult to produce photographs that will elicit surprise in viewers, who, for the most part, are experts in visual perception. Yet, despite being experts in visual perception, many people who pick up the camera for the first time are surprised at how little overlap there is between our seemingly effortless visual perception and difficulty of working with an 'objective' and non-discriminating camera lens. For example, a beginner in photography may be dismayed at the amount of clutter present in their images which they failed to notice while taking the photographs. However, training in photography technique may overcome such obstacles; skilled photographers likely use their knowledge about how a camera 'sees' the world, and begin to notice the details that are objectively registered by it to create images that are surprisingly novel. A good example is Philippe Halsman's Dali Atomicus (1948) depicting the idea of an atom by freezing a moment that we normally perceive as uninterrupted motion. Halsman chose to present several objects, cats, and Salvador Dali suspended mid-air to illustrate the concept (see Figure 3). The photographer often created such novel images in his collaborations with Dali in an effort to apply Surrealism to photography (Halsman, 1961; Luhring, 2002).

Figure 3. Dali Atomicus by Philippe Halsman (1948).

The examples presented above illustrate that the same arousal potential properties that are applied in artistic domains can be extended to photography. As creative artists, photographers also try to "solve a problem of an aesthetic, conceptual or formulaic nature" (Adams, 2007, p. 11). In a recent work, Tinio and Leder (in press) proposed a set of creative devices that artists, including photographers, use to solve such problems. Those creative tools include: "line depiction and object recognition; figure-ground and juxtaposition and visual continuation; the peak-shift effect and visual emphasis; sharpness of depiction and gaze patterns; framing and visual balance; and physical orientation and size of an artwork and access to its content; and abstraction and speed of processing" (Tinio & Leder, p. 4). Moreover, the authors propose that these concepts are amenable to experimental and neuroscientific studies. The psychological processes that lead photographers to solve aesthetic and conceptual problems can also be linked to

psychological research in other domains. In a theoretical model compatible with that of Martindale, other researchers have explained the ideational generation of novelty in artistic (and scientific) domains largely in terms of chance factors. For instance, Campbell (1960) elucidated creative productivity in terms of the Darwinian principles of blind variation and selective retention, or BVSR. Simonton (1997) developed and extended Campbell's BVSR model both methodologically and theoretically. Simonton's model has empirically described and accounted for a variety of phenomena in creative domains. Some of the explained phenomena include individual differences in creative achievement and career trajectories, and the so-called 'equal-odds' rule, whereby high-quality creative productions emerge largely through sheer quantity of production. Like Martindale, Simonton characterized the creative process in terms of two basic regimes of creative thought ideation and elaboration —where the credit for producing novelty goes mainly to ideational processes operating under chance-intensive conditions.

Criticisms to the 'Chance' Views of Creativity

While this kind of ideation-elaboration BVSR model accounts for a wide range of empirical findings it also has important limitations. For instance, if we look at the definition of creativity offered by Boden (1996), who discussed novel combinations of old ideas, where the "surprise [is] caused by … the improbability of the combination" (p. 75), it is hardly a surprise that the Darwinian approach that leaves such improbable outcomes only to chance factors has been criticized. For instance, Gabora's (2005, 2007) main criticism involved applying a biological explanation to a psychological problem. According to her, creativity is a strategic and associative process of honing ideas, which is highly sensitive to changing contextual information, as opposed to blindly generating

variations or combinations of ideas and then choosing from a set of discrete options. In a more empirical vein, Kozbelt (2008) analyzed the career trajectories of great composers, building on Simonton's methods, but found results that were highly inconsistent with some of the basic premises of the Darwinian account (e.g., the equal-odds rule). Finally, an important general drawback to the evolutionary approach to creativity is that besides the biphasic processes of ideation and elaboration, it does not explain the inner workings of how creators produce their art. Therefore, its usefulness as a detailed model of the creative process is quite limited.

Thus far, we have argued that photography is a creative endeavor where, just as in any other artistic domain, its practitioners have the opportunity to increase arousal potential by changing psychophysical, ecological, or collative properties. It is an open question however, how exactly those creative processes occur. For example, connecting elements in an unusual way is perhaps separate from the process of quickly and efficiently selecting which of the outcomes are most valuable. Due to its mechanical nature, photography potentially allows for 'stumbling' upon interesting images by chance simply by pressing a shutter release, even without fully understanding the creative value of the produced images. The models presented thus far, which describe creativity in terms of the two-fold ideation and elaboration processes, do not extensively detail the inner workings of the process of elaborating or evaluating ideas, and especially their role in producing novelty. However, it seems plausible that experienced photographers can often successfully use the knowledge of their domain to guide the process of creation, all the way from the initial idea to the final evaluation stage; for example, from the starting

image concept, through careful selection of a setup or location, actual photo shoot, to post-editing and visual display.

An alternative theoretical framework emphasizes an extensive domain-specific expert knowledge base over chance or primary process cognition. As in other domains, highly creative and successful photographers likely possess at least several years of intensive experience in the domain, which give them the requisite technical knowledge to be able to perform at a high level (see also Weisberg, 2006a). In virtually every domain that has been studied, including ill-defined artistic domains (e.g., Jausovec, 1994; Mumford, Reiter-Palmon & Redmond, 1994), an extensive domain-specific knowledge base is crucial for enabling creators to produce novel works of lasting value. Despite a dearth of studies on expertise in photography specifically, it is reasonable to think that the same extensive domain-specific training applies to facilitating creativity among photographers. Therefore, to fully understand the nature of creativity in artistic photography, it is essential to understand the nature of expertise in the domain. Ultimately, we will attempt to integrate what we know about expertise in classically studied domains and other creative domains, with what we know about the photographic process and try to explain the nature of adaptive or flexible expertise in photography (Bransford, 2000). First, however, it is necessary to lay the groundwork for that synthesis by looking at expertise in general and, more specifically, expertise in domains that are similar to photography.

Alternative Framework:

Definition of Expertise in Traditional Domains

Expertise is not a unitary psychological construct. It may encompass cognitive domains – such as chess, physics and other academic disciplines – where the problems that experts encounter might be of well-defined or ill-defined nature. Moreover, within those domains there is a possibility for developing creative or adaptive expertise, in addition to routine expertise. Finally, expertise can be developed in domains with more prominent perceptual-motor elements, like radiology, air traffic control or visual arts. Initially, we will address specifically what expertise and expert performance are and how one acquires a superior expert level of performance. Then, we will argue that expertise plays an important role in performance on creative tasks, and it can be explained using research findings on expertise in both cognitive domains and perceptual-motor domains. Most important presently, we will test a set of hypotheses about the nature of expertise in photography, a complex domain comprised of cognitive and perceptual-motor and creative elements.

Expertise can be defined in several ways. It is a highly skilled, competent performance in one or more domains (Bransford, 2000; Sternberg & Ben-Zeev, 2001). It has also been defined as superior, reproducible and extremely efficient performance on domain-specific tasks (Ericsson, 2006b; Eysenck & Keane, 2005). Numerous psychological studies have explored the characteristics of expert performance as well as the factors that affect acquisition of expertise. The initial explanations of expertise stressed the role of mental representations and often utilized computer modeling and comparisons between human and machine performance (Chase & Simon, 1973a, 1973b; Ericsson,

2006a, etc). As a result, early accounts on the nature of expertise only looked at cognitive domains. Specifically, they include Binet's (1894) and de Groot's (1965) studies on master chess players (see Gobet & Charness, 2006). These studies were later elaborated by Chase and Simon (1973a, 1973b). The early accounts of expertise specified the concept of a chunk – a unit which contains elaborate domain-specific knowledge, and the concept that experts have many more of these units in their trained domain than novices do (Eysenck & Keane, 2005). More recent studies of expertise have extended these concepts to creative domains (like visual arts, see e.g. Kozbelt, 2001; Simonton, 1997) and perceptual-motor domains (see e.g. Rosenbaum, Augustyn, Cohen, & Jax, 2006).

Mechanisms of Expertise

The major mechanism for acquiring domain specific knowledge is deliberate practice (Ericsson, 2006a) defined as a highly involved learning and execution of domain-related tasks. In general, deliberate practice is focused, pragmatic, and structured performance that, by setting goals, gradually takes a practitioner beyond their current level or in other words, their automatized comfort zone and stresses progress over 'arrested development' (Ericsson, 2006b; Feltovich, Prietula, & Ericsson, 2006; Horn & Masunaga, 2006). Deliberate practice over time changes experts' reasoning ability which starts off as better reasoning in concrete rather than abstract terms (Eysenck & Keane, 2005; Feltovich, Prietula, & Ericsson, 2006). As individuals acquire expertise, they progress from using weak or general methods of problem solving to using strong or specific knowledge-based methods. Therefore, experts rely heavily on previous knowledge as opposed to extensive search of problem spaces, which is a result of the limitations of human perception and memory (Ericsson, 2006b; Gobet & Charness, 2006). Specifically, there are marked trade-

offs among perception, memory, and problem solving in expert performance. For instance, to compensate for limitations of memory expert chess players will re-investigate the same chess move on subsequent game episodes (Gobet & Charness, 2006).

Furthermore, to compensate for cognitive limitations expert performance is highly selective. Concept-centered reasoning is replaced with quick scanning for regularities, patterns, abstractions, and integrating multiple cues. Experts' reasoning is also marked by dynamic interpretations of a scene and readiness to take action when appropriate. As experts encode new information into Long-term Memory (LTM), they create dynamic chunks or templates for action which can easily be activated and accessed from their Long-term Working Memory (LTWM), appropriately to a situation (Ericsson, 2006b; Feltovich et al., 2006). Finally, highly skilled performance is metacognitive and evaluative. Even when failing to achieve a solution, experts would be able to still reason about it, whereas novices would usually 'crash' (for example, expert physicians who fail to diagnose a patient can still continue to reason using symptoms underlying the disease). Such metacognitive ability not only monitors successful attainment of problem solutions to known problems but often helps in tackling novel situations through recognizing a problem as inside or outside of one's area of routine expertise and adjusting accordingly (Feltovich et al., 2006). The findings of cognitive trade-offs characteristic of expertise emerged mainly from studies of cognitive domains. It is important to examine whether those findings can be extended to perceptual-motor and creative domains. We set out to study whether such mechanisms (e.g., quick scanning for patterns or knowledge-based search) are present in expert performance in photography.

Perceptual-motor Expertise

There are several points of similarity as well as difference between expertise in intensively perceptual-motor domains and the more purely cognitive or intellectual domains described above (Ericsson, 2006a, 2006b; Feltovich et al., 2006). As far as the similarities, expertise in both types of domains is an exceptional skill on a task, markedly two to three standard deviations above the normal population (Starkes, 1993). In addition, in all areas there are noticeable short-term benefits of massed practice and long-term effects of distributed practice. In other words, in most domains of expertise, pacing one's sustained learning is beneficial (Rosenbaum, Augustyn, Cohen, & Jax, 2006). Interestingly, in both cognitive and perceptual-motor domains less frequent feedback about performance cements the benefits of practice on a task for a long term, whereas more frequent feedback seems to contribute to short-term effects. In both types of domains there also is evidence of crystallizing or consolidation of acquired knowledge over time so that it becomes robust to fading. It is not clear, however, whether such evidence of consolidation is simply a recovery from fatigue or a special cognitive process (Rosenbaum et al., 2006). Finally, in most cognitive as well as perceptual-motor domains studied to date, there is an observed reliance on retrieval of ready patterns or solutions, as opposed to the immediate, on-line computation of problem solutions. Therefore, expert performance in any domain is associated with simple recall of facts and procedures rather than generation of actions according to rules.

There are also differences in expert performance across different types of domains. Perceptual-motor domains of expertise differ from other domains in relying heavily on motor plans. Early research in behavioral psychology described movement as

a product of feedback (e.g., from the environment) and a long chain of associations activated one by one, forming a reflex arc. Such ideas have since been refuted (Lashley, 1951), and motor plans or schema are now described as 'feedback loops' that are often activated before any signal is received from the environment. Empirical research on skilled movement or patterns of speech errors, where action occurs very fast, has supported this idea. Thus, a schema for movement in expert performance can be thought of as a hierarchical structure of plans or routines that trigger subroutines which in turn activate yet lower plans. Such a nested and organized nature of motor plans is a useful idea when confronted with the limitations on human cognition, for example, working memory which can hold only a few meaningful chunks at a time (Miller, 1956). Furthermore, as experts form and use the complicated and hierarchically organized motor schema, time to perform the task decreases with sustained practice. Ultimately, a very small set of elements can be used to retrieve a much larger schema for action, thus not requiring the elaborate computation that would strain cognitive resources (Eysenck & Keane, 2005; Rosenbaum et al., 2006). This idea is also congruent with Ericsson's (2006) Long-term Working Memory (LTWM) model. Thus far, it is apparent that possessing expertise is associated with many advantages in performance of domain specific tasks. Expert performance has also been shown to produce limitations in performance.

Advantages and Limitations of Expertise

Expertise may be useful in circumventing the limitations of human cognition, but it is not a certain road to infallible super-cognition. Chi (2006) assembled an inventory of both experts' skills and shortcomings. The many ways in which they excel include noticing deep features of problems and quickly generating the best solutions. Associated

with it are experts' ability to deeply, qualitatively analyze a problem, and accurately monitor the process of finding a solution—all of which is done with minimal cognitive effort while exerting "greater cognitive control over those aspects of performance where control is desirable" (Chi, 2006, p. 25). The limitations of expertise listed by Chi (2006) include biases and a lack of flexibility that usually comes with superior performance, however, only in the area of expertise. In addition, within their area of expertise, skilled problem solvers rely heavily on contextual information, which through experience they have learned to associate as a web of intercorrelations that occur with a certain degree of probability. The limitations to expertise are by and large associated with experts' extensive use of mental shortcuts (Chi, 2006).[4]

Adaptive Expertise

The present research project is mainly concerned with the nature of adaptive expertise in photography, and the most interesting issue lies in how creative experts overcome the typical inflexibility of the process and the multitude of biases and functional fixedness that plagues expert performance (Chi, 2006). Arguably, there are differences in psychological processes involved in adaptive expertise versus routine expertise, and there are specific characteristics to innovative experts or virtuosos (Bransford, 2000) that are not found among routine experts or artisans. Hatano and Inagaki (1986), who coined the term

[4] The neuroscientific findings further enrich our knowledge of expert performance. Brain changes occurring as one acquires expertise in a domain include physical enlargement of some areas, decreased activation in the areas associated with the domain performance (Feltovich et al, 2006; Solso, 2001), as well as, an increased activation in the areas associated with planning and higher level cognitive functions (usually frontal and prefrontal areas; see Solso, 2001; Hill & Schneider, 2006). The role of cerebellum has been shown to be related to expertise and pattern recall; cerebellum "contributes to the prediction and preparation of sequences [such as]… symbols … stimuli and responses" (Rosenbaum et al, 2006, p. 508). Moreover, neural plasticity is an important aspect of expertise acquisition since brain areas associated with a specific performance (e.g., violin playing) become enlarged in experts as compared to non-experts. Thus far, there has been no research on which neural areas are related to expert photographer performance, a gap that will hopefully be filled as there is more research on the topic.

adaptive expertise, looked at the issue from three angles: (a) procedural versus conceptual knowledge, (b) consequences of routine expertise and (c) differences between excellence (adaptive expertise) and efficiency (routine expertise). They characterized the difference in the following way:

> A key distinction is that routine experts excel in the application of skill and knowledge to familiar problems, and adaptive experts are able to construct new knowledge as they solve problems, are more accurate in problem solving, and handle new problems more successfully. During problem solving, the cognitive processes of adaptive experts are distinguished by a greater attention to available evidence; closer analysis of data; a dialectical working back and forth from data to knowledge base; and deliberate, explicit thinking-through of questions posed to the self and conclusions. It is likely through these cognitive processes that adaptive experts build their existing knowledge base. (in Crawford, 2007, p. 3)

It is an open question how those mechanisms map onto the domain of artistic photography. Other models of adaptive expertise (e.g., Pandy et al., 2004) describe it as a function of three components: (a) factual related to retaining facts, (b) conceptual related to the ability to recognize the underlying principles, and (c) transfer of facts and principles from old to novel contexts. Pandy et al. (2004) showed an increase of conceptual and transfer knowledge as a function of applying a multimedia learning module in biomechanics. However, the ratio of these components needed for successful adaptive expert performance and whether it shifts depending on area of expertise is unknown. Perhaps, in photography, the factual component consists of the mental library of visually appealing images and the conceptual component involves a set of principles for composing images, which skilled photographers can competently transfer into novel visual settings. If that is the appropriate model then it would be interesting to investigate which of those transferable rules are most important to becoming an expert in photography.

Case studies of famous creators (Weisberg, 2006a) shed some light on the nature of adaptive expertise and elaborated on qualitative as opposed to quantitative differences among experts. It appears that some domains are naturally more amenable to development of creative expertise (e.g., music composition) than others (e.g., music performance); the latter stresses efficiency and the objective comparison of levels of routine expertise. Photography has many characteristics of a creative domain. However, training within any domain typically involves at least some aspects of routine expertise to establish technical skills which then support creative productivity. For instance, the practice of copying works of the masters within an artistic domain is often related to the acquisition of expertise, and even creators as eminent and prodigious as Mozart typically go through such 'copying style' stages while in training (Weisberg, 2006a).

Cognitive adaptability is likely but one aspect of skilled artistic photography. Another important characteristic is the fact that photography is strongly rooted in concrete perceptual-motor experience. It not only involves cognitive elements, such as chess does, but also operates through a dynamic examination of visual space and manipulation of equipment. Thus, it is important to explore the distinguishing characteristics of perceptual-motor areas of expertise such as sports, video games, or photography that likely involve coordination of multiple perceptual, cognitive, and motor systems (Starkes & Allard, 1993).

Expertise in Artistic Domains

Findings in literature on adaptive expertise in perceptual-motor domains are particularly relevant to artistic domains, which, besides cognitive and creative elements require considerable perceptual processing and motor production in order to create or

fashion artistic objects. In the last decade or so, considerable empirical research (e.g., Cohen & Bennett, 1997; Kozbelt, 2001; Solso, 2001) has been devoted to more specifically analyzing the nature of artists' advantages in visual cognition and artistic production. Empirical results clearly demonstrate considerable differences between artists and non-artists in both drawing tasks and perception tasks (e.g., recognizing the subject of out-of-focus pictures). Research in empirical aesthetics has looked closely at such advantages in artists' performance when compared to non-experts' performance. In their Visuomotor Skill Model, Kozbelt and Seeley (2007) suggested that "medium-specific technical skill may be a way of explaining perceptual differences between artists and non-artists…" (p. 83). The Visuomotor Skill Model explains creative production through processes of shifting selective attention where artists utilize both their specialized declarative knowledge about the structure of objects as well as the motor plans for drawing an object. Both kinds of knowledge prime an artist's visual system to expect diagnostic features and shift selective attention to the relevant locations. Kozbelt and Seeley's model is based on the theoretical assumptions of the renowned art historian E. H. Gombrich, who described the process of drawing and painting as essentially a top-down, schemata-driven, interactive, and perceptual hypothesis testing loop rather than a bottom-up, feature by feature analysis and depiction. "In artistic production, this [top-down process] may reduce contextual effects that could lead to drawing inaccuracies. In a different perceptual domain, expert radiologists are able to augment perceptual information with extensive domain-specific knowledge and to ignore irrelevant information" (Kozbelt & Seeley, 2007, p. 85). As a result, artists develop and utilize a set of specific conceptual and sensory-motor procedures. These valuable findings can

perhaps be extended to other forms of adaptive expertise, specifically artistic photography, to examine the creative aspects of skilled performance.

Relating Adaptive and Perceptual-motor Expertise to Photography

In light of the preceding discussion, the literature on adaptive and perceptual-motor expertise can be extended to photography. Much variability exists in the photographic process and it is related to the degree of control an artist decides to have over his or her setting. After adopting a specific style or manner of working, photographers develop their perceptual-motor schemata. However, despite the variability in working styles and potentially idiosyncratic processes and knowledge bases there likely exist commonalities in how expert photographers work. Possibly, they include looking for diagnostic features of the scene (whatever the context) and portraying primarily those relevant features (Kozbelt & Seeley, 2007). With practice, a photographer becomes an expert in attending to and choosing only the relevant cues while ignoring others, just as experienced air-traffic controllers have a narrow window of attention for the most relevant patterns of objects in their visual field (Endsley & Rodgers, 1996).

Arguably, depending on a domain, different aspects of the context become important. For instance, we would argue that experienced photographers, more so than other visual artists, need to be incredibly aware of even the smallest nuances in the patterns of light in the scene that they intend to photograph, since the final product depends so much on the quality of light. Painters, on the other hand, have much more flexibility in compensating for light as they are creating it, rather than re-creating it. Arguably the role of photographers is to search for the right light in the right moment to re-create an aesthetically pleasing instant in reality using their elaborate technical

knowledge of lenses, artificial lighting, light metering, camera configurations, reflectors, and so forth, in addition to the principles of design that other visual artists utilize as well.

Knowledge of principles of design is perhaps one of the factors that differentiates artistic from non-artistic photographers. A fine art photographer is likely trained to be extremely aware of the principles of design and uses them along with other technical knowledge in photography to elicit strong aesthetic responses (i.e., increase the arousal potential; Martindale, 1994) in viewers. Indeed, fine art college programs teach basic design as a prerequisite to any art course, be it drawing, painting, ceramics, print making, or photography. Whereas, art historians and philosophers of art point to the role of rules, such as the ability to portray symmetry, in determining the quality of art works (Tatarkiewicz, 1980).

The photographic process specifically is based on understanding temporal sequences in conjunction with using elaborate technical knowledge. Both are important factors contributing to situational awareness (SA), or an "up to date understanding of the world" (Endsley, 2006, p. 633), an important aspect of adaptive expertise. This ability to continually assess the situation is particularly important in photography, where, as we will explore later, quick and accurate response is often crucial. Situational awareness involves three major elements: (a) sustained extraction of sensory information, (b) immediate merging of this information with existing mental models, and (c) predicting future events (Endsley, 2006; Livnat, Agutter, Moon & Foresti, 2005; Ross, Shafer, & Klein, 2006). Photography is an artistic domain that perhaps more than many other artistic domains relies on chance, as visual events often unfold and evolve in unpredictable ways. Therefore, expert photographers likely develop a keen situational

awareness and one element that possibly distinguishes professional photographers from amateurs is the structure and elaboration of their situational awareness, defined here as a special kind a motor plan or schema. While it is unclear whether situational awareness differs between artistic versus non-artist photographers, its precise nature may be related to the goals of one's particular photography project, ranging from eliciting a strong aesthetic experience to communicating a coherent story.

Many important unanswered questions about the nature of expertise in photography concern the level of awareness about the process of creation that skilled photographers possess. For instance, it is plausible to assume that artistic photographers' main goal is to achieve a high level of arousal potential in viewers, and they utilize their expert training to capture interesting photographs with just the right juxtaposition of space, time, form, and light. Perhaps one characteristic of photographic expertise is quickly organizing the visual field according to universal rules of perception, such as the Gestalt principles (Freeman, 2007; Zakia, 1993). This is likely achieved through a trained perceptual hypothesis-testing process. Another possible characteristic of this perceptual hypothesis-testing dynamic in photography involves storing a bank of past satisfying results and using them to pick up and augment similar arrangements in novel scenes (Freeman, 2007). In addition, it is likely that practical issues associated with distance (angle) from the subject, timing and selection are crucial in distinguishing the quality of photographs. If so, photographic training likely develops appropriate psychological mechanisms related to the abovementioned practical issues of distance, timing, and selection. In addition, other factors, such as personality or work styles, may also affect photographers' adaptive expertise. Clearly, a diverse array of interesting psychological

testable hypotheses on the nature of expertise and creativity in artistic photography can be posed.

In sum, findings in the expertise literature have been put forth in an attempt to bridge gaps in chance-intensive theoretical models of creativity (Martindale, 1994; Simonton; 1997) by providing specific knowledge-based mechanisms that creators can use for achieving quality products. Importantly, experts have a highly developed evaluative sense for quickly recognizing accurate connections and applying them to novel situations. This in turn, enables their meaningful guidance of the creative process (Kozbelt, 2006; Kozbelt & Serafin, 2009). The means for doing so may be through declarative and dynamic hypothesis testing, specific to the task demands (Feltovich et al., 2006), a pattern-matching based on abstracted, proceduralized chunks (Kozbelt, 2001), or through applications of implicit knowledge where an artist cannot explicate the reasons for liking particular solutions more than others (Reber, 1993). All in all, the expertise literature can inform us about the regularities in models that creators develop while honing their particular styles of work (Gabora, 2007) within a high degree of conceptual idiosyncrasy. Before attempting to apply those findings to processes involved in producing creative photographs, it is important to introduce fundamental information about the medium. After the ensuing section presenting general knowledge about the photographic medium, we will return the focus to the abovementioned psychological issues and develop a set of hypotheses to motivate the present research.

Photography: History, Philosophy, and Process

Photography, as a means of recording light patterns onto a photosensitive medium, has emerged as a result of many small discoveries across several centuries and various

cultures. Notes on a pinhole camera can be found as early as in 5th Century B.C.E. in the work of Chinese philosopher Mo Ti. Developments in chemistry enabled a process where scenery could be reproduced permanently on a photosensitive surface, which initially included silver compounds (Greenspun, 2007; Photography, 2009). Nicephore Niepce made the first such photograph in 1825 or 1826 and later elaborated the process with Daguerre to quicken exposure times. First such experiments with photography produced one-of-a-kind works, daguerrotypes. Subsequent work by Talbot produced calotype and cyanotype negatives and thus the capacity for duplication (Greenspun, 2007; Photography, 2009). From then until the current digital era technical inventions have successively shortened processing times and produced increasingly higher quality images.

In particular, the introduction of the dry plate (gelatine emulsion using silver salts) in the late 1880s enabled a quicker and more economic production of durable photographs (Greenspun, 2007; Photography, 2009). With this invention, "the physical manipulations of photography shifted to the background and concerns with picture content came to the front" (Benson, 2008, p. 144). Thus, as a result of multiple technological innovations, photography paradoxically became both an art form (as the means for expression increased) as well as a pedestrian way of mass producing gimmicks (due to the increased ease of the process). Artistic photography has been used to produce works that evoke strong aesthetic experiences comparable to those elicited by other forms of expression, for example painting. Moreover, from the beginning, photographers congregated, created styles, and formed groups like any other artistic movement. One example is The Camera Club of New York founded by Alfred Stieglitz in 1884.

Initially, many art critics were ambivalent toward photography. On the one hand, they recognized the value of the medium preserving the subjective experience. On the other hand, they often expressed anxiety over what they perceived to be the destructive power of photography. Photography signified anxiety and modernism. As a sign of modernism, photography was a democratic medium. Some (e.g., the poet Charles Baudelaire) overtly hated photography and warned against its populist character. "With the introduction of lighter, cheaper cameras, which began in the late 19th century and continued throughout the 20th, it became clear that the butcher and baker could not only purchase photos but could make them, too" (Linfield, 2008, p. 1). No wonder this anti-elitist medium caused negative responses in the world of art criticism. Was it an art after all? If so, what kind of art? Such questions are still hotly debated today.

Linked to the aforementioned issues is the problem of reproducibility of aesthetic output (Benjamin, 1936). Photography is a product of scientific inventions and the industrial revolution. Both areas have traditionally been connected to craft rather than fine art. Photography, from its inception, had a utilitarian aspect to it, which many other media (e.g., painting and sculpture) did not, due to the arduous process of making. Even in its early days, photography involved an easier process than any other artistic medium and it allowed a faithful representation of reality coupled with the capacity for essentially infinite reproducibility (Benjamin, 1936). This ease of making, however, deflated the value of photography as an artistic medium in the eyes of art critics and the art world.

Given the popularity of photography, it is striking that there are not many psychological accounts on the creativity of the photographic process. The notable theorist in perceptual psychology Rudolf Arnheim devoted some of his research to comparing

photography to other creative media. Most interestingly, he described photography as a less controlled and thus a less creative process since it is dictated by the environment (an 'outside-in' approach) as opposed to control through medium and an artist's labor (an 'inside-out' approach). Consequently, Arnheim argued that "photographic documents are not the creations of an idealizing imagination that responds to the imperfections of reality with a dream of beauty. Instead, they are the trophies of a hunter who looks for the unusual in the world of what actually exists and discovered something exceptionally good" (Arnheim, 1986, p. 121).

Photography nowadays is a large and varied domain encompassing several sub-domains (Jaeger, 2007). For instance, the art program at the Academy of Art University in San Francisco has an array of courses offered in photography: history and concepts, digital photography, retouching and printing, quality of light, color, design, people, documentary, fine art portraiture, location and studio lighting, landscape, architectural and interior, still life, advertising, editorial, fashion and beauty, marketing, black and white, photojournalism, illustration, color theory, darkroom, experimental historic and contemporary processes, digital montage, and advanced concepts (Academy of Art University, 2006). In addition, listed photography career opportunities include: "digital, fashion, advertising, editorial, fine art, documentary, journalism, photo journalist, portrait photographer and photo technician" (Photography, 2009).

This breadth of types within the photographic domain likely influences the general processes learned through training. For example, the means of working employed by street photographers are likely to be at least slightly different from those employed by fine art photographers. Hurn and Jay (2008) claimed that if one compares professional, fine art

photography to photojournalism, quality will increase as you move from journalism, or 'street photography,' into fine art. Interestingly however, the process involved in the production is basically the same: "enthusiasm for subject, careful planning, working situation through many images" (p.39). The difference may be in the final selection process, where in more utilitarian, journalistic photography the selection occurs to fit the immediate goal of the project (e.g., how images illustrate a story in a newspaper or a magazine), whereas a purely fine art approach leaves the final choices to the artist.

Education in Photography and Photographers' Accounts

Since there is no well-established empirical research on photographic expertise, the educational guidelines used by teachers of photography will be examined to gain insight on the principles that budding art photographers use. In addition, we will look at photographers' own ideas on the essence of their work and the process of acquiring necessary skills and use it as a means for generating testable hypotheses on the nature of expertise in photography.

There are several valuable ideas on expertise in photography that can be found in educational materials. Freeman (2007) presented several classes of concepts that are necessary in photography training, for example, learning to work within the image frame and composing with light and color. He also presented the basic design, graphic and photographic concepts that a photographer needs to be able to work with comfortably. They include figure and ground, rhythm, depth, visual weight, lines and shapes, focus, motion, optics, and exposure (Freeman, 2007; Zakia, 1993). As far as intent, he mentioned that a photographer may choose to work within a convention or challenge themselves into experimenting. They may also try to either react to a scene or plan an

exposure and try to capture a scene with a greater or a lesser degree of complexity, and ambiguity. Both of these are related to the concept of delay; the less ambiguous the image, the more immediate the message; whereas in a highly ambiguous image "the photographer aims for the equivalent of a punchline delivered after the viewer has already entered the image" (Freeman, 2007, p. 144). The latter can be achieved for instance by spatial reorganization where the key subject is made "smaller or less central to the composition" (Freeman, 2007, p. 144).

As far as the photographic process goes, Freeman agreed that it is an understudied phenomenon, most likely since one has to describe retroactively a short (sometimes very short) set of creative events, unlike in painting where there is ample time for analysis. As a result, photographers, especially those of a reactive kind, often talk about luck or intuition rather than conscious deliberation as main contributors to the process. Yet, there is more to this. Between reactive shooting and a full control in the studio there are many in-between approaches as to how photographers work. "Reaction…relies on intuition and experience…the process has to be very fast, often allowing no time for thinking. Deliberation…[which applies to] still life and architectural photography, is slower and call on powers of reflection and constant questioning" (Freeman, 2007, p. 151). One might speculate that either approach is related to the motion or dynamics of a scene; from highly active (e.g., sports photography) to static (e.g., still life photography). The choice of style of work at least to some degree depends on the choice and personality of the artist (see Kozbelt & Durmysheva, 2007).

In general, it is clear that there are more amateur photographers than there are amateur painters, which is in line with the anecdotal "anyone can press a button." As a

result, there possibly are many amateur photographers whose primary goal is not to produce creative works. Photography is however fairly well established as an artistic domain (Phillips, 1982) although it undeniably differs from other artistic domains. One aspect that obviously differentiates photography from other art forms is the necessity and richness of the technology that photographers rely on. As Benson (2008) remarked on only one aspect of technique, the focal length (the degree of magnification of the photographed scene) "the history of photography has been one of steadily shortening focal lengths. From the classical, distanced view of the painter, photographic description shifted to encompass wider and wider angles of view" (p. 150). Within photography, as in other artistic domains, there is a clear divide between experts and non-experts and between more creative versus less creative experts. Yet, the initiation into the medium is perhaps easier for a photographer than it is for a painter; it simply is easier to produce a visually pleasing image using a camera than it is using oil paint and canvas. The photographic process allows one at least a chance of instantly producing a fairly gratifying image, which would not be possible in painting, where a long period of acquisition of specific motor skills precedes even remotely good works.

Melin (1986), who looked at the impact of technology on artistic domains, argued that both painting and photography rely heavily on the "tonal effect of light and shade" (p.55). Photography, which quickly solved a lot of problems of representation (e.g., how to accurately portray foreshortening or unusual angles) influenced several painters, for example Edgar Degas. Arguably, as a result of the development of photography, painting was freed from its imitative tendencies. However, artists in both media behave differently; a photographer is often 'in motion' and a painter is not. Photographers also

are more selective than painters as function of the ease of the process that subtracts or distills rather than creates visual information and produces a great number of images, most of which will never be exhibited in public (Barrett, 1986).

Philippe Halsman, known for his experiments within surrealist photography, provided several "rules and stimulations" that he used to produce creative images (Halsman, 1961). Several of his ideas aligned with cognitive research on creativity. Halsman initially asserted that there are two kinds of photographers, those who take photographs by grabbing already existing moments—like the master of the "decisive moment," Henri Cartier-Bresson (1999)—and those who make photographs. The former, according to Halsman, are visual reporters valuing mostly objectivity, and the latter are creators who stage and direct a photography session and actively decide what to put in front of the camera.

This idea of picture making versus picture taking is also prominent in other photographers' accounts and it is related to the degree of conscious involvement, with the picture making approach being more deliberate. Interestingly, though, most photographers talk about the intuitiveness of the process rather than conscious deliberation. Abell, a documentary photographer known for his artistic approach, asserted that his best work is done when he is "almost unconscious" (Focal Power, 2009, quote 296) and another American documentary photographer, Wessel, described his process as being "half-asleep" (Focal Power, 2009, quote 228). Nell Dorr, a pictorialist photographer, summarized, "my picture-taking and picture-making are as different as day and night. I take my pictures quite unconsciously. I see them in my mind and ... it is done without thinking. I feel the exposure. My only concern is to be ready for that moment of

truth, always ready to grasp it quickly before it's gone, or to wait patiently until that split-second when it appears" (Focal Power, 2009, quote 410).

This state of mental readiness seems of most importance, yet, it is unclear whether it is related to the level of expertise, or the attentional interplay between primary and secondary modes of cognition (Martindale, 1994). Perhaps both, the automaticity that comes with training and the semi-focused cognitive state contribute to successful creative production in photography. Both aspects speak to the creative expertise principles introduced in the above discussion of creativity (e.g., Martindale, 1994; Weisberg, 2006b). According to Halsman (1961), one might prime one's "subconscious" mind with subjects one is hoping to successfully portray, and then later resume working with hopefully novel solutions to this ill-defined problem (Mumford, Reiter-Palmon, & Redmond, 1994). Possibly, for this process to be successful, photographers need to appropriately use their primordial cognition in conjunction with their advanced expertise.

As for deliberate techniques ensuring successful photographs, Halsman suggested that one might try the rule of a direct and straightforward approach or a literal method (e.g., when photographing an idea of a ghost, Halsman put his model behind a semi-transparent curtain). This clearly speaks to Martindale's (1994) idea of evoking arousal potential through communicative values of the image. Another way to elicit arousal potential might be to emphasize novelty. To do that, one might also try an unusual technique, unusual feature or compound of features, or an absence of a feature, all of which might produce a novel photograph. Halsman (1961) produced a litany of options for photographers wanting to try unusual techniques (p. 23):

> we can use an unusual lighting, an unusual angle, an unusual exposure…We can move the camera. We can use an unusual filter which

> will change the color values. We can use an unusual lens…We can shoot our subject against an unusual background or with an unusual foreground. We can distort or foreshorten our subject. We can use an unusual composition. We can continue our efforts after the picture has been taken … Even when the photograph is finished, we can insist on an unusual layout.

Other photographers' accounts point to additional conceptual and technical issues. Elliot Erwitt's idea of making pictures is simple: "You just need practice and application of what you've learned. ... Keep working, because as you go through the process of working things begin to happen" (Focal Power, 2009, quote 86). Thus, as Kozbelt and Seeley (2007) pointed out, the photography process is related to the concept of the perceptual motor or procedural schema, where the stress is not on declarative knowledge but on working through the problem with one's body.

In photography, the creative problem is perhaps more complex than in other arts since reality can never be greatly modified using photographic images.[5] As David Bailey, an English fashion and portrait photographer, remarked, "It takes a lot of imagination to be a good photographer. You need less imagination to be a painter because you can invent things. But in photography everything is so ordinary; it takes a lot of looking before you learn to see the extraordinary" (Focal Power, 2009, quote 71). Perhaps, one of the facts of photographic expertise is training of the perceptual system to successfully find novel arrangements in ordinary scenes. Minor White, a distinguished American photographer and the co-founder of Aperture, expressed something that is common of photographers, "I'm always mentally photographing everything as practice" (Focal Power, 2009, quote 79). Hence, in photography, the main problem is in 'hunting' the

[5] The representation of reality in photography is a matter of a degree as well, since different photographers choose different levels of manipulation in their images, especially, in the modern era of digital photography and digital post editing.

right, interesting chunk of reality and representing it in visually appealing ways, using appropriate photo techniques, both related to what visual artists call the ability to 'see'.

There are specific processes that influence this 'seeing and capturing' of extraordinary pieces of reality. Hurn and Jay (2008) described two key problems important in making photographs as (a) 'where' to stand and (b) 'when' to release the shutter. Expert photographers are aware and willing to admit that they might or might not be able to get a desired image as a function of this fine tuning between camera angle and timing. Furthermore, as other creative experts, even if professional photographers fail to capture a desired image, they can reason about possible explanations and future approaches. To Cartier-Bresson, a highly esteemed French photographer who was also trained in painting:

> photography is the simultaneous recognition, in a fraction of a second, of the significance of an event as well as of a precise organization of forms which give that event its proper expression. And this organization, this precision, will always escape you, if you do not appreciate what a picture is, if you do not understand that the composition, the logic, the equilibrium of the surfaces and values are the only ways of giving meaning to all that is continuously appearing and vanishing before our very eyes. (Focal Power, 2009, quote 164)

Salgado, a social documentary photographer who uses black and white photography to portray ordinary lives with a haunting beauty, reiterated this point:

> I have a way to photograph. You work with space, you have a camera, you have a frame, and then a fraction of a second. It's very instinctive. … in this fraction of a second comes your past, comes your future, comes your relation with people, comes your ideology. (Focal Power, 2009, quote 193)

Thus skillful working with time and distance coupled with strong evaluative ability, applied to final selection of images, seem most important in training of creative

expertise in photography (Hurn & Jay, 2008). The quick and accurate responses to visually strong scenes that expert photographers exhibit can be explained by both (a) their creative ability to capture novel connections (i.e., ideation) and (b) the later elaboration (Martindale, 1994; Simonton; 1997) through for instance, strongly developed evaluative ability (Kozbelt & Serafin, 2009). The key component to ideation, which enables original merging of concepts, is the training of perceptual-motor skills without which 'seeing' or quick pattern-matching to produce striking and visually sound images would not be possible. Finally, technical or routine expertise which enables quick and automatic application of technical rules, (e.g., the compositional rule of thirds, dynamic use of frame and all visual elements within it or the manipulating depth of field) frees cognitive resources to explore novel aspects of the process. In light of the ideas on creativity and expertise which we presented thus far, we will now propose a set of empirical hypotheses about the nature of fundamental aspects of creative expertise in photography.

Goals of the Present Research

Since expertise in artistic photography has thus far rarely been the subject of direct empirical study, the preceding discussion was characterized by a high degree of speculation on the psychological processes involved in creative, expert-level artistic photography. The psychological literatures most relevant to the topic, on creativity and on expertise, have to date mostly not addressed the domain of photography. On the other hand, comments by photographers and most writings about photography have tended to focus on more conceptual or philosophical aspects of the domain (e.g., Cartier-Bresson, 1999; Clarke, 1997; Focal Power, 2009; Jaeger, 2007; Traub, Heller, & Bell, 2006), rather than on potential psychological mechanisms accounting for performance

differences. Therefore, there is little direct, empirical research literature linking our considerable knowledge of creativity and expertise to the domain of photography. It is an open question how well existing psychological models might be applied to the domain of artistic photography, since it represents a complex combination of cognitive, perceptual-motor, and creative factors. In any case, a concrete psychological characterization of expertise and the creative process in photography is clearly lacking. The proposed study will attempt to close this gap by addressing some basic questions on the nature of expertise and creativity in artistic photography.

It seems likely that expertise in photography depends on a variety of factors. Of greatest initial interest are factors that are potentially unique to the domain of photography. In particular, we hypothesized that of crucial importance are photographers' ability to compose well within a spatio-temporal frame and the evaluative ability to make a good final selection of one's best images from a shoot. The temporal or 'when' aspects of the process are for example, quick assessments reliant on visual memory patterns and the spatial or 'where' aspects involve skillful use of distance and/or angle.

Traditional methods for studying expertise often involve quasi-experimental designs comparing the performance of experts and novices on a variety of cognitive and motor tasks (e.g., Ericsson, 2006b). In the study of expertise in perceptual-motor and artistic domains, similar approaches have been used. For example, Kozbelt (2001) looked at differences on visual perception tasks among artists and non-artists. In the present research project we drew upon these approaches. In addition, we used a range of production and aesthetic judgment tasks and made them specific to photography.

Accordingly, the proposed tasks were categorized into a few different types, mirroring the presented theoretical and empirical approaches. Initially, as a way of mapping onto the traditional studies of expertise, particularly routine expertise, we looked at non-productive aspects of photography, for instance, the ability to quickly distinguish and determine the technical quality of images. Then, we looked at the creative aspects of the process using a set of production tasks. The dependent measures for the images produced in the creative part of the study emerged out of expert and non-expert judgments of the produced outcomes. The specific details on the kinds of tasks that would inform the nature of expertise in artistic photography follow.

The initial, non-production set of tasks built on the traditional cognitive psychological literature on expertise. For instance, just as expert chess players are able to reconstruct a mid-play setup and evaluate potential moves after only a brief presentation (Ericsson, 2006a), so should experienced photographers be able to recognize the 'correct' versus 'incorrect' visual photo arrangements with which they will be presented, even when presentation times are very brief. In particular, expert photographers and novices were shown images that did or did not have a substantial flaw or problem, which should be evident to an expert who has ample time to observe the image. Images were also shown for either very brief or longer durations to mimic photographers' practice of evaluating a set of images after developing the first round of prints. Participants were asked identify any problems they noticed and provide a retrospective verbal report of why an image was or was not of adequate quality, to get a sense of their metacognititve ability and the degree of declarative knowledge of principles applying to particular images. Materials were designed to possess a range of kinds of problems (e.g., poor

composition, insufficient contrast, lack of focus, etc.), to different degrees. The types and combinations of problems were theoretically motivated by consulting photography manuals (e.g., Freeman, 2007). Overall, the routine task was designed to speak to the less creative aspects of expertise in photography—ones that are very quickly retrievable, in the same way that chess masters can quickly retrieve relevant domain-specific patterns from memory in planning their next move in a chess game.

The creative aspects of photographic expertise were also evaluated based on a set of production tasks, in which participants produced a set of images. Based on those tasks, we hoped to demonstrate the difference between trained photographers and novices on several key aspects of the process. Consequently, both groups produced images under several experimental conditions. The 'where' aspect of photography (Hurn & Jay, 2008) was evaluated by asking participants to frame several interesting images out of a static but visually complex scene. The temporal or 'when' aspect of photography (Hurn & Jay, 2008) was evaluated in a setting more closely related to the authentic process. Participants were asked to capture aesthetically interesting still frames from moving images, just as a photographer would, trying to capture the essence of a dynamic event. After that, to address both the 'where' and 'when' aspects of the process, the participants were asked to frame and capture several images out of a moving, complex scene. Finally, however skilled and prepared photographers are in capturing the appropriate angle and moment in time, they are always subject to the whims of the photographed situation. As Kanashkevich (2010) remarked, "the more experienced photographers will usually tell you that great 'images of moments' are created when luck meets preparation" (¶ 6). As a result, photographers take many pictures of a scene by exploring different spatial

perspectives and depths as well as over changes in time. Accordingly, another crucial aspect of photographic expertise is selection of the best images out of a larger set of images. All three aspects (temporal, spatial and selective) were explored in the present research.

The subsequent overall quality judgments produced the dependent measures for the production tasks. In addition, a separate stand-alone aesthetic judgment study was conducted where expert photographers and novices evaluated a diverse set of images. In accordance with some previous research on aesthetic judgment (Axelsson, 2007), it seemed likely that photo professionals, who have well-developed schemata for understanding photography, would process photographic information more accurately and prefer more unusual outcomes. Based on the aesthetic judgment tasks, we expected that experts would prefer the images produced by other experts, and arguably they would try to increase the quality of their images by evoking arousal potential in viewers (Martindale, 1994). We grounded this aspect of the investigation in earlier work on aesthetic judgment (e.g., Kozbelt & Serafin, 2009). In sum, the goal of the presented research was to explore various aspects of photographic expertise by comparing the performance of trained photographers and novices on a variety of technical, creative, and aesthetic judgment tasks. The general structure of the research project follows.

General Structure of the Studies

Design: The project was divided into three quasi-experimental studies with three groups of photographers and non-photographers (Figure 4 on p.42 illustrates the structure of the studies). Studies 1 and 2 contained the routine and the productive tasks, respectively. In Study 1, a group of 20 professional photographers and 20 non-

photographers completed a routine photographic task which involved specifying photographic flaws and judging the overall quality of the presented images. The images were selected by another group of experts in an online stimulus generation study to provide a standard relative to which other responses were compared. The routine task gauged aspects of photographic expertise that do not involve producing photographs. In Study 2, the same groups of experts and non-experts who participated in Study 1 completed a productive photographic task which involved cropping images using either a static image or videos and subsequently selecting the best crops. In the second part of Study 2, another group of 15 professional photographers and 17 non-photographers rated the overall quality of the crops produced in the first part of Study 2. In Study 3, another group of participants, 15 professional photographers and 16 non-photographers, rated the images used in Study 1 to establish the differences in the aesthetic judgment criteria between the two groups.

Hypotheses: Experts were expected to outperform non-experts on both the routine (Study 1) and the productive (Study 2) tasks. In Study 2, we expected that images produced by experts would be rated as higher in quality than images produced by non-experts. The dependent measures were based on the aesthetic judgments collected from a separate group of experts and non-experts. Based on previous research (e.g. Kozbelt & Serafin, 2009), we also expected that photographers and non-photographers would differ in their aesthetic judgment criteria. However, the pattern differences in a sample of photographers have not yet been studied, and the study of aesthetic judgment was more exploratory in nature.

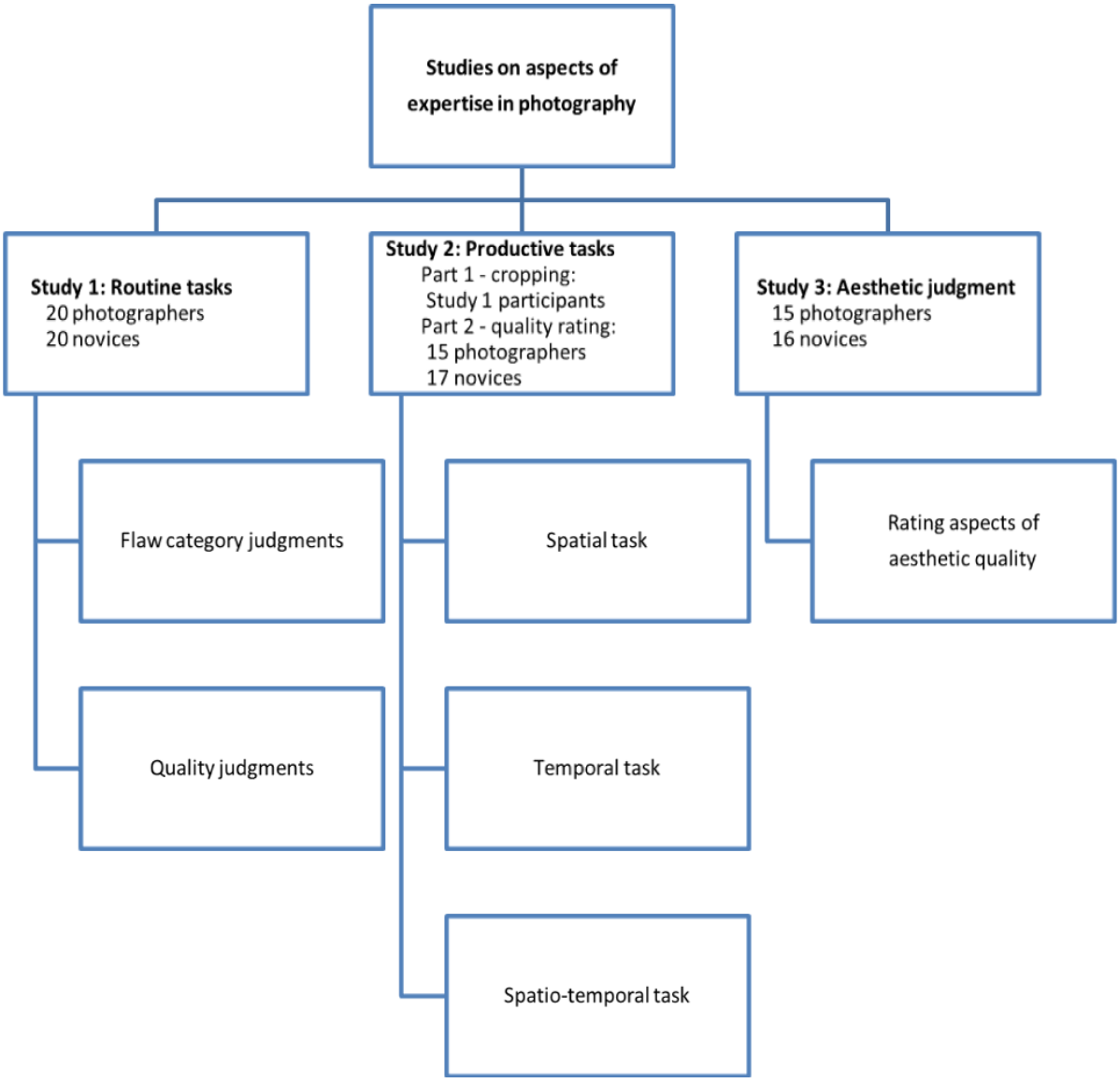


Figure 4. Structure of studies.

CHAPTER 2

STUDY 1: ROUTINE OR TECHNICAL ASSESSMENT ASPECTS OF PHOTOGRAPHIC EXPERTISE

Study 1: Method

Participants

In Study 1, participants were 20 experts (11 males, 9 females) and 20 novices (7 males, 13 females). Experts were professional photographers with an average of 9.4 years of experience in photography, M (SD) age = 33.7 (11.3). They were recruited through an online ad on Craiglist.org (see Appendix A). Novices were Brooklyn College undergraduates with no training in photography, M (SD) age = 22.8 (5.9) who were recruited through the Psychology Department subject pool. After completing a research session, which lasted approximately 1 to 1.5 hours, experts received $30 plus a $5 Starbucks gift card for participation and novices received two research participation credits required for their Introduction to Psychology course. All participants reported either medium or high computer proficiency.

General Materials and Procedures

At their arrival, each participant was first greeted by an experimenter and informed that the study would be about how people evaluate and create photographic images. Next, they were asked to read and sign a consent form. Participants were tested individually. Each session lasted approximately 1 to 1.5 hours. Within that time, participants completed the routine task as well as another productive task, presented below in as Study 2. After signing and submitting the consent form, each participant was assigned a unique code number which he or she used on all the provided forms. Then, each

participant started the routine task (assessment and evaluation of images) but was informed that they were going to complete another, creative task. At the end, each participant completed a short demographic survey (see Appendix C) which assessed their age, gender, level of education, the extent of their experience in photography, as well as their level of creative achievement in photography (adapted from the Creative Achievement Questionnaire of Carson, Peterson, and Higgins, 2005).

The initial set of tasks built on the traditional cognitive psychological literature on expertise. For instance, just as expert chess players are able to reconstruct a mid-play setup and evaluate potential moves after only a brief presentation (Ericsson, 2006), so should experienced photographers be able to recognize the 'correct' versus 'incorrect' visual photo arrangements that are presented to them, even when presentation times are very brief. Possible flaws could include for example poor composition, insufficient contrast, lack of focus, poor color balance, underexposure, overexposure, inappropriate depth of field, inappropriate shutter speed, awkward angle, cluttered background, tilted horizon, camera shake (e.g., with inappropriate f stop), lens distortion, grain or flare, etc. In Study 1, expert photographers and novices were each shown images that either did or did not possess a substantial technical flaw, which should be obvious to an expert who has ample time to observe the image. The images were chosen to possess a range of kinds of problems to different degrees (see survey in Appendix B and example Figures 5 and 6, p. 48). The types of problems were motivated and justified by consulting photography manuals (e.g., Freeman, 2007; Feininger, 1987), which describe such problems.

Stimulus Generation Study

Specific photographs included in this task were put into four main categories of important flaws (composition, lighting, camera and lens control, and subject choice), and a fifth 'no major flaws' category. To validate these categories, an online sample of 11 expert photographers evaluated the sample images. The experts were recruited via email from a prestigious online art photography website 1x.com. Of the 11 photographers, 9 were male and 2 were female, with an average of 6.5 years of photographic training and an average of 7.5 years of experience working in photography, M (SD) age = 46.5 (9.2). The photographers looked at 75 candidate images and indicated whether or not each image contained an important flaw. If flaw was detected, photographers were asked what they considered to be the most important flaw. Each image was viewed separately using an online Qualtrics.com survey, which displayed the image along with the forced-choice question on the main photographic flaw category (composition, lighting, lens, subject and no flaw) and the image overall quality rating (on a scale from 1 to 8). These ratings were analyzed to determine which images showed the highest agreement among photographers per each of the five flaw categories (see Table 1 and Appendix E). In general, there was a high agreement among the participant; the Cronbach's alpha reliability statistic was .801. Upon examining the stimulus generation data, we determined that the most agreement existed on the 'lighting' category (M = .84, SD = .09) and the least agreement existed on the 'subject' flaw category (M = .54, SD = .20). The 'lens' category received the second to highest proportion of agreement (M = .72, SD = .17) and the 'composition' (M = .64, SD = .06) and 'no flaw' (M = .66, SD = .13) categories had a similar average proportion of agreement. Later discussion of the results of Study 1 will elaborate on this issue.

Table 1
Stimulus generation study: Agreement scores across the five flaw categories

Image code	Flaw	Agreement
9038	Composition	0.64
3860	Composition	0.64
5919	Composition	0.64
3616	Composition	0.73
3854	Composition	0.55
3866	Composition	0.64
2446	Lens	0.64
6256	Lens	0.55
7883	Lens	0.73
1032	Lens	1.00
7869	Lens	0.55
8140	Lens	0.82
8638	Lighting	0.82
9990	Lighting	0.73
6163	Lighting	0.82
9923	Lighting	0.82
2084	Lighting	0.82
2281	Lighting	1.00
8317	Subject	0.64
9963	Subject	0.45
8070	Subject	0.45
7817	Subject	0.45
2968	Subject	0.36
7577	Subject	0.91
8669	no flaw	0.55
3123	no flaw	0.55
7641	no flaw	0.64
8291	no flaw	0.64
1296	no flaw	0.64
7053	no flaw	0.91

The top 30 images, spanning all five categories, with highest inter-rater agreement were used in the main part of the routine assessment aspects of photographic expertise in Study 1. The images were randomly assigned to either long-duration or short-duration condition.

Flaw Detection Task

This first task intended to mimic photographers' practice of initial technical evaluation of a set of images after developing the first round of prints or capturing a large set of digital images, which is an important skill in the domain of photography. Thus, Study 1 was set to examine routine or technical aspects of photography. The 30 images that had been validated as belonging to one of five categories (composition flaw, lens flaw, lighting flaw, subject flaw, or no flaw; see example Figures 5 and 6) in the stimulus generation study were then presented in a random order. First, 15 images were presented in a random order for 8 seconds each, and then 15 images were presented in a random order for 1 second each. Each participant completed the longer duration task first, followed by the short duration task. Each of the categories was represented in 6 images and each of the images was randomly assigned to one of the two presentation duration conditions (8 seconds versus 1 second) to ensure that the images across the two conditions were comparable in all aspects but presentation duration. All participants viewed the same set of images within the long and short duration conditions, however; within each condition the images were presented in a random order.

Figure 5. An example of a technically flawed photograph: lighting flaw (overexposure).

Figure 6. An example of a technically flawed photograph; composition flaw (violation of the ‘rule of thirds’).

The photographs were displayed as a slideshow on a 15” PC computer screen using Super Lab 4.0 software to ensure proper randomization and timing of image display. All images were displayed at the center of the screen with a ‘+’ fixation cue in the center preceding each image. All images were standardized to a size of 900 pixels at the longer edge at 72 dpi screen resolution. The viewing distance was approximately 15 inches. The initial instructions read as follows:

> You are about see 30 photographic images which may or may not contain a technical flaw. For each image, write whether it has any flaws and if so, identify the main flaw. Evaluate the images using one paper survey per image.
>
> At first, 15 images will be displayed for a 'longer' time - 8 seconds. Then, another 15 images will be displayed for a 'shorter' time - 1 second. Press any key when you are ready to proceed to the practice session.

After two practice images, where participants familiarized themselves with the display duration and the paper survey (see Appendix B), participants were instructed that the test session was about to start. Again, a total of 30 images were shown between the long (8 seconds) and the short (1 second) duration conditions. First, 15 images in the 8-second duration condition were shown in one block, preceded by two practice images. The images were presented in a random order. Then, the remaining 15 images were shown in the 1-second duration condition in one block, again, preceded by two practice images. Overall, each participant evaluated six images per each category (three in long and three in short condition). After displaying each image either for a short or longer period of time, the screen was set to blank to allow participants ample time to identify the flaw category (composition, lens, lighting, subject or no flaw; see Appendix B). Participants were also asked to identify the specific flaw in the appropriate category with

several specific examples provided for each flaw category (e.g., in the 'lighting' flaw category, participants had the following examples of possible specific flaws: "poor choice of lighting, underexposed, overexposed, insufficient contrast, excessive contrast, poor dynamic range, direct flash, inappropriate time of day, poor color balance"; see Appendix B for other examples of sub-categories). The survey also contained an overall quality assessment on a Likert scale from 1 to 8. At the end of each survey, participants also had the opportunity to provide additional comments on each image. This allowed us to get a sense of the degree of declarative knowledge of principles applying to particular images. The analysis of the sub-category judgments and qualitative judgments is not a part of this manuscript. After providing a report each participant was instructed to progress to the next image by clicking the space bar. The routine task lasted approximately 20-40 minutes and varied depending on the amount of time participants took to fill out the surveys.

Experts' ratings in the initial online stimulus generation study served as the benchmark of what counts as a 'correct' answer. Since we obtained fairly good agreement in the stimulus generation study, especially for the 'lens' and 'lighting' flaw categories, the ratings provided a strong basis for scoring performance in the routine assessment task among experts and novices in the short and long duration conditions. Participants' responses were initially coded as 1 - accurately identified appropriate flaw or 0 - did not identify flaw accurately. Of particular interest was the ability of novices to make 'correct' judgments, even when provided substantial viewing time, and the ability to make correct judgments even under a short viewing duration. Participants were instructed that only one main flaw can be identified even if they had identified several

problems with the photographs. Despite that instruction, there were several instances where a participant specified more than one flaw. In those cases, the participant received partial credit on their response if one of the specified categories was the correct category. For example, if the correct flaw category was 'composition' and a participant checked both 'composition' and 'lighting' the participant received a partial credit of 0.5. Ultimately, the analyses we performed (see the Results section below) utilized both the percentage of 'correct' flaw identifications and the actual proportions of flaw categories identified in Study 1. Additional comments to each image at the end of each survey were used to see qualitative differences between the responses of expert photographers and non-experts. Specifically, we expected the expert photographers to provide largely more specific and elaborate comments and explanations of the flaws. Again, the analysis of the qualitative judgments is beyond the scope of this manuscript and will be analyzed separately.

Overall, this task looked at routine or less creative aspects of expertise in photography, understandable via rapid domain-specific pattern matching, as is typically found in other domains. Beyond comparing performance of expert photographers, a comparison of the types of problems that were more readily identifiable by each group under the short duration condition versus the long duration condition held particular interest.

Study 1: Results

Study 1 evaluated differences between expert photographers and novices in their ability to recognize photographic flaws under either long (8 seconds) or short (1 second) time constraints. We performed a repeated-measures ANOVA to compare the two

abovementioned within-subject factors, ‘flaw category’ (five levels: composition, lens, lighting, subject, and no flaw) and ‘display duration’ (two levels: 8-second and 1-second) and one between-subjects variable, ‘expertise level’ (two levels: expert photographers and novices). The performance on the ability to recognize photographic flaws was measured in several ways:

(a) based on participants’ agreement with the flaw categories that were specified in the scoring scheme in the stimulus generation study, with 1 signifying a ‘correct’ answer and 0 signifying an ‘incorrect’ answer (see Table 1 and Appendix E). Partial agreement scores ranging between 0 and 1 were assigned to responses that specified more than one flaw category.

(b) based on partial credit scores for which participants’ flaw categorizations received the proportion agreement for that category, regardless of whether the response was the keyed ‘correct’ flaw category. This second classification of responses was based on the fact that in the stimulus generation study only two images received 100% agreement as to the main photographic flaw and the remaining 28 images received less than 100% agreement (see Table 1 and Appendix E). More specifically, each participant’s flaw response received partial credit score that represented the proportion of agreement for that category in the stimulus generation sample; for example, if the stimulus generation data showed a .91 agreement that the image had a lighting flaw and .09 agreement that there was no flaw, a participant in Study 1 would receive .91 for specifying ‘lighting’ category and .09 for specifying ‘no flaw’ category.

The data were examined for two additional trends:

(c) We checked participants' underlying base-rate responses toward specific flaw categories by determining the actual percentage of flaws they specified per 15 images in each duration condition.

(d) Finally, we examined the ratings of quality of images based on the flaw category.

For each of the four described dependent measures, we applied the same $5 \times 2 \times 2$ mixed factorial model with two within-subject factors: 'flaw' (five levels) and 'display duration' (two levels) and one between-subjects factor: 'expertise level' (two levels; see Appendix G for the summary tables of descriptive statistics and ANOVA analyses).

Analysis of Agreement with the Pre-specified Flaw Scoring Scheme

The analysis of agreement with predefined categories showed three main effects for all three variables specified in the design: flaw category, display duration, and expertise level. There were no significant interactions between the variables (see Appendix G for the summary tables of descriptive statistics and ANOVA analyses). In general, expert photographers outperformed the novices in specifying the 'correct' category, $F(1, 38) = 12.801$, $p < .01$ (see Table 2). Both groups were also differentially sensitive to four types of photographic flaws, $F(4, 152) = 33.634$, $p < .001$. Specifically, identifying the 'lighting' or the 'lens' flaw was easier than identifying the 'subject' or the 'composition' flaw. The highest proportion of correct identification of the 'no flaw' category suggests perhaps a tendency toward abstaining from finding photographic flaws. Understandably, if the 'no flaw' got the highest proportion of hits, it also got the highest proportion of correct hits, but also a high proportion of false alarms. The higher

frequency of choosing the 'no flaw' category possibly also suggests that when participants were in doubt (conceivably about the less well defined flaw categories like 'subject') they opted for the 'no flaw' category. This result is especially expected in the novice group since those participants were hypothesized to possess less technical knowledge about the potential photographic flaws. This issue is further discussed below, in the Analysis of Proportion of Specified Flaws (see below). Finally, participants responded with higher accuracy in the short duration condition compared with the long duration, $F\,(1, 38) = 11.587$, $p < .01$ (see Table 2).

Table 2
Agreement with the pre-specified flaw categories: Mean and standard error statistics for expertise, flaw category, and duration variables

Condition	Mean Accuracy	Standard Error
Experts	.443	.020
Non-experts	.341	.020
Composition	.183	.030
Lens	.501	.036
Lighting	.514	.040
Subject	.146	.022
No flaw	.617	.047
Long duration	.352	.016
Short duration	.433	.021

Note. Agreement is specified by expert photographers' responses in the stimulus generation study, coded 1 for correct answers and 0 for incorrect answers and a score between 0 and 1 for partially correct answers.

Analysis of Partial Credit Flaw Categorization Scores

As evident in Table 1 (p. 46, see also Appendix E), photographers, who defined the flaw categories in the online stimulus generation study, agreed 100% for only two of the thirty images as to what the main flaw was (agreement scores ranged between 36% and 100%, with the lowest agreement scores in the 'subject' category). In the present analysis, we looked at participants' responses as partial scores corresponding to the proportion

agreement on that response in the stimulus generation study sample of experts. For example, if a participant chose 'composition' as the major flaw, but it was not the keyed response according to the stimulus generation study experts, then the 'composition' response would receive partial credit—and that score would be based on the proportion of experts who had also identified 'composition' as the main flaw. As a result, the dependent measure in the following analysis consisted of partial credit flaw categorization scores. The design was isomorphic to the one presented in the preceding analysis: the two within-subject factors, 'flaw category' (five levels: composition, lens, lighting, subject, and no flaw) and 'display duration' (two levels: 8-second and 1-second) and one between-subjects variable, 'expertise level' (two levels: expert photographers and novices). In this analysis, the 'flaw' category variable was not defined based on the highest agreement in the stimulus generation study but was rather specified by the participants' own responses. This meant that in most cases there were not an equal number of images per flaw category. As in the first analysis, we found three main effects and a significant interaction (see Appendix G for the summary tables of descriptive statistics and ANOVA analyses).

There was a statistically significant interaction between flaw category and duration variables, $F(4, 152) = 6.379$, $p < .001$. The 'lens' and 'lighting' flaw categories in the 'short duration' condition were disproportionately easier to detect than any other flaw-duration combination. Interestingly, composition flaws were easier to detect in the long duration condition than in the short duration condition (see Figure 7, note that lens and lighting flaws were easily detected in the long duration condition). Perhaps detecting various types of photographic flaws enlists different psychological mechanisms (e.g.,

quick scanning for patterns mechanism is employed when detecting lighting or focus problems whereas slower and more deliberate decision making is employed when detecting composition problems).

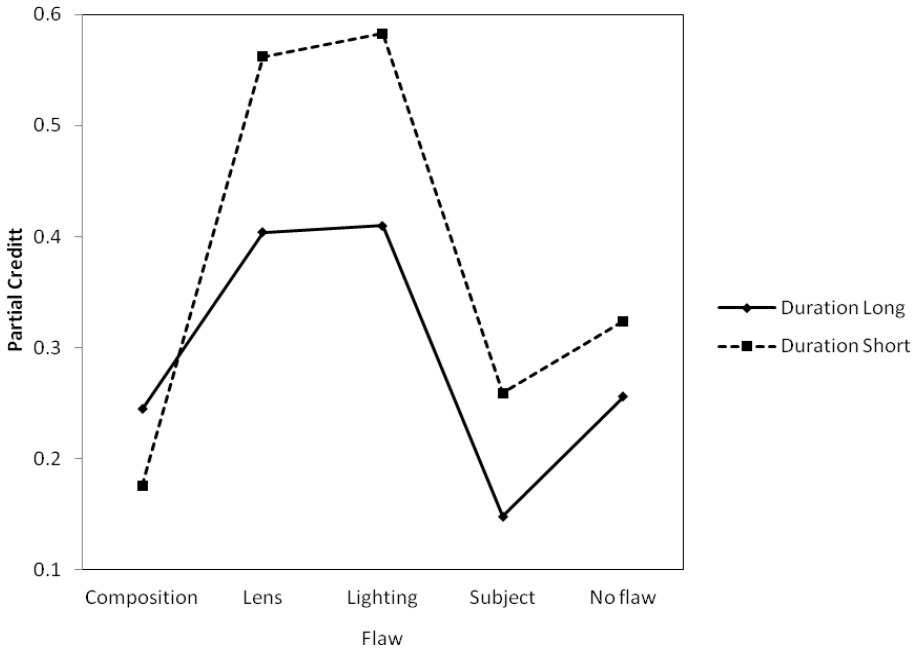


Figure 7. Interaction between flaw category and duration for partial credit scores.

The main effects analyses revealed that expert photographers outperformed the novices, F (1, 38) = 4.973, $p < .05$ (see Table 3). Both groups were also differentially sensitive to four types of photographic flaws, F (4, 152) = 35.549, $p < .001$. As in the first analysis, identifying 'lighting' and 'lens' flaws was easier than identifying 'subject' and 'composition' flaws. The 'no flaw' category did not elicit the highest average agreement in this analysis since in this case the bias toward choosing 'no flaw' was not rewarded with high scores. Participants who chose the 'no flaw' received consistently lower proportion agreement scores and missed the chance to score the higher agreement scores for other categories and thus were penalized for not using the full range of categories (the

discussion of the actual proportion of specified categories is discussed below in the Analysis of Base-rate Flaw Categorization Scores). Finally, participants also responded with higher accuracy in the short duration condition compared with the long duration, $F(1, 38) = 19.261$, $p < .001$ (see Table 3 for mean values).

Table 3
Partial flaw categorization scores: Mean and standard error statistics for flaw category, expertise, and duration variables

Condition	Mean Partial Score	Standard Error
Experts	.375	.024
Non-experts	.298	.024
Composition	.211	.020
Lens	.483	.033
Lighting	.497	.034
Subject	.203	.028
No flaw	.290	.019
Long duration	.293	.016
Short duration	.381	.023

Note. Agreement is specified by expert photographers' responses in the stimulus generation study.

Analysis of Base-rate Flaw Categorization Scores

The analysis of the percentage of photographic flaw categorizations examined possible underlying base-rates existing among expert photographers and novices across the five categories: composition, lens, lighting, subject, no flaw. The scoring scheme that we used for the analysis of agreement based on the stimulus generation study sample assumed an even distribution of the five flaw categories (composition, lens, lighting, subject, no flaw) among the 30 images. However, the preceding two analyses in Study 1 showed that both groups of participants may possess implicit base-rates favoring some categories over others. It is interesting to examine which particular flaw categories participants gravitated toward and whether there was a difference between expert photographers and novices in that respect.

The analysis of the actual proportions of responses for each category revealed a significant interaction between the flaw category and display duration variables, F (4, 152) = 4.343, $p < .01$ (see Figure 8). Specifically, it is evident that participants chose the 'no flaw' category more frequently, particularly in the short (one second) display duration condition. In addition, in the long (eight second) display duration condition, participants chose the 'composition' flaw category more frequently than in the short display duration condition. This finding parallels findings in the analysis of partial credit scores and suggests that (a) detecting composition flaws may require more time than detecting other types of flaws and (b) participants are more likely to choose the 'no flaw' category especially when not given enough time to make a decision (see Figure 8).

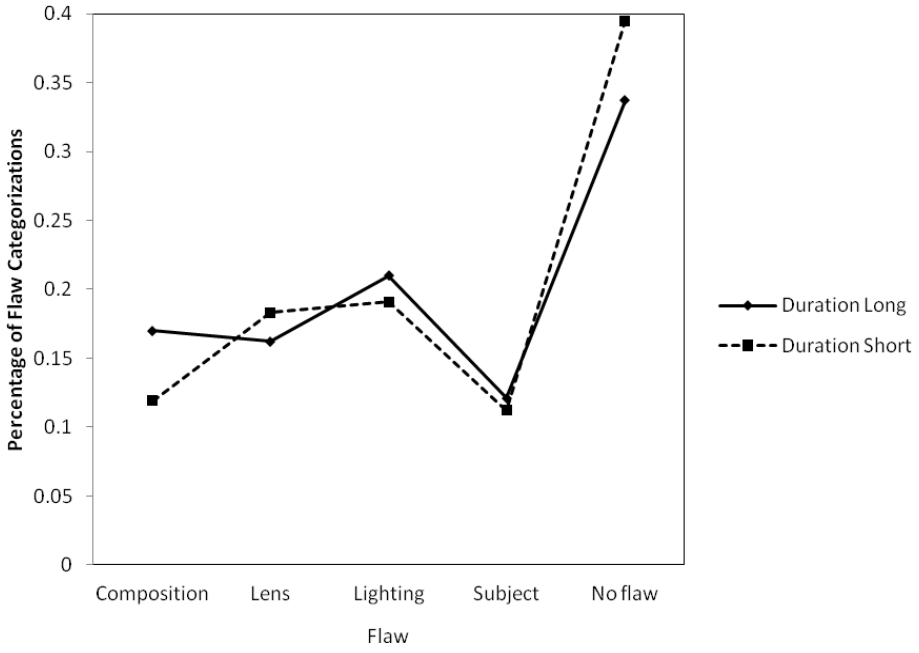


Figure 8. Interaction between flaw category and duration for percentages of specified flaws.

In general, the flaw categories differed in the proportion of responses they received, F (4, 152) = 18.226, $p < .001$. Specifically, both groups identified the 'no flaw'

category more often than the four other categories (see Table 4). If the participants in Study 1 fully agreed on the proportion of flaws within the categories the base-rate per flaw should be .20. The 'lens' and 'lighting' were the closest to that percentage and the other categories showed an imbalance: the 'subject' flaw was the least likely to be specified and the 'no flaw' category was the most likely to be specified (see Table 4).

Table 4
Percentages of specified flaw categorizations: Mean and standard error statistics for flaw category variable

Condition	Mean Percentage	Standard Error
Composition	.145	.018
Lens	.173	.016
Lighting	.200	.017
Subject	.116	.012
No flaw	.366	.033

Expert photographers' and novices' ratings showed differences in percentages of identified flaws. In particular, experts identify more composition problems and fewer 'no flaw' images when given eight seconds as opposed to one second to view each image. On the other hand, experts also identify fewer composition problems and more 'no flaw' images when given one second to view each image (see Figure 9). This trend is not evident in novices' ratings. In general however, experts chose the 'no flaw' category less frequently (33% of instances on average) than novices did (41% of instances on average), especially in the long display duration condition (29% of instances on average). Novices in the short display duration condition selected the highest number of 'no flaw' images (43% of instances on average). Thus, expert photographers were more likely to detect any type of flaw than were novices, specifically when given ample time to do so.

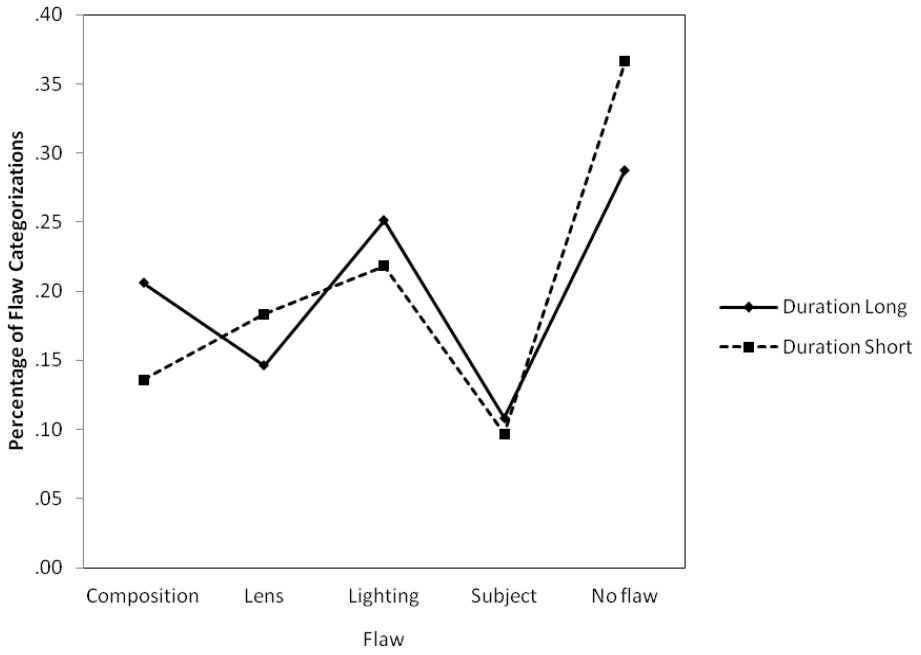


Figure 9. Interaction between flaw category and duration variables for experts' percentages of specified flaws.

Analysis of Quality Ratings

To complete the routine task results, we analyzed the overall quality ratings as the dependent measures. We applied the $5 \times 2 \times 2$ factorial model isomorphic to the above analyses: the repeated-measures ANOVA with two within-subject variables: 'flaw category' and 'display duration' and one between-subjects variable: 'expertise level'. Since a few participants omitted several quality ratings and several flaw categories (57 omissions in the matrix of 400 total responses), we replaced the missing responses with the appropriate average quality scores that corresponded to the duration-flaw-expertise combination of variables. We found three main effects and no reliable interactions (see Appendix G for the summary tables of descriptive statistics and ANOVA analyses). In general, expert photographers rated the images as lower in quality than the novices did, $F(1, 38) = 10.473$, $p < .01$ (see Table 5 for mean values). The four types of photographic

flaws and the 'no flaw' category were also rated differentially, F (4, 152) = 114.895, p < .001. Specifically, we confirmed that the images in the 'no flaw' category received the highest average quality ratings, followed by the 'composition' flaw category. Images in the 'lens' flaw category received the lowest average quality rating (see Table 5 for mean values). Finally, participants rated the overall quality more harshly in the short display duration condition than they did in the long display duration condition, F (1, 38) = 8.483, p < .01 (see Table 5 for mean values).

Table 5
Quality judgments: Mean and standard error statistics for flaw category, expertise, and duration variables

Condition	Mean Quality	Standard Error
Experts	4.176	.148
Non-experts	4.852	.148
Composition	4.450	.152
Lens	3.589	.161
Lighting	4.216	.145
Subject	3.728	.138
No flaw	6.588	.129
Long duration	4.659	.125
Short duration	4.369	.106

Note. Judgments are divided across expertise level, flaw categories, and display duration variables.

Study 1: Discussion

Study 1, which examined the technical or routine aspects of photographic expertise, demonstrated several main effects and interactions related to expertise level, category of flaw and display duration. First of all, there were marked differences between expert photographers and non-experts. Specifically, expert photographers outperformed novices in their ability to detect photographic flaws. It is interesting to note that experts were more likely to detect any category of flaw (as opposed to placing an image in the 'no flaw' category) especially when given ample time to do so. Non-experts chose the

'no flaw' category more frequently, especially, when they were given only one second to view each image. When given eight seconds to view each image, experts were more likely to uncover more composition flaws while novices did not show that tendency. Experts were also harsher critics of photographic quality.

Furthermore, the results also revealed that participants' performance varied based on category of photographic flaw and display duration. The differential effects of the category of photographic flaw involved easier detection of 'lens' and 'lighting' flaws but also harsher quality judgments of images possessing those flaws, especially 'lens' flaws. The highest average quality ratings were obtained for the 'no flaw' category, which validated the initial categorization of those images. In general, participants (particularly novices) were biased toward choosing the 'no flaw' category. The 'composition' and 'subject' were the least frequently identified flaw categories, however, in the long (8-second) display duration condition, expert participants, were more likely to detect 'composition' flaws than they did in the short (1-second) duration condition. This suggests that qualifying composition errors may require a more conscious effort and time than does detecting other types of flaws or judging an image as 'flawless'. The 'subject' category was the least agreed upon and images with perceived subject flaws were rated as second lowest in quality (images with 'lens' category of flaws received the lowest average quality ratings). In general, participants judged images more harshly when viewing the images for eight seconds each than when viewing them for one second each.

The project thus far has focused on the technical aspects of photographic expertise which arguably form the basis of photographic craft. There is no question that one cannot excel as a photographer, or any visual artist for that matter, without a firm training in the

principles of design and techniques relevant to the practiced creative domain. However, photography is also a creative field; thus, in addition to studying the technical aspects of photographic expertise, one must also look at the creative processes.

Creative processes may be essential to bolstering high quality of work in artistic photography. The next part of this research project will concentrate on the productive aspects of photographic expertise. We asked participants, photographers and novices, to utilize their skills in creating images through a set of cropping tasks. It is important to mention that even though the next study will attempt to explain productive or creative aspects of expertise, participants' performance likely involved both their creative as well as their technical skills.

CHAPTER 3

STUDY 2: PRODUCTIVE ASPECTS OF PHOTOGRAPHIC EXPERTISE

Study 2: Method

Study 2 consisted of two parts: image generation and image quality rating. The image generation portion of Study 2 included three studies in which expert photographers and novices produced new photographic images. In the image quality rating portion of Study 2, a different set of expert and novice participants rated the quality of the photographs produced in the three image generation tasks. The methodology of each kind of task is now presented.

Image Generation Tasks: Participants

Participants who completed the flaw detection task (see Study 1) were subsequently asked to complete the image generation tasks, where creative aspects of photographic expertise were evaluated. The image generation tasks were completed by the same participants as in Study 1: 20 experts and 20 novices (see Method in Study 1 for participants' information).

Image Generation Task: Materials and General Procedure

We asked participants to generate a series of digital photographic images by completing three cropping tasks. The goal of this set of tasks was to attempt to demonstrate the difference between trained photographers and novices on several key aspects of the photographic process. Both groups produced images under three experimental conditions: a spatial or 'where' condition, a temporal or 'when' condition, and a spatio-temporal mixed condition.

Image Generation Spatial Task: The 'Where' Aspect of Photography

The first image generation task, assessing the spatial or 'where' aspect of photography (Hurn & Jay, 2008) was evaluated by asking participants to frame several interesting images out of a static but visually complex scene presented as a full screen image (see Figure 10). This task was used to approximate photographers' activities involving zooming in and out of a scene in order to crop the best possible image. The image was presented on a PC desktop computer using a 15" LCD monitor. Each image was presented using the full screen version of the Windows Picture Viewer upon which a screen-capture program Cropper v1 .9.3.89 was superimposed. The cropping program consisted of a movable and re-sizeable floating frame. The frame was moved by placing the cursor within the frame and resized by dragging any of its outer edges. The frame was rectangular in shape, shaded in blue (10% opacity) with the current frame size (in pixels) displayed the in the upper left corner. Initially, participants were trained to use the Cropper software, i.e., moving and resizing the frame and double-clicking inside the frame to automatically save the image. They were allowed to zoom the basic image in and out if they chose to crop a smaller area of the image. The experimenter worked with each participant to answer any questions and ensure proper cropping and coding of images.

Figure 10. The photograph of a complex scene used in the image generation spatial task.

Each participant was initially instructed to frame and capture 5 images of which they later chose their two best images. Participants were not bound by any timeframe; however, all participants produced their five crops fairly quickly (within several minutes). The instructions read as follows:

> You will see a large and visually complex photograph. Imagine that you are capturing photographs that will later be evaluated. Using the Cropper's floating frame, crop five visually appealing images. You may use any portion of the screen, zoom in and out, and resize the frame to capture the best crop by dragging the frame and resizing it at the corners. Use as much time as you need.

The cropped images were automatically saved into a designated folder. After the cropping task each participant indicated their top two cropped images. All the images were then coded with the participant's code number and whether they are in the 'best'

category and placed in the folder designated with the participant's code. The overall quality of all the crops was later evaluated by another group of judges (see the 'Image quality rating' task description below). The participants cropped 199 images produced in the 'spatial' task, 99 produced by the 20 experts (one participant cropped four instead of five images) and 100 produced by the 20 non-experts.

Image Generation Temporal Task: The 'When' Aspect of Photography

The second image generation task in Study 2, assessing the temporal or 'when' aspect of photography (Hurn & Jay, 2008), was meant to assess photographic expertise in a somewhat more ecologically valid setting. Participants were asked to capture aesthetically interesting still frames from a video playing an urban theme, just as a photographer would, trying to capture the essence of a dynamic event. The video was displayed using YouTube.com link (http://www.youtube.com/watch?v=cSZPmHzEKUg; see Appendix F for the video screen shots) displayed at full screen setting. Again Cropper v1.9.3.89 screen-capture software was used to implement this task. In this case however, the frame was preset to encompass the entire video screen and participants were asked not to resize the frame but rather to simply double click within the capture frame when they see an interesting scene that they would like to capture as a photographic image. As in the previous task, participants first performed a practice session. Then, they were told that the length of the video is approximately 1.5 minutes long and were asked to capture a minimum of 5 images. They were asked to crop the still frames as if they were a photographer taking a photo of the scene. The instructions were as follows:

> You will see a video of a naturally occurring city scene. Imagine that you are capturing photographs that will later be evaluated. Using the Cropper's fixed frame, crop a **minimum** of five images by double clicking within the frame whenever you see a visually appealing moment. The video is 1.5 minutes long and you will only see it once. Make sure to capture the five frames within that timeframe.

After capturing the frames, participants were asked to choose their two best images to be judged by another sample of raters. The saving and file naming procedure was the same as in the 'spatial' task (see above). The total number of images produced in the 'temporal' task exceeded 200 since most participants cropped more than 5 images. Perhaps because of the time sensitive nature of the task, the participant wanted to ensure that they capture an adequate number of images. To ensure that we have an equal number of produced images as in the spatial task, we retained the selections of the two 'best' images per each participant and selected the remaining three from the larger pool of crops by means of random selection. The goal was to have 100 crops produced by the 20 experts and 100 produced by the 20 non-experts. However, because several of the participants (two experts and one novice) failed to crop the minimum of 5 images, we had fewer crops (193 instead of 200).

Image Generation Spatio-Temporal Task: The Conjunction of "Where" and "When" Aspects of Photography

The third image generation task in Study 2, assessing the conjunction of spatial and temporal aspects of photography, was explored to simultaneously speak to the 'where' and 'when' aspects of the process in the most ecologically valid setting. In the final production task, the participants were asked to frame and capture a minimum of five

images out of a moving, complex scene. As in the previous task, the participants were shown a video using YouTube.com (http://www.youtube.com/watch?v=pX3ZP9Ewnyc) in full screen mode, however, in this task they were asked to crop and resize an image in addition to capturing a visually strong moment (see Figure 11 for example crops). Again, they used the Cropper v1.9.3.89 screen-capture software to crop the images. This time however, participants were prompted to use any portion of the video to crop interesting moments. The instructions were as follows:

> You will see a video of a naturally occurring city scene. Imagine that you are capturing photographs that will later be evaluated. Using the Cropper's floating frame, crop a **minimum** of five images by double clicking within the frame whenever you see a visually appealing moment. You may use any portion of the screen and resize the frame to capture the best crop by dragging the frame and resizing it at the corners. The video is 1.5 minutes long and you will only see it once. Make sure to capture the five frames within that timeframe.

Figure 11. Example series of screen shots from a video used in the image generation spatio-temporal task.

The five produced frames were automatically saved to the designated folder (see 'spatial' task for details). In this task, participants were again instructed to crop a

minimum of 5 images. As in the previous two tasks, they were then asked to choose their two best images. In the spatio-temporal task we also wanted to ensure that we have an equal number of images as in the previous tasks, and we retained the selections of the two 'best' images per each participant and then randomly selected the remaining three from the larger pool of crops. The goal was to have a total of 200 crops but, because one of the expert participants failed to crop the minimum of 5 images, we had a total of 199 crops instead of the 200.

The images across all three production tasks were saved at a screen resolution of 72 dpi, thus quality of the images was not of print quality, yet good enough quality to present them on a computer screen. Particularly, the video crops contained a certain amount of distortion of which participants in the quality rating part were notified. The materials (images and videos) used in this project did not contain any inappropriate content. The expert photographers and non-experts in the production task produced a total of 591 crops. The three image generation tasks evaluated the aspects that we hypothesized are key to the creative part of photographic expertise, the ability to work within spatial and temporal visual elements, and the evaluative ability that allows selection of best images.

Image Quality Rating Task

The second portion of Study 2 involved collecting quality ratings of images, which provided a dependent measure for each of the three image generation tasks. In the image quality rating task, another group of photographers and non-photographers rated the overall quality of images produced in the creative task.

Image Quality Rating Task: Participants

The image quality rating task was completed by another group of experts and novices, 15 experts (11 males, 4 females) and 17 novices (6 males, 11 females). Experts were professional photographers with an average of 11.3 years of experience in photography, M (SD) age = 39.9 (12.3). Novices were Brooklyn College undergraduates with no training in photography, M (SD) age = 21.6 (3.6). They were recruited through the Psychology Department subject pool. Experts in the second part of the study received a $20 Starbucks gift card as compensation for participation and novices received one research participation credit required for their Introduction to Psychology course. All participants reported a medium to high level of computer proficiency.

Image Quality Rating Task: Materials and Procedure

Participants were informed that the study was about how people evaluate photographic images. Each participant was tested individually. Expert photographers and novices evaluated 591 images created in the creating cropping tasks described above. The images were presented in a random order using Super Lab 4.0 software on a PC computer screen. Each image was displayed separately. Participants were first instructed that they would view six practice images and were asked to rate each image on an eight-point Likert scale, with 1 indicating the lowest quality and 8 indicating the highest quality. This approach is supported by previous research on aesthetic judgment (e.g., Kozbelt, 2006; Kozbelt & Serafin, 2009), where quality rating has been shown as the strongest marker of aesthetic value. Participants were asked to utilize the whole range of the scale. They were instructed to rate each image's quality by pressing a number from 1 to 8 using the number

section of the keyboard. In addition, participants were told that the ratings should be quick assessments of quality, there were no right or wrong answers and their judgments should reflect their personal opinions of the images. Upon receiving a rating, the slideshow automatically progressed to the following image. After rating the last practice image, participants were prompted that they are about to rate 591 images using the same eight-point quality scale. At the end of the rating part, each participant filled out a short survey (see Appendix C) assessing, the basic demographic information like gender and age, level of education, and computer proficiency. The photographers were asked about their level of photographic expertise, and what area of photography they practiced. Participants were also given the opportunity to provide voluntary final comments. After the completion of the study the experimenter thanked the participant for their contribution to the research and administered the payment or school credit. The participants were then debriefed as to the purpose of the study. The photographers completed the task by meeting the experimenter either in a designated coffee shop or at a location of their choice. The novices completed the task at the experimenter's office at Brooklyn College. The entire rating task took approximately one hour to complete.

Study 2: Results

General Analytic Approach

Study 2 evaluated differences between expert photographers and novices in their ability to produce photographic images under three conditions: spatial, temporal, and spatio-temporal (Hurn & Jay, 2008). The photographic images were produced by cropping from either a complex static image (spatial task) or from a video (temporal and spatio-temporal tasks). The quality of the produced crops was rated by another group of photographers

and novices using one 'overall quality' item on an 8-point Likert scale. We performed separate repeated-measures ANOVAs for each of the three conditions considering that there were marked differences in the rated quality between the crops produced from the static image and the crops produced from the videos. Each repeated-measures ANOVA analyzed two within-subject variables, 'rater group' (two levels: expert photographers and novices) and 'author's selection' (two levels: best and other), and one between-subjects variable, 'creator expertise level' (two levels: expert photographers and novices). This combination of factors resulted in a $2 \times 2 \times 2$ mixed factorial design.

The Cronbach's alpha reliability statistics computed on the quality ratings were high. For all raters across the three tasks, the reliability was .948. For expert raters the reliability was .873 and for non-expert raters it was .927. When analyzing the ratings for each of the three different tasks the reliability scores were .910, .707, and .758, for the spatial, temporal, and spatio-temporal task respectively.

Each of the image generation tasks, using ratings from the image quality rating task, is now analyzed and discussed.

Image Generation Spatial Task Results

In the spatial task we investigated whether expert creators' crops were rated higher in quality than the non-expert creators' crops. The overall ANOVA analysis of the quality ratings of the images produced in the spatial task showed a significant interaction between the rater expertise and the creator expertise, $F\,(1, 38) = 6.793$, $p < .05$, indicating that expert raters preferred the expert creators' images (see Appendix H for summary ANOVA tables). Provided the hypothesis that experts should be able to distinguish between expert and non-expert creators, it would be beneficial to test whether this

distinction was reliable. The simple effects analysis (using Quasi-F tests) showed a significant effect of creator expertise for the expert ratings, F (1, 76) = 5.99, $p < .05$, but not for the non-expert ratings, F (1,76) = 0.52, p = n.s. (see Table 6 and Figure 12). There was no reliable interaction between selection and creator expertise. However, for the expert ratings, expert creators' selections of the 'best' images received the highest average rating whereas non-experts' 'other' images received the lowest average rating (see Figure 13), and this was the pattern we expected.

The analyses also revealed two main effects of rater group and selection. In general, expert photographer raters judged the images more harshly than the novice raters, F (1, 38) = 204.319, $p < .001$. Images judged as 'best' by the authors of the crops were judged more favorably than other images produced within the task (see Table 6), however, the effect was only marginally significant, F (1, 38) = 3.536, p = .068.

Table 6
Image generation spatial task quality ratings - creator expertise, rater expertise, and selection

Creator	Rater	Selection	Mean Quality	Standard Error
Non-expert Creators	Experts	Best	4.095	.118
		Other	3.742	.116
	Non-experts	Best	5.247	.173
		Other	5.009	.141
Expert Creators	Experts	Best	4.258	.118
		Other	4.078	.116
	Non-experts	Best	5.112	.173
		Other	4.898	.141

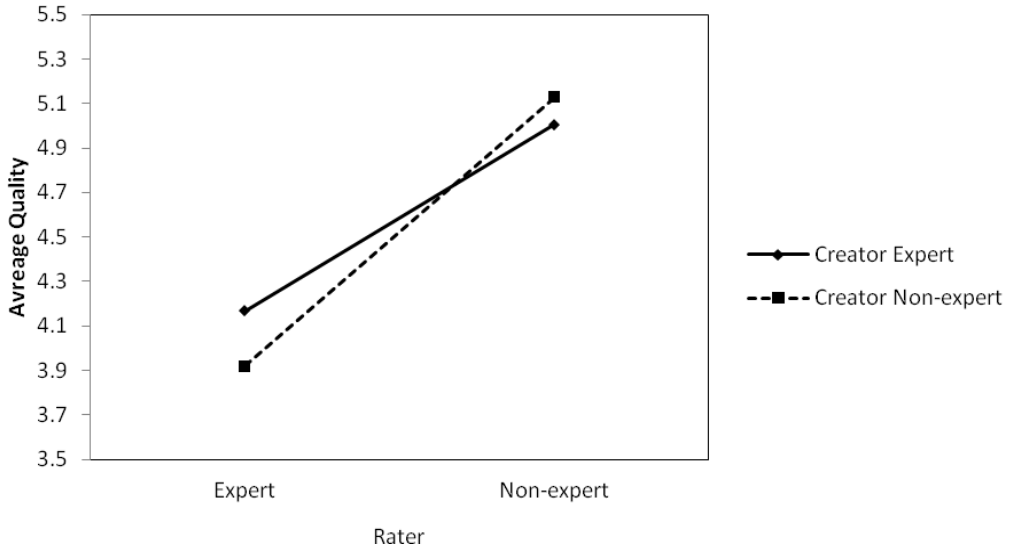


Figure 12. Image generation spatial task: Interaction between creators' and raters' expertise.

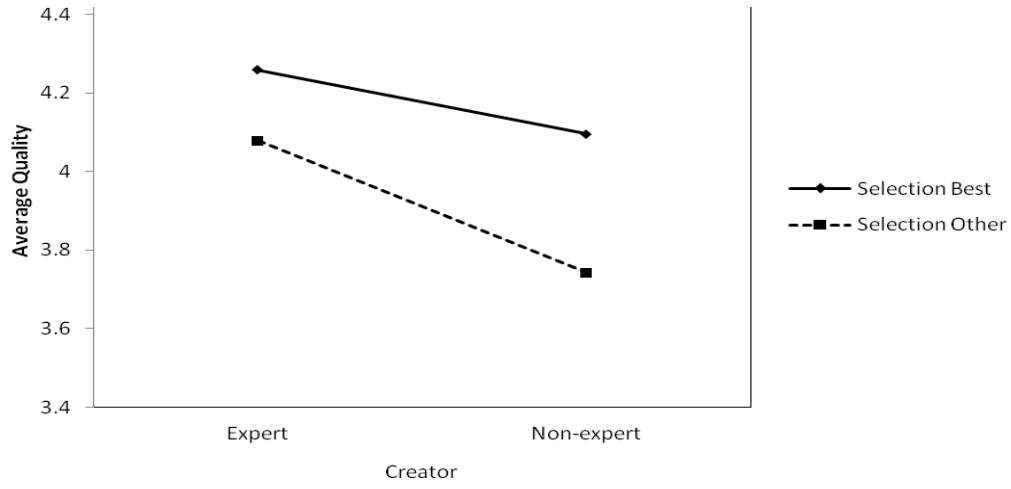


Figure 13. Image generation spatial task: Interaction between creators' expertise and selection.

Image Generation Temporal Task Results

The quality ratings for the images produced in the temporal task were markedly lower than the quality ratings for the images in the above, spatial task. This is most likely a result of the lower technical quality of crops produced from a video rather than from a static image (see the General Discussion section for analysis of the study limitations).

As in the spatial task results, we investigated whether expert creators' crops were rated higher in quality than the non-expert creators' crops. The overall ANOVA analysis produced in the temporal task showed a significant interaction between the rater expertise and the creator expertise , F (1, 38) = 6.116, $p < .05$, indicating that expert raters preferred the expert creators' images (see Appendix H for summary ANOVA tables). To examine whether experts were able to reliably distinguish between expert and non-expert creators we conducted the simple effects analysis using Quasi-F tests. As in the spatial task, the analyses showed a marginally significant effect of creator expertise for the expert ratings, F (1, 76) = 3.77, p = .057, but not for the non-expert ratings, F (1, 76) = 0.27, p = n.s. (see Table 7 and Figure 14). Thus, in the temporal task, only expert raters distinguished between the two creator groups and again preferred the expert raters' crops.

The analysis of the quality ratings for the images produced in the temporal task showed the main effect of rater group but no main effects of selection. In general, expert photographers rated the images more harshly than the novice raters, F (1, 38) = 1389.124, $p < .001$ (see Table 7 for mean values). There was no reliable difference between images judged as 'best' by the authors of the crops and the 'other' images produced, F (1, 38) = .099, p = n.s.

Table 7
Image generation temporal task quality ratings - creator expertise, rater expertise, and selection

Creator	Rater	Selection	Mean Quality	Standard Error
Non-expert Creators	Experts	Best	2.988	.072
		Other	3.008	.053
	Non-experts	Best	4.035	.057
		Other	3.999	.044
Expert Creators	Experts	Best	3.063	.072
		Other	3.139	.053
	Non-experts	Best	3.987	.057
		Other	4.000	.044

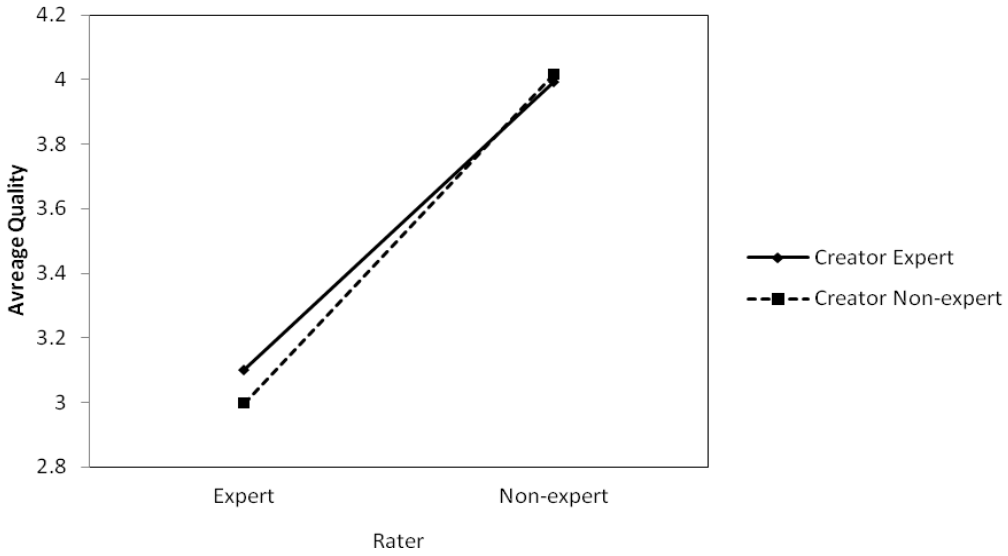


Figure 14. Image generation temporal task: Interaction between creators' and raters' expertise.

Image Generation Spatio-Temporal Task Results

As in the temporal task, the quality ratings for the images produced in the spatio-temporal task were markedly lower than the quality ratings for the images in the spatial task (see the General Discussion section for analysis of the study limitations).

The overall ANOVA analysis produced in the spatio-temporal task produced a slightly different pattern of results than in the previous two tasks with a significant interaction between the rater expertise and selection variables, F (1, 38) = 8.045, $p < .01$ (see Appendix H for summary ANOVA tables). The simple effects analysis (using Quasi-F tests) indicated a significant effect of selection for the expert ratings, F (1, 76) = 20.90, $p < .001$, but not for the non-expert ratings, F (1, 76) = 0.32, p = n.s. (see Table 8 and Figure 15). Thus, in the spatio-temporal task, only expert raters distinguished between 'best' versus 'other' images whereas the non-expert raters were not able to do so (see Figure 15).

Quality ratings of the images produced in the final spatio-temporal also task showed the main effects of rater group and of selection, but the main effect of creator expertise level did not reach significance. As in the previous two tasks, expert photographers rated the images as lower in quality than the novice raters did, F (1, 38) = 179.124, $p < .001$ (see Table 8). There was no reliable effect of the expertise level of the creator, F (1, 38) = 2.547, p = n.s. However, expert creators received consistently higher quality ratings (see Table 8) which is in line with the findings in the spatial and temporal tasks.

Table 8
Image generation spatio-temporal task quality ratings - creator expertise, rater expertise, and selection

Creator	Rater	Selection	Mean Quality	Standard Error
Non-expert Creators	Experts	Best	2.433	.045
		Other	2.241	.055
	Non-experts	Best	2.744	.066
		Other	2.690	.078
Expert Creators	Experts	Best	2.555	.045
		Other	2.344	.055
	Non-experts	Best	2.816	.066
		Other	2.800	.078

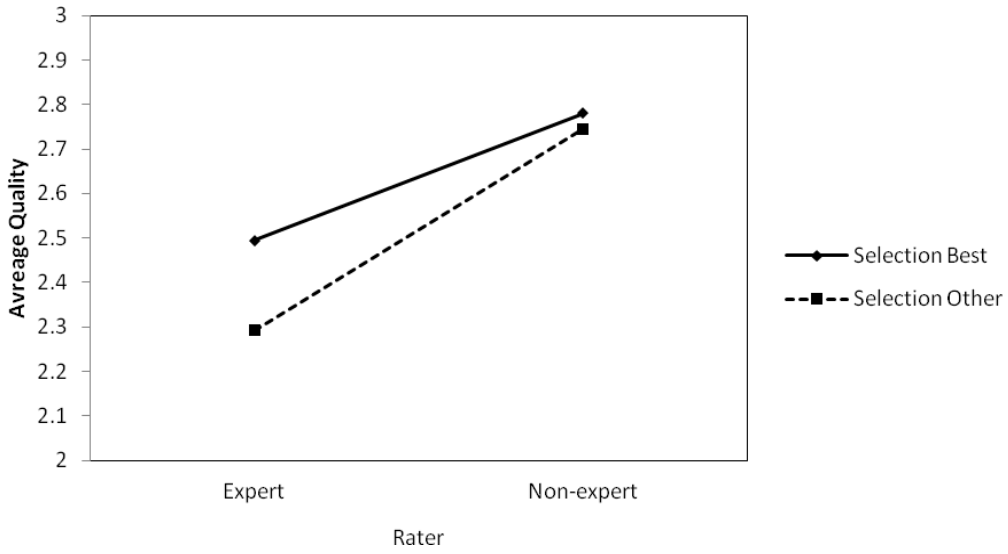


Figure 15. Image generation spatio-temporal task: Interaction between raters' expertise and selection.

Study 2: General Discussion of the Three Image Generation Tasks

Several patterns emerged when we analyzed the judgments on the creative crops produced by expert photographers and non-experts across the three different tasks: spatial, temporal and spatio-temporal.

First of all, there was a robust effect of raters' expertise. Across all three tasks, expert photographers judged the crops more harshly than novice raters did. This effect is in line with some of the previous research looking at quality judgments made by expert and non-expert judges (e.g., McManus, Zhou, I'Anson, Waterfield, Stover, & Cook, 2011) and shows that expertise sharpens one's evaluative skills within the domain of expertise.

Furthermore, we observed significant or nearly significant effects of selection on quality judgments in the spatial and spatio-temporal tasks, with the latter task showing a stronger effect. The selection variable concerned the participants' choices of 'best' versus 'other' images. Interestingly, the effects of selection were observed only in the expert quality ratings suggesting that non-expert raters are not sensitive to picking up the information about possibly better overall quality of some images when presented within a large set of visually similar images. It is plausible to link expert photographers' better performance on choosing the best images to their extensive experience in comparing and quickly selecting the best images from contact sheets or digital image libraries. Since novices have not been trained in such quick scanning of multiple images, they arguably possess no such skill. The effect of selection, however, was not as robust as the effect of raters' expertise. In addition, in the temporal task, which involved stopping a video to capture a still frame, there was no effect of selection. This can likely be explained by the

novelty and the difficulty of the task (selecting a frame from a video); the task was arguably more difficult than the spatial task, which involved a static image. However, by the time participants started the spatio-temporal task, which also used a video, they likely have had sufficient practice and were able to take some of the cognitive focus off of the difficulty of the task. In addition to the effect of selection in the spatial and the spatio-temporal tasks, we also found a significant interaction between selection and rater expertise variables in the spatio-temporal task. Again, this interaction showed that only the expert raters were able to differentiate between images selected as 'best' versus 'other'.

Another effect that emerged in the spatial and temporal tasks was the interaction between creators' expertise level and raters' expertise level. The analysis of simple effects revealed that in those tasks only expert raters were able to differentiate between the crops created by expert photographers and the ones created by non-experts. In those analyses we found either a statistically significant ($\alpha = .05$) or a nearly significant effect of creators' expertise, with experts' crops receiving higher overall quality ratings across all three tasks. This finding that experts are better at differentiating artworks is in line with some research (e.g., Kozbelt & Serafin, 2009) and in opposition to other research (e.g., McManus et al., 2011). Research on artistic expertise is still in its infancy and future research efforts will likely establish whether expertise level has a robust effect on a variety of domain specific creative tasks. Artistic tasks are usually ill-defined (e.g., Jausovec, 1994; Mumford, Reiter-Palmon & Redmond, 1994) and quality ratings of creative products will likely produce 'noisier' patterns than ratings of well-defined problems. In the presented research, contrast the results in Study 2 which included ill-

defined problems and with the results in Study 1 which included slightly more well-defined problems.

Remarkably, we did not find the abovementioned effects of creators' expertise, selection and reliable interactions in the non-experts' ratings. A tentative general conclusion, after examining some technical and creative aspects of photographic expertise, would be that experts are better and more coherent at rating, discriminating and creating images – despite some recent research findings suggesting otherwise (see McManus et al., 2011, Study 6). However, we acknowledge that except for the effect of rater expertise, the effects were not very strong, which possibly explains the contradictory findings in the literature. Conceivably, a higher level of experimental control (e.g., presentation of a wider range of photographic stimuli, larger sample sizes, accounting for sex differences) would increase the possibility of establishing whether experts are better on creative tasks at least partially as a function of their expertise.

Aside from the technical and creative skills, it would be interesting to examine the specific aspects that make up aesthetic quality of photographs and whether aesthetic judgment criteria in photography are affected by one's level of expertise in the domain. We examined this question in Study 3 by looking at differences in aesthetic judgment criteria among expert photographers and non-experts.

CHAPTER 4

STUDY 3: AESTHETIC JUDGMENT CRITERIA

Study 3: Method

Participants

Study 3 included 15 experts (7 males, 8 females) and 16 novices (4 males, 12 females). Experts were professional photographers with an average of 15.1 years of experience in photography, M (SD) age = 41.8 (12.6). Novices were Brooklyn College undergraduates with no training in photography, M (SD) age = 23.6 (7.7). Experts received a $20 Starbucks gift card compensation for participation and novices received one research participation credit required for their Introduction to Psychology course. Both groups reported medium to high computer proficiency.

Just as in Study 1, the sample of experts was recruited through several sources: ads (Craigslist.org), emailing photography faculty at the International Center of Photography in New York City, and recommendations by other photographers who participated in Study 1. Non-experts were psychology undergraduates recruited through the Brooklyn College Psychology Department subject pool (see ads in Appendix A).

Materials and Procedures

In Study 2, participants were informed that the study is about how people evaluate photographic images. Each participant was tested individually. The non-experts performed the task in the experimenter's office at Brooklyn College whereas expert photographers performed the task at various meeting locations in New York City (e.g., coffee shops, other campuses, or a participant's residence; the most often used meeting and convenient location, however, was a large coffee shop). This was possible as the task

consisted of rating 30 images on a PC laptop computer screen. Participants were advised to bring headphones in case of noisy/disruptive conditions. Initially, each participant filled out a consent form. The main aesthetic judgment task was used to establish criteria that experts and non-experts use when evaluating photographic images. Participants evaluated the 30 images described in Study 1. The images were presented in a random order using Super Lab 4.0 software. Participants were instructed that they will see 30 photographic images, and they will rate each image's quality by filling out a 26-item survey. They were also asked to advance through the slideshow at their own pace but to try to finish within the allotted time frame (one hour); thus, each rating took on average almost 2 minutes—which is comparable to previous research (e.g., Kozbelt, 2006; Kozbelt & Serafin, 2009). The survey items were based on another study of aesthetic evaluation (Kozbelt & Serafin, 2009), a study of aesthetic evaluation in photography (Axelsson, 2007) and aesthetic criteria used in a photographic manual (Freeman, 2007). There were a few overlaps among the items when they were pooled and they are represented as one item. The final survey included the following 26 dichotomous items, which were evaluated on a Likert scale from 1 to 8: Weak composition/Strong composition, Not original/Very original, Weak content/Strong Content, Unconventional/Conventional, Unplanned/Planned, Documentary - objective intent/Expressive - subjective intent, Unpleasant/Pleasant, Tasteless/Tasteful, Uncomfortable/Comfortable, Unappealing/Appealing, Expressionless/Expressive, Lifeless/Lively, Uninteresting/Very interesting, Unfamiliar/Very familiar, Rare/Common, Unexpected/Expected, Incomprehensible/Comprehensible, Simple/Complex, Clear/Ambiguous, Static/Dynamic, Passive/Active, Concrete/Abstract, Not obvious/Very obvious, Not realistic/Very

realistic, Low technical quality/High technical quality, Low overall quality/High overall quality. Each survey item was presented separately at the bottom of the screen. After rating an image on each item, participants proceeded to rate the image on the next survey item until the image was rated on all 26 items. After the 26th rating, the following image was displayed and the new survey began. At the end of the study, each participant filled out the same short demographic survey used in Study 1 (see Appendix C). After the completion of the study the experimenter thanked the participant for their contribution to the research and administered the payment or school credit. The participants were then debriefed about the purpose of the study.

Study 3: Results

In Study 3, we examined aesthetic judgment criteria of expert photographers and novices. A maximum-likelihood factor analysis with varimax rotation (four factors) revealed that experts and non-experts show both similarities and differences in their aesthetic judgment criteria. For experts' responses the four factors jointly explained 62% of the variance and for the novices' responses the four factors jointly explained 47% of the variance. In general, experts' responses show a clearer pattern suggesting that the group possesses more well-defined judgment criteria. In the analysis of experts' responses, almost half of the survey items loaded strongly on the first factor which suggests an overall quality factor (see Table 9, items are sorted according to the loading strengths on factor 1 in the expert group). Experts associated quality with a host of variables: pleasantness, appeal, tastefulness, comfort, expressiveness, content, composition, and technical quality. In the analysis of experts' responses, overall quality loading on the first factor was weaker than some of the items. The strongest loadings

suggest that the factor also represents appeal, tastefulness, pleasantness, comfort, interest, content, and composition.

Table 9
Aesthetic judgment factors and factor loadings

Item	Experts				Non-experts			
	F1	**F2**	**F3**	**F4**	**F1**	**F2**	**F3**	**F4**
Pleasant	**0.91**	0.13	0.10	-0.02	**0.73**	0.07	0.23	0.08
Appealing	**0.84**	0.25	0.27	-0.01	**0.89**	0.06	0.17	0.08
Tastefulness	**0.81**	0.19	0.07	-0.11	**0.80**	0.08	0.10	-0.03
Comfort	**0.73**	-0.07	-0.03	0.17	**0.69**	0.22	0.12	0.13
Quality	**0.73**	0.38	0.27	-0.05	0.46	0.00	0.29	**0.61**
Expressiveness	**0.67**	0.23	0.48	-0.05	0.39	-0.01	**0.60**	0.08
Technical quality	**0.58**	0.27	0.22	0.07	0.39	0.16	0.14	**0.76**
Content	**0.57**	0.50	0.40	-0.07	**0.60**	-0.15	0.28	0.20
Composition	**0.57**	0.37	0.29	0.04	**0.60**	0.04	0.06	0.28
Lively	**0.55**	0.19	**0.58**	-0.07	0.26	0.05	0.72	0.05
Interesting	**0.54**	**0.57**	0.43	-0.11	**0.64**	-0.15	0.45	0.18
Originality	0.37	**0.63**	0.32	-0.20	0.36	-0.30	0.27	0.19
Complexity	0.34	0.40	0.46	-0.32	0.32	-0.38	0.38	0.01
Comprehensible	0.28	-0.13	-0.04	0.48	0.28	**0.54**	0.03	0.19
Dynamism	0.27	0.20	**0.84**	-0.17	0.10	-0.14	**0.68**	0.13
Active	0.23	0.11	**0.78**	-0.24	0.13	0.02	**0.78**	0.07
Document/ expressionist	0.16	0.09	0.28	-0.24	0.13	-0.02	0.42	0.07
Abstract	0.07	0.07	0.27	-0.64	0.11	-0.40	0.35	-0.07
Realism	0.01	-0.22	0.10	0.63	0.06	0.44	0.04	0.20
Planned/Reactive	0.01	-0.16	-0.26	0.03	0.13	0.24	-0.22	0.03
Obvious	-0.04	-0.33	-0.17	**0.74**	-0.01	0.42	0.14	0.08
Ambiguity	-0.06	0.13	0.19	**-0.75**	0.04	**-0.51**	0.27	-0.08
Familiarity	-0.12	**-0.70**	-0.08	0.38	0.13	**0.55**	0.01	-0.17
Conventionality	-0.17	**-0.58**	-0.21	0.32	0.07	0.49	-0.05	0.05
Expected	-0.26	**-0.75**	-0.26	0.34	-0.08	**0.69**	-0.09	-0.18
Rare/common	-0.28	**-0.80**	-0.19	0.27	-0.13	**0.81**	-0.10	-0.12

Note. Expert photographer raters' factor loadings are on the left, and non-expert raters' factor loadings are on the right. Items were sorted by the first factor loadings according to the expert ratings. Loadings with absolute value above .50 are bolded.

For novices, the only high loadings on the fourth factor are overall quality and technical quality (see Table 9) suggesting that non-experts associate those two aspects

together and separately from other aesthetic aspects of images. For both groups, factor 2 represented originality/familiarity dimension and factor 3 represented dynamism. For experts' responses, the fourth factor represented obviousness or realism. Interestingly, non-experts clustered items such as realism or not-abstract together in the second, 'familiarity' factor, whereas experts clustered those as a separate, fourth factor: comprehensible, not-abstract, realistic, obvious, not-ambiguous. This possibly suggests that non-experts fold realism under familiar whereas experts treat it as a separate factor. Contrary to previous research using drawings (Kozbelt, 2006; Kozbelt & Serafin, 2009), we did not find that experts associate quality mainly with abstraction whereas non-experts value realism. Yet, we did see that novices do seem to associate quality with technical skill separately from all other aspects of aesthetic quality, a pattern not evident in the experts' data.

Study 3: Discussion

We found both similarities and differences between expert photographers and novices. For instance, both groups valued appeal and pleasantness of images. The similarities in responses suggest that with the ubiquity of high quality visual stimuli, most people are experts in visual perception and they share at least some aesthetic judgment criteria. However, the results also revealed important differences in aesthetic judgment between expert photographers and non-experts that presumably stem from the differences in training between both groups. First of all, experts' responses show more clearly articulated patterns as to the importance of the different aesthetic factors. Photographers associated quality with several aspects such as pleasantness, technical quality, content and expressiveness, which suggests that this group requires many aesthetic factors to

converge before they consider an image as high in quality. This pattern was not as evident in the non-experts' responses. On the contrary, novices seemed to separately associate overall quality with technical quality mostly which suggests that this group can view images as either high or low in quality simply if they possess the associated high or low technical quality (perhaps, subjectively defined). This finding at least partially replicated previous finding in other artistic domains (e.g., Kozbelt, 2006; Kozbelt & Serafin, 2009). Perhaps this stress that non-experts place on technical quality is anecdotally relevant to liking 'calendar art' or 'elevator music' which arguably represent proper technical execution but rarely are considered fine art. To further elucidate and validate the above results, future research should include a larger number of participants in both expert-photographer and novice groups as well as a wider range of photographic stimuli. Perhaps, including abstract photographs, emotionally charged photographs (e.g., war images), sports photographs, etc., would allow for a better teasing out of the factors affecting aesthetic judgment of photographs. Overall, this pattern of responses suggests that training in an artistic domain such as photography at least somewhat alters aesthetic judgment criteria. However, Study 3 was largely exploratory and a more extensive set of responses would be needed to establish a more sound factor structure.

CHAPTER 5

GENERAL DISCUSSION

Summary of the Research Findings

The present research is one of the first attempts to empirically study factors that underlie expertise in artistic photography. The hypotheses that we set out to test were mostly supported. Firstly, experts outperformed non-experts on both the routine and productive tasks. In addition, the aesthetic judgment criteria of expert and non-experts raters showed both similarities and differences which may suggest that variability in aesthetic experience is mediated by level of expertise.

Technical or Routine Aspects of Photographic Expertise

In Study 1 we examined routine aspects of photographic expertise. The stimuli were photographs selected based on agreement among expert photographers in the stimulus generation study as to the major type of photographic flaw represented in each image. There were five categories of images, with four flaw categories: lighting, lens, composition, and subject, and one 'no flaw' category. The performance of expert photographers and non-experts in Study 1 was evaluated based on that categorization. The results demonstrated that expert photographers outperformed novices in their ability to detect photographic flaws. In addition, experts judged photographic quality more harshly than non-experts.

Beyond the effect of expertise, we also found differential performance based on flaw categories and display duration. In general, participants were more likely to correctly identify 'lens' and 'lighting' flaws than the 'composition' or 'subject' flaws. Interestingly, images possessing flaws that were easier to detect were also judged as

lower in overall quality, especially images containing ‘lens’ flaws. The highest average quality ratings were obtained for the ‘no flaw’ category, which validated the initial categorization. However, it is worth mentioning that participants were biased toward choosing the ‘no flaw’ category. One possible explanation for that bias lies in the fact that participants were not able to detect the flaws, especially the more subtle ones and when only given a very short time (one second) to view the image. However, in general, participants were remarkably more accurate in detecting flaws when presented the images for a shorter period of time, but they also rated images as lower in quality when viewing them for a shorter duration. This pattern suggests that participants (especially trained photographers) may rely on quick, gut reactions for accurate estimates of technical errors and critical quality judgments. This advantage of short presentation may be especially applicable to the domain of photography, which relies heavily on quick selection of a small number of high quality images out of a larger image set (e.g., choosing one outstanding image out of a contact sheet containing 36 images). In addition, immediate impact plays a great role in many genres of photography (e.g., advertising).

Not all technical issues, however, benefited from shorter presentation. ‘Composition’ and ‘subject’ were the least frequently identified flaw categories, especially in the one-second display condition. When given eight seconds to view images, participants were more likely to correctly detect composition flaws. This suggests that identifying composition errors may require more conscious effort and time than does detecting other types of flaws or determining whether an image is basically flawless. The ‘subject’ category received the lowest number of accurate identifications. In addition, images with perceived ‘subject’ flaws were rated as second lowest in quality

(images with 'lens' flaws received the lowest average quality ratings). This may suggest that evaluating content is a highly idiosyncratic activity, and experts in particular, may not feel comfortable in discriminating among photographic subjects (McManus et al., 2011). Conversations with some of the photographers who completed Study 1 revealed that they often assumed that authors must have intentions for taking photographs and therefore few subjects are truly 'wrong.' Hurn and Jay (2008) argued that successful photographic training is not obtained for its own sake but rather through deep interest in the photographed subject. "A unique [photographic] style … is the by-product of visual exploration, not its goal" (Hurn & Jay, 2008, p.56). Therefore, the issue of 'subject' or content is perhaps independent of other aspects of technical training in photography or may be more tightly linked to the productive or creative side of photography.

Productive or Creative Aspects of Photographic Expertise

In the productive tasks (Study 2), expert photographers and novices produced a series of images based on the hypothesis that spatial, temporal, and selections factors affect creative photography production. As hypothesized, we found that images produced by experts were rated higher in overall quality (based on judgments by a separate group of experts) than images produced by non-experts under all the conditions: spatial, temporal, and spatio-temporal. The effects were marginally significant, but in a consistent direction across studies. In addition, expert judges also preferred the selections of the 'best' images (in two of the three conditions, spatial and spatio-temporal). There was also a strong effect of raters' expertise. Across all three tasks, expert photographers judged the crops more critically than novice raters did. This effect suggests that expertise likely sharpens one's evaluative skills within the domain of expertise.

Non-expert raters were not sensitive to the image groupings based on expertise of creators and selection variables. Perhaps since novices do not disassociate overall quality from technical quality (see the discussion of the aesthetic judgment criteria below), they do not distinguish the multiple facets of artistic quality among the images, arguably because of their technical inferior quality (e.g., slight pixelization). Therefore, it is possible that the images were rated only for technical quality, all other aspects being unrecognized. Experts possibly can see beyond technical quality and therefore, detect multiple potential merits in photographs. Nonetheless, non-experts in general judged the images more favorably than experts did but produced no patterns of results to align with study variables: creator expertise and selection. The key to understanding why non-experts produced no cohesive pattern of results may lie in how their aesthetic judgment criteria differ from experts' criteria.

Aesthetic Judgment Criteria

The analysis of photographers' and non-photographers' aesthetic judgment criteria did reveal differences between the two groups (consistent with previous research, e.g., Kozbelt & Serafin, 2009). However, interesting similarities emerged as well. For example, both groups associated appeal and pleasantness with quality. The similarities in aesthetic criteria in photography, which depicts realism, are expected at least to some degree since most people are experts in visual perception. On the other hand, the pattern of differences in our sample of photographers and non-photographers was not the same as patterns found when looking at other type of visual artists, such as when painters were compared to novices. Kozbelt and Serafin (2009) found that artists mainly value originality whereas novices mainly value technical skill. In our sample, we found that

despite the similarities in judgment criteria, photographers' patterns were more well defined and took into account many criteria (e.g., pleasantness, technical quality, content and expressiveness) to establish overall quality.

Both groups also showed that they paid attention to such factors as originality and dynamism. The difference between the two groups emerged only on the fourth factor where for the novices responses technical quality and overall quality were the only components of that factor. Photographers' ratings showed no such factor. This is a curious trend especially considering anecdotal evidence that novices are perhaps more receptive to 'calendar art' or 'elevator music'—in other words, pieces that are technically correct but possess little artistic value. However thought provoking, these findings are exploratory. A larger sample of participants, more diverse image selection, and additional survey items would be needed to establish a more reliable factor structure.

Implications and Significance of the Research Findings

The most obvious merit of this study lies in simply identifying the main aspects of expertise in artistic photography. In general, the above findings imply that expertise influences not only photographers' technical or routine skills, but that it also potentially affects both their ability to create high quality works and their aesthetic judgment criteria. This is in opposition to 'chance' views of creativity (e.g., Martindale, 1990; Simonton, 1997) which assume no role of expertise in the creative process. In fact, the 'chance' accounts provide little insight into the exact processes that guide creativity.

Notably, the present study is, to our knowledge, one of the first controlled, empirical investigations of the topic of creative expertise in photography. Despite photography's popularity, the multitude of publications on its technical aspects,

photographers' comments, and the many theoretical treatments on the creative and aesthetic value of photographs, few of the notions in the literature and anecdotal sources have been systematically tested. Such a gap between art theory and experimentation is common to other arts as well (Reber, 2008). There is undeniable value to theoretical accounts, and the present study drew from these sources. For example, on the value of 'spatio-temporal' and selective abilities as crucial to photography, Holleley (2009) wrote: "All photography is a process of selection. Initially the photographer goes out into the world and selects slivers of time and space. Subsequently, after the images are processed, individual images are selected from the proof sheet and printed. Finally, there comes a stage when these images accumulate to the point at which another selection process comes into play. This final stage is called editing" (p. 3). This research project began to elucidate the nature of the initial steps in taking photographs. Later stages, like editing, might be tackled in future research.

Thus, several interesting findings emerged in the present research and may be used to formulate tentative conclusions about the nature of expertise in artistic photography. For example, we found that experts are better than novices at detecting photographic flaws and that some flaws are easier to detect than others. Viewing time for an image plays a role as well (e.g., when detecting a composition flaw, one needs more time, whereas with lighting or lens flaws, a very short time is sufficient to make a judgment). The 'subject' flaw was the least agreed upon among participants. Perhaps, as McManus et al. (2011) stated, it is very hard to convince artists to see that there is anything definitely wrong with the content of an image. Therefore, 'subject selection' is potentially not a technical flaw and should be treated separately while a library of

concrete, technical flaws can be expanded. For example, in a very recent study, McManus et al. (2011) included the Hicks (2005) Rules of Composition: focal point, rule of thirds, format, line, tonal mass, accent, balance, pattern or compositional shape, leading the eye, concentration of interest, tonality, and color.

The ambivalence about the choice of subject may potentially be related to higher openness and tolerance of ambiguity among expert photographers. Both of these factors are more likely to be linked to the creative rather than routine aspects of expertise. Indeed, research shows a correlation between creativity and tolerance of ambiguity, with tolerance of ambiguity defined as “the ability to tolerate contradictory and incalculable information” (Grube, 2002, p. 431). Lubart (1999) argued that tolerance of ambiguity is a desirable trait for creativity because creative problem solving necessarily involves reconciling several ill-defined problem components at any given step of the process. Rogers (1954) described other factors that are important to creativity:

> The creative process is defined as the "emergence in action of a novel relational process" from the interreaction of a unique organism and its material and circumstantial environment. The creative impulse is "self-actualizing" and arises out of personal need; not all originality is creative, for it must be manifest in the extensional world. Certain inner conditions are prerequisite: lack of rigidity, tolerance of ambiguity, extensional orientation; "an internal locus of evaluation," or a feeling that the creation satisfies and expresses oneself; and the "ability to toy with elements and concepts" (p. 249).

It is worth exploring in detail the specific factors that are essential to creativity in artistic photography. In the present research we hypothesized and confirmed that time, space, and selection are key elements to adaptive expertise in photography. Undeniably, the creative process in photography differs from processes employed in other visual arts. Unlike paintings, photographs are not renderings or imitations but rather traces of real

scenes and there potentially is power in them that no realistic painting has. From the perspective of expertise research, the decisions that photographers learn to make through years of training—for instance, deciding where to stand, when to press the shutter, and determining which images are best—help produce the most powerful 'traces' of the real. This power of photography is related to some characteristics of human cognition. For example, we have a tendency to forget perceptual details but retain semantic or meaning information of what we encounter (Eysenck & Keane, 2005). However, with the emergence of media such as photography or moving pictures, both, the essence and the perceptual detail are preserved which makes those media so powerful. In other words: "Art critic John Berger … affirms that the photograph is a remnant of the real, unlike any other visual image before it: A photograph is not a rendering, an imitation or an interpretation of its subject, but actually a trace of it. No painting or drawing, however naturalist, belongs to its subject in the way that a photograph does" (Navab, 2001, p. 73). Susan Sontag considered quality of photography to be mystical and aggressive at the same time, "something stenciled off the real, like a footprint or a death mask" (Navab, 2001, p. 73). Therefore, photographers are mostly expert trace hunters. They prevent memories from fading and losing the visual nuances over time by preserving both details and essence of the visual story. There needs to be a selectivity in terms of which details need to be preserved (e.g., perhaps a cluttered background will not be a well-valued memory since it will distract rather than add to the meaning of the visual story).

Photographers are also visual editors of reality. For example, they make decisions as to what is visually important to show along with written stories. Painters select too; however, they are not constricted in terms of time and space, and most of their editing is

slow. Photographers often cannot afford to move slowly when capturing photos. Trained photographers will instinctively begin by positioning themselves appropriately with a sharp focus on the subject, ready to capture it at any moment. Hurn and Jay (2008) mentioned that timing is so crucial, and events often evolve so fast, that photographers will first establish whether the background and its relation to the picture frame work well and then focus all their attention on capturing the subject. From a cognitive psychological perspective this mechanism makes sense, we only have a finite attentional capacity and it needs to be spent wisely (Eysenck & Keane, 2005). To evaluate the plausibility of this process, it would be appropriate to conduct a study where expert photographers and novices create images while their eye movements are tracked to see the differences in distribution of visual focus (Tinio & Leder, in press). In general, people usually do not perform well on divided attention tasks, especially if they involve one perceptual modality—e.g., photographers trying to attend to both foreground and background would have two visual attention tasks. Thus, something has to give. To overcome that, expert photographers indeed learn to excel at framing, finding the appropriate position, and the readiness to capture the appropriate moment (Tinio & Leder, in press). The spatio-temporal task in Study 2 provided the most ecologically valid approximation of this typical photographic process. The task, which included cropping frames out of a video, indeed yielded superior performance by expert photographer in both capturing the images and selecting the most visually appealing of the set.

Limitations

The spatio-temporal task in Study 2 was a reasonable attempt to approximate the experience of capturing images without using actual photography equipment. Removing

cameras from the equation was important to create a task where both expert and novices had a chance at producing sound images. Therefore, the task was simplified to allow only a comparison of psychological variables related to general aspects of photographic expertise, independent of the highly variable equipment details. However, this simplification of the photographic process into a computer task may have somewhat lowered the ecological validity of this research. The limited new empirical literature on psychological aspects related to photography has mostly relied on computer-based tasks (e.g., Davies, Tompkinson, Donnelly, Gordon, & Cave, 2006; McManus et al., 2011; Tinio, Leder, & Strasser, 2011). Perhaps future research methodologies will include use of actual photographic equipment.

Traditionally, research on expertise is largely quasi-experimental and not experimental to allow for comparisons of experts to novices (e.g., Ericsson, 2006b; Kozbelt, 2006; Kozbelt & Serafin, 2009; McManus et al., 2011). This approach which arguably increases ecological validity is also more susceptible to possible third variables and consequently limits causal inferences. For example, in the present research, it is possible that the experts who responded to the study ads had characteristics not shared by the population of photographers they were to represent and that would prevent generalization to all photographers. In addition, the age and gender differences between experts and novices may have at least partially contributed to the results. The expert group was on average about 10 years older with more variation among the ages than the non-expert group where the average age was slightly over 20 years old with little variation (the expected college student age). Thus, the novice group was presumably more uniform and in general less experienced than the expert group. In addition, gender

may have affected the results. The expert groups had either an equal distribution of males and females or a higher proportion of males to females, whereas all three novice groups had a higher proportion of females to males. Finally, we did not pre-select experts based on subject matter and type of photography (e.g., event versus fine art). A digital and video production expert working mostly in event photography is most likely different from someone trained in the analog photography whose main intention is less utilitarian and more concerned with producing fine art or aesthetically pleasing images.

In addition to possible problems with the matching participants, there are a few potential problems concerning the stimuli. One possible problem was related to the range of images that we used. In the technical flaw detection task there was perhaps too much or too little variety in the presented images. To expand the image selection, we would need to add other genres not represented in the sample (e.g., sports photographs). On the other hand, perhaps an opposite approach, were one photograph is manipulated to produce only one specific type of flaw, would be better at elucidating the differences among experts and non-experts in their ability to judge images' technical quality. Arguably, the latter task would be ecologically valid since many expert photographers regularly capture multiple similar images of the same subject and choose only ones that are technically and visually best. It is possible that the aesthetic judgment task would benefit from more variable set of images; for example, we did not have any sports or fashion photographs or photographs evoking strong emotional reactions (e.g., war photographs).

Finally, another potential problem related to stimuli was the low technical quality, especially of the videos in the temporal and spatio-temporal conditions which resulted in

a restriction of range in the quality ratings. Most images were rated similarly and using a restricted range on the lower end of the spectrum (roughly between 1 and 4) as opposed to utilizing the whole range from 1 to 8. Tinio et al. (2011) found that aesthetic judgments are affected by technical quality and degrading technical aspects like contrast, sharpness, and grain will lower the overall quality ratings. In addition, adding several technical problems will have a compounding effect of lowering quality ratings. Tinio et al. (2011) specifically found that degradation of contrast differentially affected quality ratings of both man-made scenes and natural scenes, with the former being judged more critically. In the present study, we used video footage of a city scene which, with the added low technical quality, possibly had a bigger impact on quality ratings than a natural scene would have. Natural scenes possibly possess stronger visual content and require less arousal potential or, in other words, visual enticing of viewers (Martindale, 1994; Cleveland, 2004). Accordingly, using a video of a natural scene would potentially have smaller impact on the judged quality of the crops.

Applications

Despite the minor methodological problems, the present research demonstrated several interesting findings that may find more or less direct applications. Photography training seems the most direct and fitting application. For example, understanding that detecting certain types of flaws (e.g., lens flaws) is much faster than detecting flaws related to the composition of the image may be useful in training beginner photographers to leave time and attention for examining composition of an image and trust that with ample training lens and lighting flaws should be detected quickly and without conscious effort. In that sense, perhaps detecting lens flaws is more amenable to ‘automatizing’ or

'proceduralizing' than detecting composition flaws (Eysenck & Keane, 2005). In addition, since experts were more attuned to picking other experts' and higher quality images, it seems budding photographers should rely on experts' opinions when choosing their own best images (e.g., for display). Arguably, when learning the selection skill, new photographers should closely observe how other experts perform their selections. Anecdotally, as a new photography student, after I developed my first roll of film I let my friend, who was experienced in photography, choose the best photos to enlarge. Just as described in the present project, the photographer made very quick assessments about which images were worth enlarging after a short glance at the contact sheet.

Another photography training application that is potentially needed is developing a survey along the lines of the one we used in Study 1 (routine task) to train new photographers in the skill to detect photographic flaws. Such an instrument would standardize the crucial abilities that photographers use to establish images' technical quality.

The knowledge that experts are better at determining whether images were produced by expert photographers or novices and that there are slight differences in aesthetic judgment criteria between experts and non-experts is useful in situations where one needs to produce images for a specific audience. For example, if an image is intended for the general audience (e.g., magazine readers), perhaps high technical quality is a priority. If however, an image is intended for the highly focused group of photography experts many other factors need to converge to produce compelling images (e.g., pleasantness, originality, and dynamism, in addition to technical quality). It is worth examining whether other types of experts in visual artistic domains – e.g., painters,

graphic artists, web designers – are similarly responsive to such convergence of multiple image quality factors. Previous research with painters (e.g., Kozbelt, 2006; Kozbelt & Serafin, 2009) suggests that this may the case, particularly given the fact that experts associate quality with originality.

Future Directions

Hurn and Jay (2008) pointed out that professional photographers usually do not start to photograph because they are interested in photography just as painters do not start painting because they are interested in painting for its own sake. In both cases, the starting point is an intense interest in a subject whereas the craft, be it using a camera or a brush, is a tool. Perhaps some beginner photographers produce no striking images because they lack this intense connection with content to be photographed. Arguably, when we fish for a subject, we find it hard to catch one, but when we know a great deal and are passionate about a particular subject the photographic opportunities are more likely to occur. For that reason, future research should possibly involve a pre-selection stage where participants will be chosen based on their interests (e.g., portraiture or architecture) and given tasks that either match or do not match their subject interest. This pre-selection should occur for both expert photographers and novices. Such a design would establish whether there is an effect of expertise as well as whether there is an effect of matching subject matter. The condition where experts create images within their chosen subject matter would most likely produce photographs of superior quality. In addition, our finding that the 'subject' flaw category produced the least agreement possibly indicates the idiosyncrasies in people's favored subjects and it is necessary to take that factor out of the equation when trying to establish differences between experts

and non-experts. Thus, to study expertise in any domain one needs to first define the area of expertise as finely as possible. In the case of photography, that means establishing the type of photography on which an expert is mainly focused (e.g., sport, people, architecture). Because photography involves many techniques and serves multiple purposes, defining the particular intended function is important as well (e.g., fashion, advertising, editorial, fine art, documentary, photojournalism, events, portraiture).

Future research should explore the discrepancies in the limited literature on photographic expertise. We found that experts were able to differentiate between crops produced by other experts and novices. There is some disconfirming evidence to this finding coming from research by McManus et al. (2011) who found that experts did not favor crops produced by other experts. The researchers argued that this finding can be explained by the idiosyncrasies in taste. Possible directions could include exploring methodological factors such as technical coordinates, subject matter of the photographic stimuli used in study design, instructions to participants, or control of the level of expertise. The discrepancies may be due to the fact that the experts in the McManus et al. (2011) study were all students enrolled in the Masters Degree in Photography program and could potentially have an intermediate level of expertise. Ample research in the area of expertise suggests that it takes about 10 years to develop a sufficient level of expertise to produce a work of lasting value (Kaufman & Kaufman, 2007; Simonton, 1997)

Future research should also examine the level of creativity needed in photography and compare it with other domains, such as painting. Possibly, photographers are usually considered craftsmen rather than creators. In addition, once aspects of photographic expertise are explored in enough detail, further research may explore the advantages and

disadvantages of photographic expertise just as it has been established in research on expertise in other domains (e.g., Chi, 2006). It would be interesting to see whether expert photographers are susceptible to functional fixedness and biases which are typical of expert performance, particularly when it involves routine tasks.

Finally, photographers' personality and working styles would be interesting to evaluate as potential contributors to expert performance. Research has to some extent explored relationships between creative process and personality (e.g., in Domino & Giuliani, 1997; Henry & Solano, 1983; and especially Kulich & Goldberg, 1978—who found that extraverts produce images that are later judged as more active or mobile), but more research would clearly be useful. Experts' working styles will likely vary. In particular, some photographers may be idea-driven (i.e., 'finders') and others may be process-driven (i.e., 'seekers') (see Durmysheva & Kozbelt, 2010; Galenson, 2001; Kozbelt & Durmysheva, 2007). Alternately, the best expert photographers may perhaps possess a skill set that allows them to shift between the idea-driven and process-driven strategies depending on the immediate demands of the assignment.

APPENDICES

APPENDIX A
Ads for recruiting experts and non-experts

Study 1 & Study 2 (part 1)

Participants Wanted for Experiment on Photography

Participants are needed for a study in the Brooklyn College Psychology Department on how people judge and create photographs. You will evaluate and create several images in a series of computer based tasks. You will also fill out several surveys about your personality and style of work. **To participate, you must be a photographer with several years of experience who focuses on the artistic and aesthetic aspects of photography.** Session times are flexible. **The session lasts about 1.5 - 2 hours and pays $30 plus $5 Starbucks gift card.** If you have additional questions or would like to make an appointment please contact Joanna Serafin, 4311 James Hall, e-mail: JSerafin@brooklyn.cuny.edu, phone: 951-718-5000 ext. 1708.

Participants Wanted for Experiment on Photography

Participants are needed for a study in the Brooklyn College Psychology Department on how people judge and create photographs. You will evaluate and create several images in a series of computer based tasks. You will also fill out several surveys about your personality and style of work. **Only non-artists, non-art majors and individuals with no experience in photography can participate in the study.** Session times are flexible. The study is worth two credits and lasts about 1.5 - 2 hours. If you have additional questions or would like to make an appointment please contact Joanna Serafin, 4311 James Hall, e-mail: JSerafin@brooklyn.cuny.edu, phone: 951-718-5000 ext. 1708.

Ads for recruiting experts and non-experts in Study 2 (part 2) & Study 3

Participants Wanted for Experiment on Photography

Participants are needed for a study in the Brooklyn College Psychology Department on how people judge photographs. You will evaluate the aesthetic value of a series of computer based images. **To participate, you must be a photographer with several years of experience who focuses on the artistic and aesthetic aspects of photography.**

Session times are flexible. **The session lasts about one hour and pays $20 Starbucks gift card.** If you have additional questions or would like to make an appointment please contact Joanna Serafin, 4311 James Hall, e-mail: JSerafin@brooklyn.cuny.edu, phone: 951-718-5000 ext. 1708.

Participants Wanted for Experiment on Photography

Participants are needed for a study in the Brooklyn College Psychology Department on how people judge photographs. You will evaluate the aesthetic value of a series of computer based images. **Only non-artists, non-art majors and individuals with no experience in photography can participate in the study.** The study is worth one credit and lasts about one 4hour. If you have additional questions or would like to make an appointment please contact Joanna Serafin, 4311 James Hall, e-mail: JSerafin@brooklyn.cuny.edu, phone: 951-718-5000 ext. 1708.

APPENDIX B

Photo Quality Evaluation Survey

ID# _____ Image number_____

The photograph has: _____ major flaw(s) _____ no major flaws

If applicable, check the image's **main** flaw category (please identify only one flaw that you find most important):

Composition: _____ Specify:

_____

[e.g., poor composition, violation of the "rule of thirds", inappropriate angle, weak foreground, cluttered background, awkward perspective, lack of balance/dynamism, poor choice of frame shape, tilted horizon]

Camera & lens control: _____ Specify:

_____

[e.g., lack of focus, displaced focus, camera shake, slow shutter speed, inappropriate depth of field, lens distortion, poor choice of lens]

Lighting: _____ Specify:

_____

[e.g., poor choice of lighting, underexposed, overexposed, insufficient contrast, excessive contrast, poor dynamic range, direct flash, inappropriate time of day, poor color balance]

Subject: _____ Specify:

_____

[e.g., weak content, poor choice of moment, visually uninteresting]

Rate overall quality:

Lowest 1 2 3 4 5 6 7 8 Highest

Other comments:

_____

APPENDIX C

Demographic information survey

ID# _____ **DATE_____**

Age_____ Gender: M F

Expert photographer _____ Not an expert photographer _____

Highest attained level of education:

High School: ____ College: _____ Graduate: _____

Total years of education: _____

Total years of education in photography: _____

Total years of working systematically within photography: _____

Rate your basic computer proficiency (e.g. word processing, web browsing):

Low: ____ Medium: ____ High: ____

Rate your computer image editing skills (e.g. using Photoshop, Lightroom):

Low: ____ Medium: ____ High: ____

Rate your darkroom skills (e.g. film developing, photo developing):

Low: ____ Medium: ____ High: ____

Creative Achievement in Photography

Place a check mark beside sentences that apply to you

___ 0 I have no recognized talent in photography

___ 0 I have no training in photography

___ 1 I am moderately proficient in using photographic equipment

___ 2 I am extremely proficient in using photographic equipment

___ 3 I have created several artistic, photographic images (number ____)

___ 4 My photographic talent has been critiqued in a local publication or exhibition

___ 5 My photographs have been professionally published (number of times ____)

___ 6 My photographs have been sold publicly

___ 7 My photographs have published in a national publication (number of times ____)

My specific photographic activities include:

___ Fine art

___ Teaching

___ Commercial (e.g., fashion, product photography)

____ Photojournalism

____ Street

___ Portrait (e.g., headshots, studio portraiture)

____ Travel

____ Other; specify:_____

Is “photographic impact” related to its technical quality? _____

Final comments: _____

APPENDIX D
Aesthetic judgment survey items

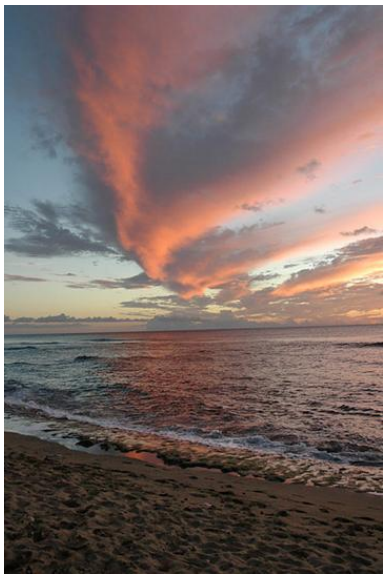
ID# _____ Image number_____

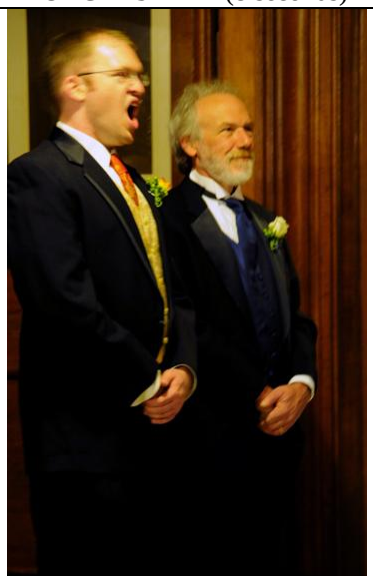
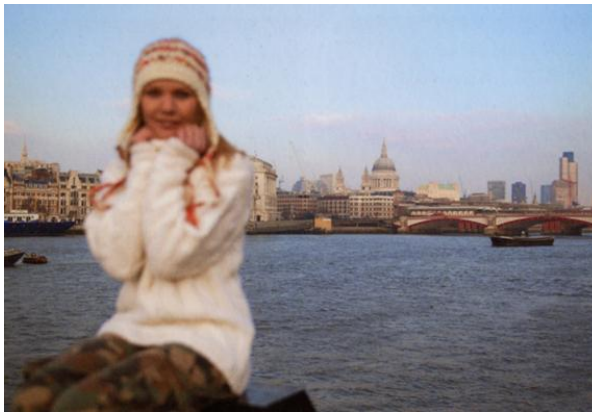
Rate the image's overall quality:

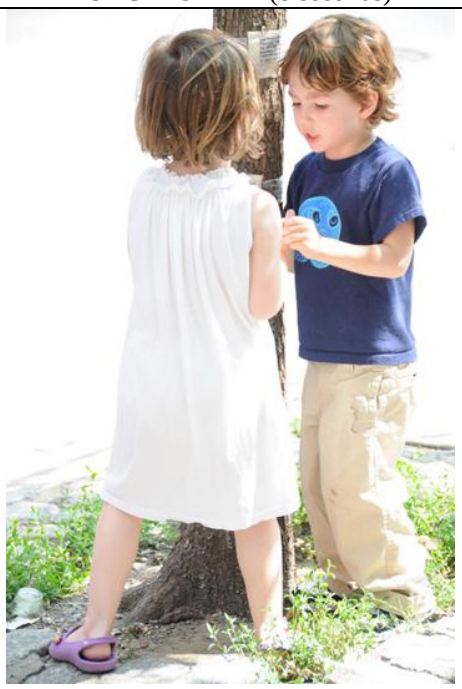
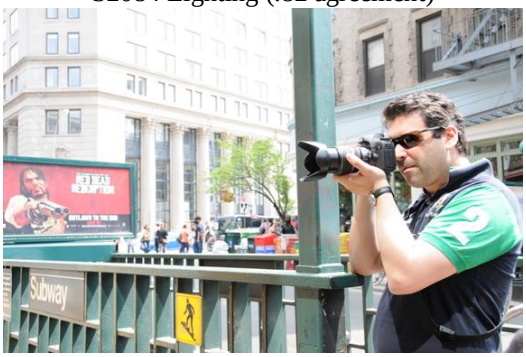
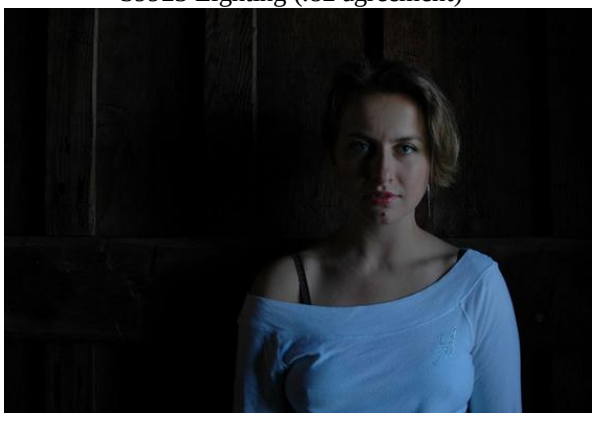
Lowest quality	1	2	3	4	5	6	7	8	Highest quality
Lowest technical quality	1	2	3	4	5	6	7	8	Highesttechnical quality
Weak composition	1	2	3	4	5	6	7	8	Strong composition
Not original	1	2	3	4	5	6	7	8	Original
Weak content	1	2	3	4	5	6	7	8	Strong content
Conventional	1	2	3	4	5	6	7	8	Challenging
Planned	1	2	3	4	5	6	7	8	Reactive
Documentary	1	2	3	4	5	6	7	8	Expressionist
Unpleasant	1	2	3	4	5	6	7	8	Pleasant
Tasteless	1	2	3	4	5	6	7	8	Tasteful
Uncomfortable	1	2	3	4	5	6	7	8	Comfortable
Unappealing	1	2	3	4	5	6	7	8	Appealing
Expressionless	1	2	3	4	5	6	7	8	Expressive
Lifeless	1	2	3	4	5	6	7	8	Lively
Not interesting	1	2	3	4	5	6	7	8	Interesting
Unfamiliar	1	2	3	4	5	6	7	8	Familiar
Rare	1	2	3	4	5	6	7	8	Common
Unexpected	1	2	3	4	5	6	7	8	Expected
Incomprehensible	1	2	3	4	5	6	7	8	Comprehensible
Simple	1	2	3	4	5	6	7	8	Complex
Clear	1	2	3	4	5	6	7	8	Ambiguous
Static	1	2	3	4	5	6	7	8	Dynamic
Passive	1	2	3	4	5	6	7	8	Active
Concrete	1	2	3	4	5	6	7	8	Abstract
Obvious	1	2	3	4	5	6	7	8	Not obvious
Realistic	1	2	3	4	5	6	7	8	Unrealistic

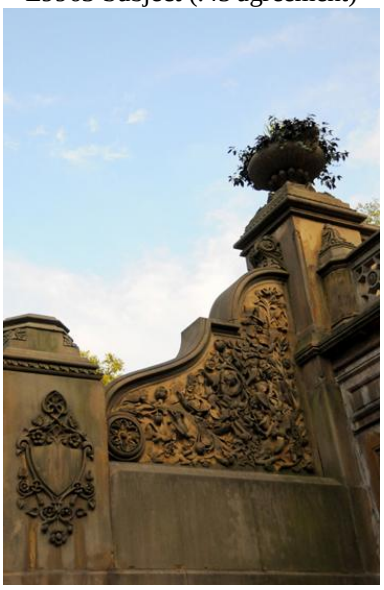
APPENDIX E

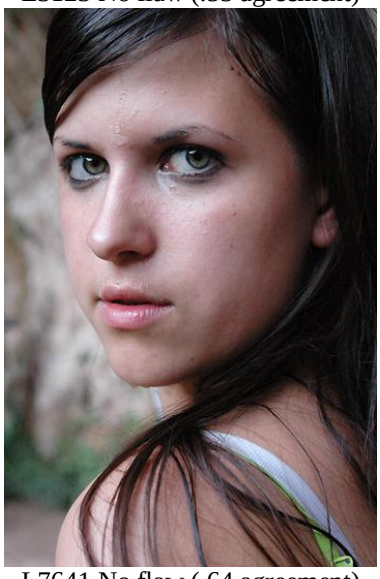
Study 1 photographic stimuli and generation study agreement scores

LONG DISPLAY (8 seconds)	SHORT DISPLAY (1 second)
 L3860 Composition (.64 agreement)	 S3616 Composition (.73 agreement)
 L9038 Composition (.64 agreement)	 S3866 Composition (.64 agreement)
 L5919 Composition (.64 agreement)	 S3854 Composition (.55 agreement)

LONG DISPLAY (8 seconds)	SHORT DISPLAY (1 second)
 L7883 Lens (.73 agreement)	 S7869 Lens (.55 agreement)
 L2446 Lens (.64 agreement)	 1032 Lens (1.00 agreement)
 L6256 Lens (.55 agreement)	 S8140 Lens (.82 agreement)

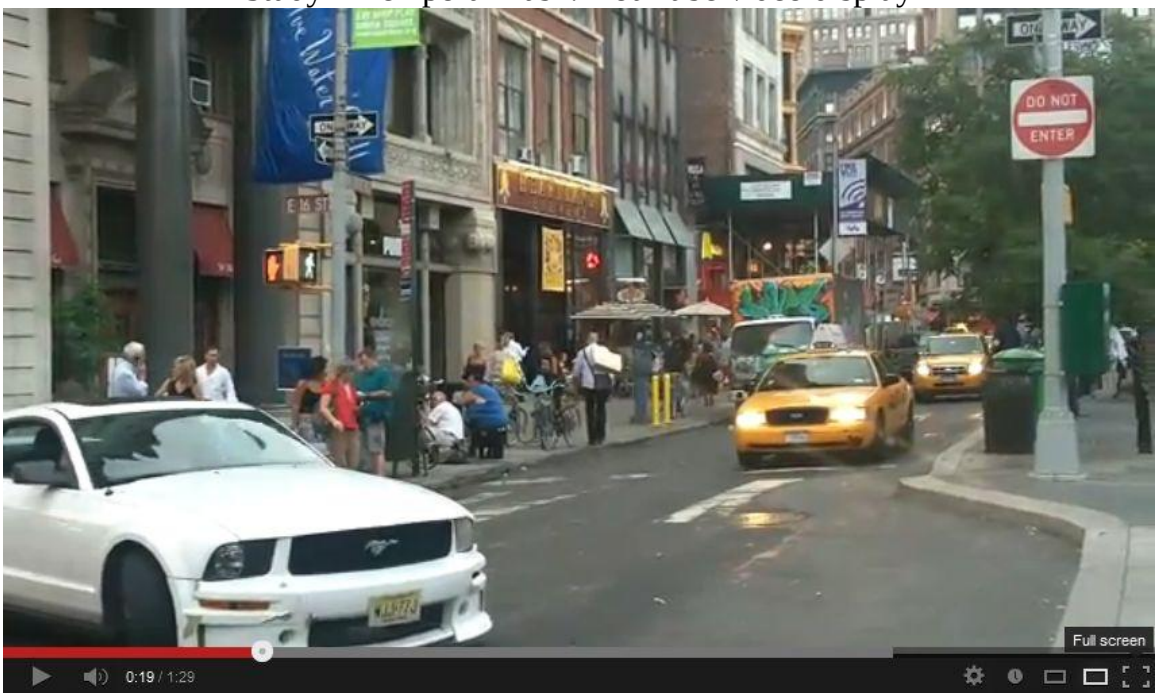
LONG DISPLAY (8 seconds)	SHORT DISPLAY (1 second)
	
L6163 Lighting (.82 agreement)	S2084 Lighting (.82 agreement)
	
L8638 Lighting (.82 agreement)	S9923 Lighting (.82 agreement)
	
L9990 Lighting (.73 agreement)	S2281 Lighting (1.00 agreement)

LONG DISPLAY (8 seconds)	SHORT DISPLAY (1 second)
 L9963 Subject (.45 agreement)	 S7817 Subject (.45 agreement)
 L8317 Subject (.64 agreement)	 S2958 Subject (.36 agreement)
 L8070 Subject (.45 agreement)	 S7577 Subject (.91 agreement)

LONG DISPLAY (8 seconds)	SHORT DISPLAY (1 second)
 L8669 No flaw (.55 agreement)	 S1296 No flaw (.64 agreement)
 L3123 No flaw (.55 agreement)	 S7053 Composition (.91 agreement)
 L7641 No flaw (.64 agreement)	 S8291 No flaw (.64 agreement)

APPENDIX F

Study 2 Temporal Task: YouTube video display



APPENDIX G
Study 1 Results Summary Tables

Study 1: Analysis of Agreement with the Pre-specified Flaw Categories

expertise * duration * flaw

Measure: Agreement with Pre-specified Flaw Categories

					95% Confidence Interval	
Expertise	duration	flaw	Mean	Std. Error	Lower Bound	Upper Bound
non-experts	L	comp	.150	.058	.032	.267
		lens	.403	.058	.285	.521
		lighting	.331	.056	.218	.444
		subject	.066	.041	-.017	.149
		no flaw	.584	.079	.424	.744
	S	comp	.083	.048	-.014	.179
		lens	.443	.061	.319	.566
		lighting	.484	.080	.322	.646
		subject	.183	.050	.080	.285
		no flaw	.684	.073	.537	.831
experts	L	comp	.250	.058	.132	.367
		lens	.475	.058	.357	.593
		lighting	.585	.056	.472	.698
		subject	.125	.041	.042	.208
		no flaw	.551	.079	.391	.710
	S	comp	.250	.048	.153	.346
		lens	.685	.061	.561	.808
		lighting	.656	.080	.494	.818
		subject	.209	.050	.106	.311
		no flaw	.651	.073	.504	.798

Tests of Within-Subjects Effects

Measure: Agreement with Pre-specified Flaw Categories

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
duration	Sphericity Assumed	.650	1	.650	11.587	.002	.234
	Greenhouse-Geisser	.650	1.000	.650	11.587	.002	.234
	Huynh-Feldt	.650	1.000	.650	11.587	.002	.234
	Lower-bound	.650	1.000	.650	11.587	.002	.234
duration * expertise	Sphericity Assumed	.015	1	.015	.267	.608	.007
	Greenhouse-Geisser	.015	1.000	.015	.267	.608	.007
	Huynh-Feldt	.015	1.000	.015	.267	.608	.007
	Lower-bound	.015	1.000	.015	.267	.608	.007
Error(duration)	Sphericity Assumed	2.133	38	.056			
	Greenhouse-Geisser	2.133	38.000	.056			
	Huynh-Feldt	2.133	38.000	.056			
	Lower-bound	2.133	38.000	.056			
flaw	Sphericity Assumed	14.573	4	3.643	33.634	.000	.470
	Greenhouse-Geisser	14.573	3.237	4.501	33.634	.000	.470
	Huynh-Feldt	14.573	3.668	3.973	33.634	.000	.470
	Lower-bound	14.573	1.000	14.573	33.634	.000	.470
flaw * expertise	Sphericity Assumed	.763	4	.191	1.762	.139	.044
	Greenhouse-Geisser	.763	3.237	.236	1.762	.154	.044
	Huynh-Feldt	.763	3.668	.208	1.762	.146	.044

	Lower-bound	.763	1.000	.763	1.762	.192	.044
Error(flaw)	Sphericity Assumed	16.465	152	.108			
	Greenhouse-Geisser	16.465	123.021	.134			
	Huynh-Feldt	16.465	139.370	.118			
	Lower-bound	16.465	38.000	.433			
duration * flaw	Sphericity Assumed	.334	4	.083	1.785	.135	.045
	Greenhouse-Geisser	.334	3.483	.096	1.785	.144	.045
	Huynh-Feldt	.334	3.978	.084	1.785	.135	.045
	Lower-bound	.334	1.000	.334	1.785	.189	.045
duration * flaw * expertise	Sphericity Assumed	.191	4	.048	1.021	.398	.026
	Greenhouse-Geisser	.191	3.483	.055	1.021	.393	.026
	Huynh-Feldt	.191	3.978	.048	1.021	.398	.026
	Lower-bound	.191	1.000	.191	1.021	.319	.026
Error(duration*flaw)	Sphericity Assumed	7.108	152	.047			
	Greenhouse-Geisser	7.108	132.358	.054			
	Huynh-Feldt	7.108	151.182	.047			
	Lower-bound	7.108	38.000	.187			

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: Agreement with Pre-specified Flaw Categories

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	61.520	1	61.520	748.821	.000	.952
expertise	1.052	1	1.052	12.801	.001	.252
Error	3.122	38	.082			

a. Computed using alpha = .05

Study 1: Analysis of Partial Credit Flaw Categorization Scores

expertise * duration * flaw

Measure: Partial credit flaw categorization scores

					95% Confidence Interval	
expertise	duration	flaw	Mean	Std. Error	Lower Bound	Upper Bound
non-experts	L	comp	.201	.033	.135	.267
		lens	.362	.044	.273	.451
		lighting	.418	.048	.322	.515
		subject	.140	.036	.068	.212
		no flaw	.200	.030	.139	.261
	S	comp	.113	.042	.028	.198
		lens	.456	.062	.331	.581
		lighting	.567	.072	.422	.712
		subject	.249	.063	.121	.378
		no flaw	.278	.031	.215	.341
experts	L	comp	.290	.033	.223	.356
		lens	.446	.044	.356	.535
		lighting	.402	.048	.305	.498
		subject	.156	.036	.084	.229
		no flaw	.311	.030	.250	.372
	S	comp	.239	.042	.155	.324
		lens	.669	.062	.544	.793
		lighting	.600	.072	.455	.745
		subject	.268	.063	.139	.396
		no flaw	.370	.031	.307	.433

Tests of Within-Subjects Effects

Measure: Partial credit flaw categorization scores

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
duration	Sphericity Assumed	.781	1	.781	19.261	.000	.336
	Greenhouse-Geisser	.781	1.000	.781	19.261	.000	.336
	Huynh-Feldt	.781	1.000	.781	19.261	.000	.336
	Lower-bound	.781	1.000	.781	19.261	.000	.336
duration * expertise	Sphericity Assumed	.040	1	.040	.984	.327	.025
	Greenhouse-Geisser	.040	1.000	.040	.984	.327	.025
	Huynh-Feldt	.040	1.000	.040	.984	.327	.025
	Lower-bound	.040	1.000	.040	.984	.327	.025
Error(duration)	Sphericity Assumed	1.542	38	.041			
	Greenhouse-Geisser	1.542	38.000	.041			
	Huynh-Feldt	1.542	38.000	.041			
	Lower-bound	1.542	38.000	.041			
flaw	Sphericity Assumed	6.633	4	1.658	35.549	.000	.483
	Greenhouse-Geisser	6.633	3.321	1.997	35.549	.000	.483
	Huynh-Feldt	6.633	3.773	1.758	35.549	.000	.483
	Lower-bound	6.633	1.000	6.633	35.549	.000	.483
flaw * expertise	Sphericity Assumed	.297	4	.074	1.593	.179	.040
	Greenhouse-Geisser	.297	3.321	.089	1.593	.190	.040
	Huynh-Feldt	.297	3.773	.079	1.593	.183	.040
	Lower-bound	.297	1.000	.297	1.593	.215	.040

Error(flaw)	Sphericity Assumed	7.090	152	.047			
	Greenhouse-Geisser	7.090	126.195	.056			
	Huynh-Feldt	7.090	143.366	.049			
	Lower-bound	7.090	38.000	.187			
duration * flaw	Sphericity Assumed	.756	4	.189	6.379	.000	.144
	Greenhouse-Geisser	.756	2.810	.269	6.379	.001	.144
	Huynh-Feldt	.756	3.137	.241	6.379	.000	.144
	Lower-bound	.756	1.000	.756	6.379	.016	.144
duration * flaw * expertise	Sphericity Assumed	.065	4	.016	.545	.703	.014
	Greenhouse-Geisser	.065	2.810	.023	.545	.641	.014
	Huynh-Feldt	.065	3.137	.021	.545	.661	.014
	Lower-bound	.065	1.000	.065	.545	.465	.014
Error(duration*flaw)	Sphericity Assumed	4.503	152	.030			
	Greenhouse-Geisser	4.503	106.777	.042			
	Huynh-Feldt	4.503	119.212	.038			
	Lower-bound	4.503	38.000	.119			

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: Partial credit flaw categorization scores

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	45.360	1	45.360	384.802	.000	.910
expertise	.586	1	.586	4.973	.032	.116
Error	4.479	38	.118			

a. Computed using alpha = .05

Study 1: Analysis of Percentage of Specified Flaws

expertise * duration * flaw

Measure: Percentage of specified flaws

					95% Confidence Interval	
expertise	duration	flaw	Mean	Std. Error	Lower Bound	Upper Bound
non-experts	L	comp	.133	.033	.067	.200
		lens	.178	.025	.128	.229
		lighting	.168	.026	.115	.222
		subject	.134	.022	.089	.179
		no flaw	.386	.050	.285	.486
	S	comp	.103	.023	.055	.151
		lens	.183	.023	.136	.230
		lighting	.163	.026	.110	.216
		subject	.127	.022	.082	.171
		no flaw	.425	.049	.326	.523
experts	L	comp	.206	.033	.139	.273
		lens	.146	.025	.096	.197
		lighting	.251	.026	.198	.305
		subject	.109	.022	.063	.154
		no flaw	.288	.050	.187	.388
	S	comp	.136	.023	.088	.183
		lens	.184	.023	.137	.230
		lighting	.218	.026	.165	.271
		subject	.097	.022	.052	.142
		no flaw	.366	.049	.268	.464

Tests of Within-Subjects Effects

Measure: Percentage of specified flaws

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
duration	Sphericity Assumed	1.600E-7	1	1.600E-7	1.322	.257	.034
	Greenhouse-Geisser	1.600E-7	1.000	1.600E-7	1.322	.257	.034
	Huynh-Feldt	1.600E-7	1.000	1.600E-7	1.322	.257	.034
	Lower-bound	1.600E-7	1.000	1.600E-7	1.322	.257	.034
duration * expertise	Sphericity Assumed	4.000E-8	1	4.000E-8	.330	.569	.009
	Greenhouse-Geisser	4.000E-8	1.000	4.000E-8	.330	.569	.009
	Huynh-Feldt	4.000E-8	1.000	4.000E-8	.330	.569	.009
	Lower-bound	4.000E-8	1.000	4.000E-8	.330	.569	.009
Error(duration)	Sphericity Assumed	4.600E-6	38	1.211E-7			
	Greenhouse-Geisser	4.600E-6	38.000	1.211E-7			
	Huynh-Feldt	4.600E-6	38.000	1.211E-7			
	Lower-bound	4.600E-6	38.000	1.211E-7			
flaw	Sphericity Assumed	3.071	4	.768	18.226	.000	.324
	Greenhouse-Geisser	3.071	2.065	1.487	18.226	.000	.324
	Huynh-Feldt	3.071	2.242	1.370	18.226	.000	.324
	Lower-bound	3.071	1.000	3.071	18.226	.000	.324
flaw * expertise	Sphericity Assumed	.294	4	.073	1.744	.143	.044
	Greenhouse-Geisser	.294	2.065	.142	1.744	.180	.044
	Huynh-Feldt	.294	2.242	.131	1.744	.177	.044

	Lower-bound	.294	1.000	.294	1.744	.194	.044
Error(flaw)	Sphericity Assumed	6.403	152	.042			
	Greenhouse-Geisser	6.403	78.451	.082			
	Huynh-Feldt	6.403	85.209	.075			
	Lower-bound	6.403	38.000	.168			
duration * flaw	Sphericity Assumed	.137	4	.034	4.343	.002	.103
	Greenhouse-Geisser	.137	3.105	.044	4.343	.006	.103
	Huynh-Feldt	.137	3.503	.039	4.343	.004	.103
	Lower-bound	.137	1.000	.137	4.343	.044	.103
duration * flaw * expertise	Sphericity Assumed	.025	4	.006	.799	.527	.021
	Greenhouse-Geisser	.025	3.105	.008	.799	.500	.021
	Huynh-Feldt	.025	3.503	.007	.799	.513	.021
	Lower-bound	.025	1.000	.025	.799	.377	.021
Error(duration*flaw)	Sphericity Assumed	1.198	152	.008			
	Greenhouse-Geisser	1.198	118.008	.010			
	Huynh-Feldt	1.198	133.095	.009			
	Lower-bound	1.198	38.000	.032			

Tests of Between-Subjects Effects

Measure: Percentage of specified flaws

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	16.002	1	16.002	1.322E8	.000	1.000
expertise	1.600E-7	1	1.600E-7	1.322	.257	.034
Error	4.600E-6	38	1.211E-7			

Study 1: Analysis of Quality Ratings

expertise * duration * flaw

Measure: Quality ratings

					95% Confidence Interval	
expertise	duration	flaw	Mean	Std. Error	Lower Bound	Upper Bound
non-experts	1	comp	4.877	.241	4.390	5.365
		lens	4.068	.284	3.493	4.644
		lighting	4.834	.261	4.305	5.363
		subject	4.454	.251	3.945	4.963
		no flaw	6.972	.200	6.567	7.378
	2	comp	4.405	.291	3.815	4.994
		lens	3.998	.271	3.449	4.548
		lighting	4.074	.225	3.618	4.529
		subject	3.714	.276	3.155	4.273
		no flaw	7.127	.215	6.691	7.562
experts	1	comp	4.383	.241	3.896	4.871
		lens	3.177	.284	2.601	3.752
		lighting	4.000	.261	3.471	4.529
		subject	3.541	.251	3.032	4.050
		no flaw	6.285	.200	5.879	6.690
	2	comp	4.135	.291	3.546	4.725
		lens	3.111	.271	2.562	3.661
		lighting	3.957	.225	3.502	4.413
		subject	3.203	.276	2.644	3.762
		no flaw	5.970	.215	5.535	6.405

Tests of Within-Subjects Effects

Measure: Quality ratings

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
duration	Sphericity Assumed	8.402	1	8.402	8.483	.006	.182
	Greenhouse-Geisser	8.402	1.000	8.402	8.483	.006	.182
	Huynh-Feldt	8.402	1.000	8.402	8.483	.006	.182
	Lower-bound	8.402	1.000	8.402	8.483	.006	.182
duration * expertise	Sphericity Assumed	.775	1	.775	.782	.382	.020
	Greenhouse-Geisser	.775	1.000	.775	.782	.382	.020
	Huynh-Feldt	.775	1.000	.775	.782	.382	.020
	Lower-bound	.775	1.000	.775	.782	.382	.020
Error(duration)	Sphericity Assumed	37.640	38	.991			
	Greenhouse-Geisser	37.640	38.000	.991			
	Huynh-Feldt	37.640	38.000	.991			
	Lower-bound	37.640	38.000	.991			
flaw	Sphericity Assumed	469.590	4	117.398	114.895	.000	.751
	Greenhouse-Geisser	469.590	3.591	130.775	114.895	.000	.751
	Huynh-Feldt	469.590	4.000	117.398	114.895	.000	.751
	Lower-bound	469.590	1.000	469.590	114.895	.000	.751
flaw * expertise	Sphericity Assumed	4.684	4	1.171	1.146	.337	.029
	Greenhouse-Geisser	4.684	3.591	1.305	1.146	.336	.029
	Huynh-Feldt	4.684	4.000	1.171	1.146	.337	.029
	Lower-bound	4.684	1.000	4.684	1.146	.291	.029
Error(flaw)	Sphericity Assumed	155.311	152	1.022			
	Greenhouse-Geisser	155.311	136.451	1.138			
	Huynh-Feldt	155.311	152.000	1.022			
	Lower-bound	155.311	38.000	4.087			
duration * flaw	Sphericity Assumed	3.457	4	.864	1.018	.400	.026
	Greenhouse-Geisser	3.457	3.650	.947	1.018	.396	.026
	Huynh-Feldt	3.457	4.000	.864	1.018	.400	.026

	Lower-bound	3.457	1.000	3.457	1.018	.319	.026
duration * flaw * expertise	Sphericity Assumed	3.958	4	.990	1.165	.328	.030
	Greenhouse-Geisser	3.958	3.650	1.084	1.165	.328	.030
	Huynh-Feldt	3.958	4.000	.990	1.165	.328	.030
	Lower-bound	3.958	1.000	3.958	1.165	.287	.030
Error(duration*flaw)	Sphericity Assumed	129.094	152	.849			
	Greenhouse-Geisser	129.094	138.701	.931			
	Huynh-Feldt	129.094	152.000	.849			
	Lower-bound	129.094	38.000	3.397			

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: Quality ratings

Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	8151.678	1	8151.678	1868.391	.000	.980
expertise	45.692	1	45.692	10.473	.003	.216
Error	165.792	38	4.363			

a. Computed using alpha = .05

APPENDIX H

Study 2 ANOVA Summary Tables

Spatial Task

Tests of Within-Subjects Effects

Measure: Quality ratings

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
RATER	Sphericity Assumed	41.847	1	41.847	204.319	.000	.843
	Greenhouse-Geisser	41.847	1.000	41.847	204.319	.000	.843
	Huynh-Feldt	41.847	1.000	41.847	204.319	.000	.843
	Lower-bound	41.847	1.000	41.847	204.319	.000	.843
RATER * CREATOR	Sphericity Assumed	1.391	1	1.391	6.793	.013	.152
	Greenhouse-Geisser	1.391	1.000	1.391	6.793	.013	.152
	Huynh-Feldt	1.391	1.000	1.391	6.793	.013	.152
	Lower-bound	1.391	1.000	1.391	6.793	.013	.152
Error(RATER)	Sphericity Assumed	7.783	38	.205			
	Greenhouse-Geisser	7.783	38.000	.205			
	Huynh-Feldt	7.783	38.000	.205			
	Lower-bound	7.783	38.000	.205			
SELECTION	Sphericity Assumed	2.427	1	2.427	3.536	.068	.085
	Greenhouse-Geisser	2.427	1.000	2.427	3.536	.068	.085
	Huynh-Feldt	2.427	1.000	2.427	3.536	.068	.085
	Lower-bound	2.427	1.000	2.427	3.536	.068	.085
SELECTION * CREATOR	Sphericity Assumed	.097	1	.097	.141	.709	.004
	Greenhouse-Geisser	.097	1.000	.097	.141	.709	.004
	Huynh-Feldt	.097	1.000	.097	.141	.709	.004
	Lower-bound	.097	1.000	.097	.141	.709	.004
Error(SELECTIO)	Sphericity Assumed	26.077	38	.686			
	Greenhouse-Geisser	26.077	38.000	.686			
	Huynh-Feldt	26.077	38.000	.686			
	Lower-bound	26.077	38.000	.686			
RATER * SELECTION	Sphericity Assumed	.016	1	.016	.243	.625	.006
	Greenhouse-Geisser	.016	1.000	.016	.243	.625	.006
	Huynh-Feldt	.016	1.000	.016	.243	.625	.006
	Lower-bound	.016	1.000	.016	.243	.625	.006
RATER * SELECTION	Sphericity	.055	1	.055	.835	.367	.021

* CREATOR	Assumed						
	Greenhouse-Geisser	.055	1.000	.055	.835	.367	.021
	Huynh-Feldt	.055	1.000	.055	.835	.367	.021
	Lower-bound	.055	1.000	.055	.835	.367	.021
Error(RATER*SELECTION)	Sphericity Assumed	2.519	38	.066			
	Greenhouse-Geisser	2.519	38.000	.066			
	Huynh-Feldt	2.519	38.000	.066			
	Lower-bound	2.519	38.000	.066			

Tests of Between-Subjects Effects

Measure: Quality ratings
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	3319.517	1	3319.517	5676.560	.000	.993
CREATOR	.160	1	.160	.273	.604	.007
Error	22.221	38	.585			

Temporal Task

Tests of Within-Subjects Effects

Measure: Quality ratings

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
RATER	Sphericity Assumed	36.533	1	36.533	1389.124	.000	.973
	Greenhouse-Geisser	36.533	1.000	36.533	1389.124	.000	.973
	Huynh-Feldt	36.533	1.000	36.533	1389.124	.000	.973
	Lower-bound	36.533	1.000	36.533	1389.124	.000	.973
RATER * CREATOR	Sphericity Assumed	.161	1	.161	6.116	.018	.139
	Greenhouse-Geisser	.161	1.000	.161	6.116	.018	.139
	Huynh-Feldt	.161	1.000	.161	6.116	.018	.139
	Lower-bound	.161	1.000	.161	6.116	.018	.139
Error(RATER)	Sphericity Assumed	.999	38	.026			
	Greenhouse-Geisser	.999	38.000	.026			
	Huynh-Feldt	.999	38.000	.026			
	Lower-bound	.999	38.000	.026			
SELECTION	Sphericity Assumed	.013	1	.013	.099	.755	.003
	Greenhouse-Geisser	.013	1.000	.013	.099	.755	.003
	Huynh-Feldt	.013	1.000	.013	.099	.755	.003
	Lower-bound	.013	1.000	.013	.099	.755	.003
SELECTION * CREATOR	Sphericity Assumed	.028	1	.028	.213	.647	.006
	Greenhouse-Geisser	.028	1.000	.028	.213	.647	.006
	Huynh-Feldt	.028	1.000	.028	.213	.647	.006
	Lower-bound	.028	1.000	.028	.213	.647	.006
Error(SELECTION)	Sphericity Assumed	4.979	38	.131			
	Greenhouse-Geisser	4.979	38.000	.131			
	Huynh-Feldt	4.979	38.000	.131			
	Lower-bound	4.979	38.000	.131			
RATER * SELECTION	Sphericity Assumed	.035	1	.035	.929	.341	.024
	Greenhouse-Geisser	.035	1.000	.035	.929	.341	.024
	Huynh-Feldt	.035	1.000	.035	.929	.341	.024
	Lower-bound	.035	1.000	.035	.929	.341	.024
RATER * SELECTIO * CREATOR	Sphericity Assumed	.000	1	.000	.003	.957	.000
	Greenhouse-Geisser	.000	1.000	.000	.003	.957	.000
	Huynh-Feldt	.000	1.000	.000	.003	.957	.000
	Lower-bound	.000	1.000	.000	.003	.957	.000
Error(RATER*SELECTION)	Sphericity Assumed	1.424	38	.037			
	Greenhouse-Geisser	1.424	38.000	.037			
	Huynh-Feldt	1.424	38.000	.037			
	Lower-bound	1.424	38.000	.037			

Tests of Between-Subjects Effects

Measure: Quality ratings
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	1990.838	1	1990.838	27952.366	.000	.999
CREATOR	.063	1	.063	.883	.353	.023
Error	2.706	38	.071			

Spatio-temporal Task

Tests of Within-Subjects Effects

Measure: Quality ratings

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
RATER	Sphericity Assumed	5.459	1	5.459	179.124	.000	.825
	Greenhouse-Geisser	5.459	1.000	5.459	179.124	.000	.825
	Huynh-Feldt	5.459	1.000	5.459	179.124	.000	.825
	Lower-bound	5.459	1.000	5.459	179.124	.000	.825
RATER * CREATOR	Sphericity Assumed	.004	1	.004	.145	.705	.004
	Greenhouse-Geisser	.004	1.000	.004	.145	.705	.004
	Huynh-Feldt	.004	1.000	.004	.145	.705	.004
	Lower-bound	.004	1.000	.004	.145	.705	.004
Error(RATER)	Sphericity Assumed	1.158	38	.030			
	Greenhouse-Geisser	1.158	38.000	.030			
	Huynh-Feldt	1.158	38.000	.030			
	Lower-bound	1.158	38.000	.030			
SELECTION	Sphericity Assumed	.559	1	.559	6.994	.012	.155
	Greenhouse-Geisser	.559	1.000	.559	6.994	.012	.155
	Huynh-Feldt	.559	1.000	.559	6.994	.012	.155
	Lower-bound	.559	1.000	.559	6.994	.012	.155
SELECTION * CREATOR	Sphericity Assumed	.001	1	.001	.012	.914	.000
	Greenhouse-Geisser	.001	1.000	.001	.012	.914	.000
	Huynh-Feldt	.001	1.000	.001	.012	.914	.000
	Lower-bound	.001	1.000	.001	.012	.914	.000
Error(SELECTION)	Sphericity Assumed	3.038	38	.080			
	Greenhouse-Geisser	3.038	38.000	.080			
	Huynh-Feldt	3.038	38.000	.080			
	Lower-bound	3.038	38.000	.080			
RATER * SELECTION	Sphericity Assumed	.278	1	.278	8.045	.007	.175
	Greenhouse-Geisser	.278	1.000	.278	8.045	.007	.175
	Huynh-Feldt	.278	1.000	.278	8.045	.007	.175
	Lower-bound	.278	1.000	.278	8.045	.007	.175
RATER * SELECTION * CREATOR	Sphericity Assumed	.008	1	.008	.236	.630	.006
	Greenhouse-Geisser	.008	1.000	.008	.236	.630	.006
	Huynh-Feldt	.008	1.000	.008	.236	.630	.006
	Lower-bound	.008	1.000	.008	.236	.630	.006
Error(RATER*SELECTION)	Sphericity Assumed	1.315	38	.035			
	Greenhouse-Geisser	1.315	38.000	.035			
	Huynh-Feldt	1.315	38.000	.035			
	Lower-bound	1.315	38.000	.035			

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	1063.406	1	1063.406	6546.158	.000	.994
CREATOR	.414	1	.414	2.547	.119	.063
Error	6.173	38	.162			

REFERENCES

Academy of Art University (2006). *Catalog*. Retrieved July 15, 2009 from http://catalog.academyart.edu/catalogBrowsing/landing/true/mode/ONCAMPUS.5.1.

Adams, A. (2007). Introduction. "You don't take a photograph, you make it". Jaeger, A-C. (Editor). *Image makers, image takers: interviews with today's leading curators, editors and photographers*. New York: NY: Thames & Hudson.

Arnheim, R. (1986). *New essays on the psychology of art.* Los Angeles, CA: University of California Press.

Axelsson, Ö. (2007). Towards a psychology of photography: Dimensions underlying aesthetic appeal of photographs. *Perceptual and Motor Skills, 105*(2), 411-434.

Berlyne, D.E. (1971). *Aesthetics and psychobiology*. New York: Appleton-Century-Crofts.

Barrett, T. (1986). Teaching about Photography: Selectivity, Instantaneity, and Credibility. *Art Education, 39*(3), 12-15.

Benjamin, W. (1936) *The Work of Art in the Age of Mechanical Reproduction* [Web Page]. URL http://www.marxists.org/reference/subject/philosophy/works/ge/benjamin.htm [1912, June 9].

Benson, R. (2008). *The printed picture*. New York: The Museum of Modern Art.

Binet, A. (1894). *Psychologie des grands calculateurs et joueurs d'echecs.* Paris: Hachette. [Republished by Slatkine Ressources, Paris, 1981]

Boden, M. A. (1996). What is creativity? Boden M. A. (Editor), *Dimensions of creativity.* Cambridge, MA: MIT Press.

Bransford, J. D., (2000). How experts differ from novices. J. D. Bransford, A. L. Brown, & R. R. Cocking (Editors), *How people learn: Brain, mind, experience, and school.* Commission on Behavioral and Social Sciences and Education National Research Council. Washington, DC: National Academy Press.

Briski, Z. (Producer/Writer/Director), & Kauffman, R. (Producer/Writer/Director). (2004). *Born into Brothels: Calcutta's Red Light Kids* [Motion picture]. United States: Think Film & HBO Cinemax Documentary Films.

Campbell, D. T. (1960). Blind generation and selective retention in creative thought as in other thought processes. *Psychological Review, 67*, 380-400.

Carson, S. H., Peterson, J. B., & Higgins, D. M. (2005). Reliability, validity, and factor structure of the Creative Achievement Questionnaire. *Creativity Research Journal, 17,* 37-50.

Cartier-Bresson, H. (1999). *The mind's eye writings on photography and photographers*. Millerton, N.Y: Aperture.

Chase, W. G. & Simon, H. A. (1973a). Perception in chess. *Cognitive Psychology, 4,* 55-81.

Chase, W. G. & Simon, H. A. (1973b). The mind's eye in chess. In W. G. Chase *Visual Information Processing.* London: Academic Press.

Chi, M. T. H. (2006). Two approaches to the study of experts' characteristics. K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Editors), *The Cambridge handbook of expertise and expert performance* . New York: Cambridge University Press.

Clarke, G. (1997). *The photograph*. Oxford, New York: Oxford University Press.

Cleveland, P. (2004). How much visual power can a magazine take? *Design Studies, 26* 271-317.

Cohen, D. J., & Bennett, S. (1997). Why can't most people draw what they see? *Journal of Experimental Psychology: Human Perception and Performance, 23,* 609-621.

Crawford, V. M. (2007). Adaptive expertise as knowledge building in science teachers' problem solving. *Proceedings of the Second European Cognitive Science Society (EuroCogSci07)*. May 23-27, 2007, Delphi, Greece.

Davies, C., Tompkinson, W., Donnelly, N., Gordon, L., & Cave, K. (2006). Visual saliency as an aid to updating digital maps. *Computers in Human Behavior, 22,* 672-684.

DeGroot, A. D. (1965). *Thought and choice in chess.* The Hague: Mouton.

Dennett, T. (2009). Jo Spence's camera therapy: personal therapeutic photography as a response to adversity. *European Journal of Psychotherapy & Counseling, 11,* 7-19.

Domino G. & Giuliani, I. (1997). Creativity in three samples of photographers: a validation of the adjective check list creativity scale. *Creativity Research Journal, 10 (2 & 3),* 193-200.

Durmysheva, Y., & Kozbelt, A. (2010). The Creative Approach Questionnaire: Operationalizing Galenson's finder-seeker typology in a non-expert sample. *International Journal of Creativity and Problem Solving, 20,* 35-55.

Endsley, M. R. (2006). Expertise and situation awareness. K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Editors), *The Cambridge handbook of expertise and expert performance* . New York: Cambridge University Press.

Endsley, M. R. & Rodgers, M. D. (1996). Attention distribution and situation awareness in air traffic control. In *Proceedings of the 40th Annual Meeting of the Human Factors and Ergonomics Society*, 82-85.

Ericsson, K. A. (2006a). The influence of experience and deliberate practice on the development of superior expert performance. K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Editors), *The Cambridge handbook of expertise and expert performance*. New York: Cambridge University Press.

Ericsson, K. A. (2006b). An introduction to The Cambridge Handbook of Expertise and Expert Performance: its development, organization, and content. K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Editors), *The Cambridge handbook of expertise and expert performance* . New York: Cambridge University Press.

Eysenck, M. W., & Keane, M. T. (2005). *Cognitive Psychology: a student's handbook* (5th Ed.). New York: Psychology Press.

Feininger, A. (1987). *Nauka o Fotografii.* Warszawa: Wydawnictwa Artystyczne i Filmowe.

Feltovich, P. J., Prietula, M. J., & Ericsson, K. A. (2006). Studies of expertise from psychological perspectives. K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Editors), *The Cambridge handbook of expertise and expert performance*. New York: Cambridge University Press.

Focal Power (2009). *The Photo Quotes Archive.* Retrieved on August 10, 2009 from http://www.focalpower.com/app/quote/subjects/.

Freeman, M. (2007). *The photographer's eye: composition and design for better digital photos.* Burlington, MA: Focal Press.

Gabora, L. M. (2005). Creative thought as a non-Darwinian evolutionary process. *Journal of Creative Behavior, 39,* 65-87.

Gabora, L. (2007). Why the creative process is not Darwinian. Commentary on 'The creative process in Picasso's Guernica sketches: Monotonic improvements versus nonmonotonic variants' by D. K. Simonton. *Creativity Research Journal, 19*(4), 361-365.

Galenson, D. W. (2001). *Painting outside the lines: Patterns of creativity in modern art.* Cambridge, MA: Harvard University Press.

Gobet, F., & Charness, N. (2006). Expertise in chess. K. A. Ericsson, N. Charness, P. J.

Feltovich, & R. R. Hoffman (Editors), *The Cambridge handbook of expertise and expert performance*. New York: Cambridge University Press.

Greenspun, P. (2007). *History of photography timeline.* Retrieved from http://photo.net/history/timeline.

Grube (2002). Tolerance of ambiguity, art therapy and psychiatric illness. *Psychiatr Prax, 29(*8):431-7.

Halsman, P. (1961). *Halsman of the creation of photographic ideas*. New York: Ziff-Davis.

Hatano, G. and K. Inagaki (1986). Two courses of expertise. In *Child development and education in Japan*: 262–272.

Help-Portrait. (2010). *Help portrait community site*. Retrieved on 11.18.2010 from http://community.help-portrait.com/.

Henry, W. P. & Solano, C. H. (1983). Photographic style and personality: developing a coding system for photographs. *Journal of Psychology, 115*, 79-87.

Hicks, R. W. (2005). Composition. R Lenman (Editor), *The Oxford Companion to the Photograph.* Oxford: Oxford University Press.

Hill, N. M., & Schneider, W. (2006). Brain changes in the development of expertise: neuroanatomical and neurophysical evidence about skill based adaptations. K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Editors), *The Cambridge handbook of expertise and expert performance*. New York: Cambridge University Press.

Holleley, D. (2009). *Photo-editing and presentation. A guide to image editing and presentation for photographers and visual artists.* Rochester, NY: Clarellen, RIT Cary Graphic Arts Press.

Horn, J., & Masunaga, H. (2006). A merging theory of expertise and intelligence. K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Editors), *The Cambridge handbook of expertise and expert performance*. New York: Cambridge University Press.

Hurn, D., & Jay, B. (2008). *On being a photographer: a practical guide.* Anacortes, WA: LensWork Publishing.

Grube, M. (2002). Tolerance of ambiguity, art therapy and psychiatric illness. *Psychiatr Prax., 29*(8), 431-7.

Jaeger, A.-C. (2007). *Image makers, image takers: interviews with today's leading curators, editors and photographers*. New York: NY: Thames & Hudson.

Jausovec, N. (1994). Metacognition in Creative Problem Solving. M. A. Runco *Problem finding, problem solving, and creativity*. Norwood, NJ: Ablex Publishing.

Kanashkevich, M. (2010). *5 more common mistakes aspiring travel photographers make (and how to avoid them)*. *Retrieved from Digital Photography School Web site:* http://www.digital-photography-school.com/travel-photography-mistakes.

Kauffman, S. B., & Kauffman, J. C. (2007). Ten Years to Expertise, Many More to Greatness: An Investigation of Modern Writers. *Journal of Creative Behavior, 41*(2), 114-124.

Kozbelt, A. (2008). Longitudinal hit ratios of classical composers: Reconciling Darwinian and expertise acquisition perspectives on lifespan creativity. *Psychology of Aesthetics, Creativity, and the Arts, 2,* 221-235.

Kozbelt, A. (2006). Dynamic evaluation of Matisse's 1935 "Large Reclining Nude." *Empirical Studies of the Arts, 24,* 119-137.

Kozbelt, A. (2001). Artists as experts in visual cognition. *Visual Cognition*, 8, 705-723.

Kozbelt, A., & Durmysheva, Y. (2007). Lifespan creativity in a non-Western artistic tradition: A study of Japanese ukiyo-e printmakers. *International Journal of Aging and Human Development, 65,* 23-51.

Kozbelt, A., & Seeley, W. P. (2007). Integrating art historical, psychological, and neuroscientific explanations of artists' advantages in drawing and perception. *Psychology of Aesthetics, Creativity, and the Arts, 1,* 80-90.

Kozbelt, A., & Serafin, J. (2009). Dynamic evaluation of high- and low-creativity drawings by artist and non-artist raters. *Creativity Research Journal, 21,* 349-360.

Kulich, R. J. & Goldberg, R.W. (1978). Differences in the production of photographs: A potential assessment technique. *Perceptual and Motor Skills, 47(1),* 223-229.

Lange, D. (Photographer). (1936). *Migrant Mother.* [Online image]. Retrieved 22 August, 2009: http://www.loc.gov/rr/print/list/128_migm.html from The Library of Congress – Prints and Photographs Division.

Lashley, K.S. (1951). The problem of serial order in behavior. In L.A. Jeffress (Ed.), *Cerebral mechanisms in behavior: The Hixon symposium* (pp. 112-146). New York: Wiley.

Linfield, S. (2008). *The Treacherous Medium.* Retrieved on April 9, 2009 from http://bostonreview.net/BR31.5/linfield.php.

Livnat, Y., Agutter, J., & Moon, S. a. F. S. (2005) *Visual Correlation for Situational Awareness* [Web Page]. Accessed on June 11, 2009, from http://www.sci.utah.edu/publications/yarden05/VisAware.pdf.

Lubart, T.I. (1999). Creativity across cultures. R. J. Sternberg (Editor) *Handbook of creativity.* New York: Cambridge University Press.

Luhring, B. (1992). *Philippe Halsman: Dali Atomicus.* Retrieved July 25, 2009, from Luhring Design Web site: http://www.luhring-design.com/information/essays/dali-atomicus/philippe-halsman.html.

Martindale, C. (2009). The evolution and end of art as Hegelian tragedy. *Empirical Studies of the Arts, 27*(2), 133-140.

Martindale, C. (1994). How can we measure a society's creativity? In M. A. Boden (Ed.) *Dimensions of creativity* (pp. 159-198). Cambridge, MA: MIT Press.

Martindale, C. (1990). *The clockwork muse: the predictability of artistic change*. New York: Basic Books.

McManus, I. C., Zhou, F. A., I'Anson, S., Waterfield, L., Stover, K., & Cook, R. (2011). The psychometrics of photographing cropping: The influence of colour, meaning, and expertise. *Perception, 40*, 332-357.

Miller, G. A. (1956). The Magical Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Information. *Psychological Review, 63*, 81-97.

Melin, W. E. (1986). Photography and the Recording Process in the Age of Mechanical Reproduction. *Leonardo, 19*(1), 53-60.

Mumford, M. D., Reiter-Palmon, R., & Redmond, M. R. (1994). Problem construction and cognition: applying problem representations in ill-defined domains. M. A. Runco *Problem finding, problem solving, and creativity*. Norwood, NJ: Ablex Publishing.

Navab, A.D. (2001). Re-Picturing of Photography: A Language in the Making. *Journal of Aesthetic Education, 35*(1), 69-84.

Pandy, M. G., Petrosino, A.J., Austin, B., and Barr, R. (2004). Assessing Adaptive Expertise in Undergraduate Biomechanics. *Journal of Engineering Education, 93*(3): 211-222.

Phillips, C. (1982). The judgment seat of photography. *October, 22*, 27-63.

Photography (2009). [Web Page]. Retrieved on April 13, 2009 from http://en.wikipedia.org/wiki/Photography.

Reber, A. S. (1993). *Implicit learning and tacit knowledge: An essay on the cognitive unconscious.* New York: Oxford University Press.

Reber, R. (2008). Art in its experience: can empirical psychology help assess artistic value? *Leonardo, 41*(4), 367-372.

Rogers, C. R. (1954). Toward a theory of creativity. *Etc., 11*, 249-260

Rosenbaum, D. A., Augustyn, J. S., Cohen, R. G., & Jax, S. A. (2006). Perceptual-motor expertise. K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Editors), *The Cambridge handbook of expertise and expert performance*. New York: Cambridge University Press.

Ross, K. G., Shafer, J. L., & Klein, G. (2006). Professional judgments and "Naturalistic Decision Making". K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Editors), *The Cambridge handbook of expertise and expert performance*. New York: Cambridge University Press.

Simonton, D. K. (1997). Creative productivity: A predictive and explanatory model of career landmarks and trajectories. *Psychological Review, 104,* 66-89.

Solso, R. L. (2001). Brain activities in a skilled versus a novice artist: an fMRI study. *Leonardo, 34*(1), 31-34.

Starkes, J. L. (1993). Motor experts: opening thoughts. In Starkes, J. L. & Allard, F. (Editors) *Cognitive issues in motor expertise.* Amsterdam: North-Holland.

Starkes, J. L. & Allard, F. (Editors) (1993). *Cognitive issues in motor expertise.* Amsterdam: North-Holland.

Sternberg, R. J. & Ben-Zeev, T. (2001). *Complex cognition: The psychology of human thought.* New York: Oxford University Press.

Tatarkiewicz, W. (1980). *A History of Six Ideas: An Essay in Aesthetics*. The Hague: Martinus Nijhoff; Warsaw: Polish Scientific Publishers.

Tinio, P. P. L., & Leder, H. (in press). The Means to Art's End: Styles, Creative Devices, and the Challenge of Art. In A. S. Bristol, J. C. Kaufman, & O. Vartanian (Eds.), *The Neuroscience of Creativity*. Cambridge, MA: The MIT Press.

Tinio, P. P. L., Leder, H., & Strasser, M., (2011). Image quality and the aesthetic judgment of photographs: Contrast, sharpness, and grain teased apart and put together. *Psychology of Aesthetics, Creativity, and the Arts, 5*(2), 165-176.

Traub, C.H., Heller, S., & Bell, A.B. (Eds). (2006). *The education of a photographer.* New York, NY: Allworth Press.

Weisberg, R. W. (2006a) Modes of expertise in creative thinking: evidence from case studies. K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Editors), *The Cambridge handbook of expertise and expert performance*. New York: Cambridge University Press.

Weisberg, R. W. (2006b). *Creativity: understanding innovation in problem solving, science, invention, and the arts*. Hoboken, NJ: John Wiley.

Wilton, K.. (2008). *Interview: Martin Schoeller.* Retrieved on July 25, 2009, from Artinfo
Web site: http://www.artinfo.com/news/story/26725/martin-schoeller/.

Yu, C. (2004). Aesthetics of photography: combining the viewer's and the artist's standpoints. *Art Criticism, 19*(1), 63-74.

Zakia, R. D. (1993). Photography and Visual Perception. *Journal of Aesthetic Education, 27*(4), 67-81.