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An artistic exploration of inattention blindness†

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An experiment about inattention blindness was conducted within the context of an art exhibition as opposed to a laboratory context in order to investigate the potential of art as a vehicle to study attention and its disorders. The project utilized a flash animation, *Stealing Attention*, that was modeled after the movie by Simons and Chabris (1999) but with significant experimental differences, involving context and staging, the emotional salience of the objects depicted, and the prior art viewing experience of participants. The study involved two components: observing if viewers watching an animation in a gallery could be distracted from noticing the disappearance of stolen museum antiquities (the targets) by the overlaid flashing images of a card game (the distractors) and then observing whether repetition of the depicted targets throughout the gallery installation could facilitate a redirection of attention that allowed viewers to perceive the targets not initially noted in the animation. My findings were that, after viewing the entire installation and then re-viewing the animation, 64% of the viewers who did not initially remark on the targets in the animation were then able to see them. The discussion elaborates on these findings and then considers ways in which the implications of inattention blindness paradigms might be more fully rendered by uniting insights from the two disciplines of art and neuroscience than by either alone.

Keywords: attention, inattention blindness, art installation, gallery, museum, art context, animation, antiquities

INTRODUCTION

In recent years considerable literature has been published on attention by art historians, historians of science, and philosophers in addition to neuroscientists (e.g., Baxandall, 1995; Crary, 1999; Hagner, 2003; Rollins, 2004; Stafford, 2007). They have made important contributions that specifically highlight attention in relationship to art, and their insights have informed our understanding of the attentional system. The fact that art, itself, is constitutive of attentional phenomena suggests why it should hold special interest for neuroscientists. My perspective as an artist has allowed me to locate a point of entry into this rich historical research through exploring inattention blindness, which is the intriguing phenomenon of not being able to see things in plain sight (Mack and Rock, 1998). This paper examines my art experiment, including its challenges and implications. It also explores the possibility that certain artworks, when engaged, can serve as an attentional training ground.

After introducing the topic of inattention blindness, I describe examples of its exploration in several scientific studies. I then relay my own experience in staging an experiment about this phenomenon in an art gallery, including methods, results, and possible confounds. The attentional system and ability to focus are subsequently considered within a broad context of learning. This is followed by a discussion of inattention blindness in art history and then by an analysis of some of the related neuroscience, such as the ability to make attention switches. Finally, I consider why inattention blindness can be more fully rendered through uniting insights from multiple disciplines.

INATTENTION BLINDNESS

The phenomenon of inattention blindness or, more formally, "inattentional blindness" as coined by psychologists Mack and Rock (1998) has been examined by scientists for several decades. Inattention blindness is related to other phenomena, such as the "attentional blink" (the failure to detect a second salient target occurring in succession after the first target) and "change blindness" (the inability of our visual system to detect alterations to something staring us straight in the face); all engage similar principles although change blindness also involves memory. A variety of methods are used by neuroscientists to accomplish the visual disruption; they may insert a blank screen or use a "flicker," a "blink," or diverters like "mudsplashes." A variety of tools can implement the disruption, including stereoscopes, visual masking, and dichoptic methods. Using dynamic visual displays, a series of studies of inattention blindness were conducted in the 1970s and 1980s during which observers were asked to report on a task. As a result of the assignment, viewers often did not notice staged events, causing neuroscientists to conclude that people only remember those objects that receive their focused attention.

Other factors play a role in inattention blindness; cultural bias regarding what is noticed is, in itself, a whole area subject to extended study as are pre-attentive processes. Repeated trials appear to make a difference with respect to perception. Vision scientists Maljkovic and Nakayama (1994) reported that in search for a singleton target, when the unique feature varies randomly

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from trial to trial the deployment of focal visual attention is faster when the target feature is the same as in past trials than when it is different, a phenomenon called priming of pop out. (Note that the term, pop out, as used here differs from its use in commonly used pop out ads on the internet. Clearly advertisers bank on the phenomenon of subliminal priming). Performance was also enhanced when the target occupied the same spatial position on consecutive trials (Maljkovic and Nakayama, 1996). However, psychologists Treisman and DeSchepper (1996) found that ignoring a distractor on one trial made it easier to ignore the same item on subsequent trials. Inattention blindness has been explored by Neisser and Becklen (1975), Mack and Rock (1998), and expanded upon by psychologists, Simons and Chabris (1999), among others. In the latter's well known study, "Gorillas in our midst: sustained inattentional blindness for dynamic events," a movie sequence of a complex basketball scene was shown to observers who were directed to count the number of ball exchanges made in a ball game. During the movie, few viewers noticed that an actor dressed in a gorilla suit walked through the scene. On the basis of their results, Simons and Chabris suggested that the likelihood of noticing an unexpected object depends on the similarity of that object to other objects in the display and on the difficulty of the priming monitoring task. They further concluded that observers attend to objects and events; the spatial proximity of the critical unattended object to attended locations did not appear to influence detection.

STAGING INATTENTION BLINDNESS IN AN ART GALLERY

To study inattention blindness in the context of an art exhibition, I utilized an animation that resulted from my collaboration with Michael E. Goldberg, Director of the Mahoney Center for Brain and Behavior, Columbia University, NYC. My study involved two components: observing if viewers watching an animation in a gallery could be distracted from noticing the disappearance of stolen museum antiquities (the targets) by the overlaid flashing images of a card game (the distractors) and then observing whether repetition of the depicted targets throughout the gallery installation could facilitate an "attention switch" that allowed viewers to perceive the targets not initially noted in the animation when re-viewing it again. The reasoning was that the informal "learning" taking place through contextual cueing might cause viewers to recognize the overlooked targets.

I became especially interested as an artist in the boundary between normality and pathology. Part of my motivation was to test first-hand whether the embodied knowledge of images, emotion, and social context that is deeply embedded in art practices is capable of supplementing neuroscience's understanding of attention and its disorders. Part of the controversy over the diagnosis of attention deficit hyperactivity disorder (ADHD) involves determining whether ADHD symptoms such as distraction fall within the bounds of normal perception. The construction of an installation and collaborative animation allowed participants to experience the constraints on the attentional system. Showing the animation within the experimental context of a gallery setting provided a way for viewers to experience a common failure of perception along with an opportunity to reflect upon this experience. The project raised four questions: (1) What does attention make possible? (2) Can attention be shifted? (3) Does art training help prevent distraction? and (4) Can art train attention? My findings showed that, after viewing the entire installation and then re-viewing the animation, 64% of the viewers who did not initially remark on the targets in the animation were then able to see them. I have used the term "remark" rather than "see" because it is possible that pre-attentive viewing had occurred but had not yet been brought to conscious awareness. I discuss the implications of these results with regard to my premise that art offers a training system for the attentional system.

Images of looted Iraqi antiquities were programmed to gradually disappear over the course of a 3-min animation, and the distraction of viewing hands with flashing cards made them hard to discern (**Figure 1**). A directive was issued at the onset of the animation to "count the number of times the Queen of Hearts appears." After one playing, viewers were questioned about what they had observed; those who did not see the targets were invited to walk around the gallery and then re-view the animation. The aim was to assess whether the repetition of images of looted objects throughout the gallery in static displays could cause the targets to become more salient and result in viewers redirecting their vision from the foreground to the background of the animation.

The design of my own artistic study was different from the scientific studies just considered. As far as I am aware, art experiments are seldom conducted that have explored inattention blindness. In addition, psychophysical tests are not frequently conducted in settings apart from laboratories, and I wanted to determine if a gallery had any advantages over these situations. In fact, scientists, themselves, are increasingly investigating the operations of vision under more natural conditions. As an early example, Neisser (1982) demonstrated the value of studying animals under naturalistic conditions. Unlike such experiments, however, my art installation, *Stealing Attention*, constituted a far from neutral test. It referenced the 2003 US invasion of Iraq and conceivably aroused some of the strong emotions many Americans felt in being led into

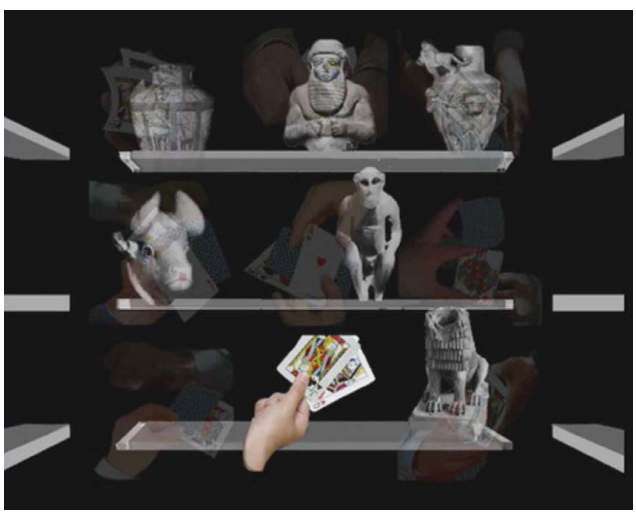

FIGURE 1 | An animation overlay of images of hands playing "three-card monte" (http://www.complexityart.com/subs/images/flash/stealing_attention_feldman.mov).

war on a misleading premise. The gallery exhibition broadened the parameters of objective scientific testing in that the art encouraged viewers to identify emotionally with the loss of the Iraqi heritage signified by the looting of antiquities.

The distractors in my art experiment were hands with cards that flashed rapidly and were intended to symbolize the game Three-Card Monte. This game is directly in line with other con games in which the card dealer's rapid hand movements keep the person placing the bet from noticing the removal of the winning card. I based some of my images in the animation and throughout the entire installation on works by Caravaggio and Georges de la Tour that dealt with the theme of card thefts. These are images well known to artists and art historians. Many museum goers will recall the mid-sixteenth century work titled *The Conjuror*, by Hieronymus Bosch, which is a study of distraction related to Three-Card Monte. As Macknik et al. (2008) pointed out, in Bosch's artwork the magician performs the shell game for a crowd in medieval Europe, while pickpockets steal the belongings of the distracted spectators.

In psychological parlance, the hand movements of the card dealer in our animation were "distractors" intended to direct attention away from the "critical stimulus" or true targets (the removal of antiquities). The animation symbolically linked the Iraqi invasion and stolen antiquities with the Bush administration's own hidden objectives. In my interpretation, the administration's false claims of weapons of mass destruction were meant to distract the public from the real targets of invading Iraq and toppling Saddam Hussein. Nevertheless, I underestimated the difficulty of choosing a disappearing, partially hidden object to be the stimulus that would capture the viewer's attention, especially when distracted.

MATERIALS AND METHODS

The audience for the exhibition comprised predominantly gallery and museum goers, including scientists, students, and the general public. My study was designed to assess the effects of gallery contextualization upon attentional shifts. My assumption was that art audiences will sometimes have developed special skills; frequent gallery-goers often learn to look intensely and compare viewing works of art with prior experiences. The installation was designed to foster such informal learning through repeating the depictions of similar objects (images of both the targets and distractors) in different media as the viewer moved through the exhibition space. My exhibition offered an opportunity to try to assess the influence of an esthetic environment to promote informal learning; commercial galleries are often conditioned by trends and will rarely accommodate this kind of interest. Written materials accompanied the exhibition, including the title of the exhibition (*Stealing Attention)*, signage (the names of the art works displayed and other information), and a press release; all provided minimal clues as to the content of the exhibition. Another advantage of a public exhibition for a psychophysical test is that serious art visitors will often be engaged in visual search and discrimination tasks. Although viewers are generally free to wander at will, the layout and flow through gallery spaces are often carefully crafted. For example, many artists and curators juxtapose specific objects and images to build a totality of relationships that offer more as a whole than when seen individually. To prompt viewers who did not initially see the targets in the animation after several viewings, I had placed static images of the targets throughout the installation in order to re-direct their attention to the targets when they returned to the animation. I therefore considered their possible movements through the space and installed static works that could provide repeated cues.

I asked a series of questions to determine what viewers saw before and after moving through the exhibition space[1]. To a limited extent I was able to assess the involvement of people by:

- Observing how they moved through the gallery and whether they read signage.
- Soliciting their comments to assess if they recognized my artistic intentions.
- Identifying whether they requested information or proposed a hypothesis.
- Interpreting their responses, particularly emotional reactions.
- Determining if "flexible thinking" occurred as evidenced by a revision of what they saw.

My study was repeated in several different contexts and with a variety of formats. The animation that I designed with Goldberg was modeled after the Simon and Chabris animation, but with significant differences. The Flash animation program was randomized both positionally and temporally and prevented the viewer from predicting what card would flash and where it would be located on the screen or from determining what antiquity, assuming it was perceived, would next be removed. In each cycle all nine images of the hands of Three-Card Monte players were displayed once and were taken from a pool of nine "cells" of images of hands "playing" cards. Going through one cycle of nine random positions took approximately 2.7 s (0.3 s × 9). One of the nine cells showed the Queen of Hearts. It stayed on the screen for about 300 ms. The construction of the animation included the additional image of a yellow circle that preceded each appearance of the image of the Queen of Hearts with which it was temporally linked. It was on view for only a moment, thus serving as a "flicker" that further distracted the viewer from noticing the disappearing relics. Every third time the yellow circle appeared a target disappeared from one of the three depicted shelves in the background of the animation. It took 30 cycles to go from an image of 10 relics on three shelves to three empty shelves. At this point approximately 81 s had passed, and the program then displayed a gradually fading mound of rubble suggestive of the aftermath of the looting of the museum. The program then paused for 20 s before starting the next iteration. I learned by much trial-and-error what conditions would best foster recognition of the phenomenon in the context of an art exhibition. To collect as much data as possible, I created both a gallery situated and studio-situated experimental situation that allowed me to assess the presence of re-directed viewing among a sample of participants. Data came from the following sources:

[1]The questions were loosely adapted from a 2003 study jointly conducted by the Isabella Stewart Gardner Museum and Institute for Learning Innovation Institute; see http://www.gardnermuseum.org/education/research.

- Gallery situated: Michael Steinberg Fine Arts during the course of the exhibition (March 19–April 18, 2009) and Ronald Feldman Fine Arts (May 15–July 23).
- Studio-situated: Attendance from two art classes (April 30, 2010 and November16, 2010) and two Art/Sci Salons (April 8, 2010 and December11, 2010).

In its first gallery viewing at Michael Steinberg Fine Arts, the animation occupied a fully lit room that contained several mixed-media two-dimensional representations (**Figure 2**). The exhibition title and signage were intended to offer suggestive clues as to the content of the exhibition without being "giveaways." The same antiquities were depicted in these art works as those shown within the Flash animation. These mixed-media works on wood contained figure–ground reversals and Necker illusion perspective reversals, in which the depiction alternatively recedes and juts forward. The depicted setting for these "thefts" was the interior of a museum sometimes identified through applied lettering as the National Museum of Iraq.

Upon leaving this entrance space, the visitor entered a corridor that had six art works, each $30 \times 24''$. These consisted of a combination of real and illusory images in which some of the forms were painted to look like collage. The images depicted were of hands appropriated from either Caravaggio or de la Tour paintings. They grasped looted Eastern antiquities that were partially hidden behind playing cards (**Figure 3**). The partial transparency of the hands and cards was very similar to the transparency of the targets in the animation.

The corridor opened into a back room, which had several more of my art works and into a smaller installation room that was painted black (**Figure 4**) and featured a single empty white shelf. Suspended just above the shelf were prints from a database of looted Iraqi objects, which featured images identical to those shown in the Flash animation. If someone viewed the entire exhibition and then returned to the animation, these additional clues were designed to make it more evident that the animation showed the disappearance of stolen Iraqi antiquities. The titles of the static works also provided such clues as *Conning Baghdad*, *Graffiti in Iraq*, and *Fleeced Chariot*.

During the Michael Steinberg Fine Arts exhibition, visitors were asked what they observed. During the opening and a pre-scheduled class visit, a video camera was positioned facing out from the

FIGURE 3 | *Disappearing Act,* painted (illusory) and real collage.

FIGURE 2 | Installation view of "stealing attention."

FIGURE 4 | Black installation room, bare shelf with print-outs of looted Iraqi antiquities.

wall toward the viewers. I eliminated all but three of those interviewed at the opening, which, with these exceptions, did not offer a consistent testing situation. Having observed the difficulty of target detection during the opening (where there were additional distractions), after the opening I slowed the rate of the flashing hands to make target detection easier.

I was able to approximate similar circumstances of viewing in my studio space to that of Michael Steinberg Fine Arts, including static art works and database prints. This enabled me to document the responses of several different groups of visitors to my studio, including artists, art historians, and musicians.

For a third display at Ronald Feldman Fine Arts, NYC, I created a multi-unit work (**Figure 5**).

Since I did not have the entire gallery space to work with, I needed to provide more clues to the viewer within the animation. This time, instead of the header, "Would you like to play Three-Card Monte?" the text in the animation asked whether the viewer would like to play Three-Card Monte with George W. Bush. When the image of rubble appeared at the end of each iteration, for a brief moment an almost subliminal message appeared that identified the scene as "The National Museum of Iraq." Given the limited space I also needed to rely on depicted still images in one part of the three-part work as a way to contextualize the animation. The animation was placed next to a painted collage, and both were juxtaposed with an empty shelf (over the monitor) from which prints of looted objects dangled. In this way a viewer could compare the images of missing antiquities in each of the three units and flesh out the connections between them. The viewer was therefore offered several ways of assimilating and correlating information.

FIGURE 5 | Installation at Ronald Feldman Fine Art, NYC.

RESULTS

A total of 82 individuals, predominantly from the arts, were observed in the experiment at all three locations. More than half the participants were female; all were adults and predominantly Caucasian. Overall, 32 of these 82 (39%) remarked on the targets after their initial viewing of the animation. Of the 50 who did not initially remark on the targets, 32 (64%) did after having seen additional visual prompts (**Table 1**).

During the scheduled visit of an art history class on March 28, 2009, several groups of viewers arrived at the gallery at different times. They totaled 19 viewers who consisted predominantly of art history students along with unidentified viewers who joined the groups. Since clusters of people were involved, I asked those present to indicate to me what they saw privately and not to discuss their findings aloud. Of this group, 13 of the 19 viewers did not initially see the targets (the disappearing antiquities). I asked the viewers what they saw in the animation both before they walked through the entire installation and then afterward, while they re-viewed the animation. While people continued to watch the animation, I asked them to report on the cards and anything else they saw. Of 13 viewers, six now saw the targets. For those who still did not see the targets, I explicitly asked them to ignore the distractors; all but one viewer saw the targets. While people walked around the exhibition, I would often ask them what they thought the work was about. I had opportunities to test the perceptions of other gallery-goers in similar ways. Of 31 additional viewers to the show, 18 did not initially see the targets. Of these, 10 saw the targets after moving through the exhibition and re-viewing the animation while being asked the same questions as previously. For those who still did not see the targets, when asked explicitly to ignore the distractors, all but one viewer saw the targets.

After the exhibition had concluded, a small art group of six people (experienced art goers) came to my studio; only two of the six initially saw the targets. Upon further viewing and walking around the studio to see the related still images, only two did not

Table 1 | Summary results of targets seen at three locations.

Location	Occasion	Number of viewers	Target seen	Target unseen	Target seen on re-viewing
Steinberg	Art class and others	19	6	13	6
Steinberg	Various	31	13	18	10
Studio	Art group	6	2	4	4
Studio	Musicians	7	2	5	4
Studio	Art/sci	10	5	5	4
Feldman	Various	8	3	5	4
Studio	Viewer EF	1	1	0	0
Total		82	32	50	32
Percentage seeing target			39.0%		64.0%

see the targets. After being asked to disregard the hands while re-viewing the animation, all saw the targets. Another small group of seven musicians from Juilliard also participated. Of this group, two quickly saw the critical targets (one almost immediately), and four succeeded before being asked to disregard the distractors. Eleven more people from two art and science gatherings saw the experimental set up at my studio at varied times; six of them initially saw the targets, and after further viewing, all did. There was one especially intriguing interchange. After only a single iteration one artist was able not only to provide the correct number of times that the Queen of Hearts appeared, but she was also able to see the disappearing antiquities. I asked her how she accomplished this so quickly, and she said that her art training had provided her with this ability.

I had further opportunity to test the phenomenon of inattention blindness during a group exhibition at Ronald Feldman Fine Arts that included my art work. Of the eight viewers with whom I spoke, three saw the targets after two iterations. Four of the remaining five later saw them after several more iterations of the animation, and the fifth viewer saw them after I asked him to disregard the distractors.

POTENTIAL CONFOUNDS

I could correlate my observations with the likelihood that learning had occurred but could not make causal inferences about the effect of the repeated images on such learning, since several factors could have influenced the ability of some viewers to see the targets after first missing them. One potential confound was interpreting the ability of viewers to remark on the target when re-viewing the animation after having seen the rest of the installation. There is the possibility of improved performance simply as a result of repeated viewing of the animation. Although this is a possible explanation of the results, it is unlikely because viewers who initially saw the animation (who had not yet gone through the entire installation) who did not remark on the targets generally also saw the animation several times. The animation was continuously playing so most viewers would have seen several iterations by the time they answered my initial question ("What do you see?"). Of course I could not know how much repetition would be needed for a target to attract attention. My understanding was that costs are involved in switching attention and something else must occur to enable the perception of a target besides repeated viewing. It also seems plausible that after failing to observe the target, repeated viewings could reinforce the blindness, which was the point that Treisman and De Shepper had made about the increased ability of viewers to ignore distractors after ignoring them once.

Another confound was that the animation was continuously playing so most viewers would have seen several iterations by the time they answered my initial question ("What do you see?"). Although I tried to direct people when to start viewing the animation, it was not always possible to control. Some viewers did not see the animation from the beginning, and, as a result, did not see the assigned task ("Count the number of times the Queen of Hearts appears!") at first viewing. In addition, questions often needed to be asked of groups of viewers rather than individuals raising the likelihood of influence from reports by others even though people were asked to speak with me later privately. Apart from those viewers who were questioned, no effort was made to control the flow of people through the exhibition space. As a result, an average viewer might have seen the animation at any point in its iteration while viewing the exhibition in its entirety.

The complexity of the large-scale works on wood might also have been a confound since these works did not offer instant recognition of the targets. However, for most viewers, the smaller works and dark room installation with the database prints, in particular, were giveaways in terms of identifying the targets.

Each of the three circumstances of viewing (the two galleries and studio installation) was somewhat different. Finally, I had no way of determining whether the visitors would apply/transfer knowledge gained about inattention blindness to other contexts. The actual risk of the experiment was that, if the clues provided to the viewer were insufficient, the viewer might remain entirely unaware of the relics disappearing and only perceive flashing hands and cards in the animation and view the animation and installation as being unrelated. At the other extreme, if viewers received too many clues, the risk was that viewers might not realize that their recognition of the existence of a fundamental perceptual problem comprised the basic content of the exhibition. In other words, it was important that viewers could intuit the artistic intentions. The ideal situation was to enable the viewer to become suddenly and consciously aware that the relics were disappearing. To set up conditions to foster this "epiphany" proved a difficult challenge. It necessitated many preliminary trials varying the speed of the hands flashing and their degree of transparency until a successful balance had been judged to be achieved.

It should be noted that this investigation had no control group. As already observed, it was also difficult to control the parameters in a way that facilitated rigorous testing (e.g., starting and stopping the animation after each viewing to regulate the number of repetitions to which each viewer was exposed). In addition, such regulation would have been self-defeating; as the project involved esthetics in relation to learning, it was also important to maintain the ambiance of a gallery as opposed to a psychological experiment. I therefore collected information as unobtrusively as possible.

DISCUSSION OF THE ART EXPERIMENT

I found support that art can re-direct attention based on the evidence that after walking around the full installation, more than half of the viewers who had not originally been aware of the targets subsequently remarked on them when they re-viewed the animation. Perhaps the strongest indication that learning (defined as a gain in awareness) may have occurred was that, based on participants' comments, it became evident that some of those who had originally not understood what the animation had to do with the rest of the installation had subsequently gained the understanding that their own "attention" skills determined whether or not the animation and installation were linked. In other words, the installation encouraged self-reflection about the constraints on our attentional system that everyone experiences but of which few are consciously aware.

This experiment does not offer proof of a direct link between art training and the ability to perform attentional switches although it does, perhaps, suggest some of the potential for art to modulate

the attention of engaged participants. In addition this experiment did not disambiguate learning (possibly through a priming effect) and repetitive viewing. Further refinements for the future might include a control group unaccustomed to art exhibitions, assuming that this could be done without disrupting the esthetic environment. Another control could consist of a group led through the installation before viewing the dynamic stimulus on the grounds that it might help distinguish whether repetitive viewing or priming enabled the seeing of the targets in the re-viewed animation. In point of fact, many viewers did go directly to the back or the middle of the exhibition, particularly when others blocked their view of the animation, but systematic questions related to perceiving the targets were not asked of them.

The mixed-media paintings featured depicted images of stolen antiquities identical to those shown in the background of the animation and primed the viewers to recognize those objects (**Figure 6**).

For some viewers, the collage paintings in my exhibition reinforced the viewer's gradual realization that perceptual issues were the subject of the installation. My process was to start by making a drawing that served as the basis for a digital print (**Figure 7**). It was deliberately made smaller than the wood on which it was mounted. A process ensued of cutting, rotating, and repositioning the print on the wood. When pulled apart, the print disrupted some of the continuity of perspective and forms (thus also disrupting the illusionism). All of the repositioning and superimposed painting created a maze of figure/ground reversals, rotations, and line displacements. The paintings thus displayed the circumstances under which illusion occurs and is destroyed. Perspectival illusions were also disrupted by mental attempts to piece the original units together, so these works served as another way to show the viewer how attention could be misdirected. As I noted previously, the complexity of these works might also have been a confound since it made instant recognition of the targets difficult. However, when coupled with the dark room installation and smaller montages that focused on the hands, cards, and targets, sufficient clues were provided to allow recognition of the targets. In addition, the incorporation of text within the large-scale works sometimes indicated that the National Museum of Iraq and looting were the subjects of the art. The role of the static art works and black room installation within the exhibition became that of "context-providers" as opposed to existing solely as discrete art objects. They provided "contextual cueing" (Chun and Jiang, 1998) and served as emotional signifiers, likely prompting recognition of the targets within the animation.

CONDITIONS OF VIEWING

Mack and Rock have pointed out that three kinds of conditions are generally involved in tests of inattention blindness: inattention, divided attention, and full attention. In my project, the trials were conducted as viewers watched the animation. The first trial was held after the viewer saw the first iteration of the animation and before viewing the entire installation. The second trial was held after subjects viewed the installation and while they re-viewed the animation. Both the first and second trials were inattention trials. The viewers were only asked to report on what they saw. During the second trial, as subjects continued to watch the animation, they were asked to observe the flashing cards and "anything else." This was an explicit divided attention task since the viewers were asked to report on both the distraction and the presence of something else. The divided attention trial thus provided information about the subjects' ability to see both the targets and distractors. If someone still did not see the targets, I conducted a full attention trial in which the subject was explicitly asked to disregard the distraction task (i.e., the flashing cards) and report only the presence of something else on the screen (e.g., the critical targets). With the full attention trial almost all the viewers succeeded in identifying the critical targets.

Returning to the first of the four questions (What does attention make possible?), I could now answer in agreement with the findings of Mack and Rock that attention is necessary for perception. The assigned task in the animation (count the number of times the

FIGURE 6 | Static work *Fleeced* Chariot, paint (illusory) and real collage on wood, 2009.

Queen of Hearts appears) directed attention to the distractors and at least half the viewers were effectively blind to the targets. This "blinded" group of viewers only succeeded in seeing the targets when their attention had been switched to the circumstances of either divided attention or full attention. Mack and Rock made it clear that the important scientific measure is to compare reports of the critical stimulus in the inattention trial with those in the full attention trial because this difference indicates what is contributed by attention.

With regard to the second question (Can attention be shifted?), most viewers were engaged in a visual search task for the Queen of Hearts. The exceptions were those who disregarded the task, those who successfully divided their attention, and those who started viewing the animation after the counting task had been assigned and were initially unaware of the task. The assigned task guaranteed that many viewers would be looking in the general area without expecting or looking for the targets. My findings agreed with Mack and Rock's observation that attention can be shifted when the viewer realizes that something other than what is most visually obvious is at stake. In this case, the distractors were the most obvious thing. However, for more than half of the viewers who had not remarked on the targets at the first trial, the installation created a salient alternative: namely the disappearing antiquities. The way this switch might have occurred is discussed later in this paper. But it seems to me that the important point was that, by viewing the installation in its entirety, many viewers recognized my artistic intention and, as a result, could remark on the targets.

FIGURE 7 | ***Conning Baghdad,*** **paint (illusory) and real collage on wood, 2009.**

The third question (Does art training help prevent distraction?) asked whether seasoned art viewers might integrate input from the animation into a framework of prior knowledge gained from their gallery or life experience and override the tendency to follow the instructions provided at the onset of the animation. Despite the fact that many viewers reading the instruction immediately started to search for the Queen of Hearts, many were able to see the targets after only a few iterations. In addition, there was evidence that some could do both operations (see the distractors and targets simultaneously). How did they accomplish this? I attributed it to the fact that most viewers in my survey were routine gallery-goers and had learned to encompass a whole visual field.

During the 1960s, psychoanalyst Anton Ehrenzhweig had developed a theory that "de-differentiated" viewing was a mark of creativity as opposed to "gestalt-based" viewing proposed by Gestalt theorists such as Rudolf Arnheim and Ernst Gombrich that singled out one particular area of a visual field at the expense of others (Jones, 1996, p. 325). Piaget (1930) used the term "syncretistic" while explaining how children viewed causality. A distinctive feature of children's art was to emphasize a juxtaposition of parts. Ehrenzweig (1962, 1971) similarly described syncretic vision as seeing-together, meaning vision that can ignore the distinctions between figure and ground. He championed this approach to creativity, explaining that syncretism involves the idea of looking at a field without differentiation (such as seeing the figure at the expense of the ground). He stated that no single act of attention can take in the whole of the visual field, but the mark of good art was to be able to create a work in which every detail was viewed as part of the overall structure. Findings have suggested that highly creative individuals deploy their attention in a diffuse rather than a focused manner (Ansburg and Hill, 2003). Ehrenzweig concluded that grasping the picture as an indivisible whole is accomplished by a scattering of focus and serves the vital purpose of aiding survival in the real world. According to Ehrenzweig, this de-differentiated viewing would also allow us to see the two profiles of Rubin's vases simultaneously although he could not test this at the time (Ehrenzweig, 1971, pp. 22–23). The idea was that a viewer can be receptive and take in a mass of concrete detail without needing to consciously identify it. Another word for this visual talent is flexibility. A later study similarly concluded that "formal art training results in a global recognition of the pictorial structures involved along with narrative concerns. Attention is shifted away from local feature analysis and information gathering" (Nodine et al., 1993, p. 227). These explanations are suggestive of why one artist in my

study was able to see the targets and distractors simultaneously and quickly. It also explains how the training that artists receive is essential to developing such flexibility.

Other gallery-goers reported that they had difficulty tracking the cards and stopped counting them altogether. However, this did not seem to impact on their ability to see or not see the background targets. A similar result was reported by Simon and Chabris. Michael Goldberg, who showed the animation to a group of physiology students and colleagues at Columbia (before it had been adjusted for speed and without benefit of any of the contextualization of the animation provided by the installation), noted that most of his viewers saw only the flashing hands and cards. This difference of response between the scientists (at the laboratory) and artists (at the gallery) is suggestive of the difference in training between these groups, but it is inconclusive since the animation shown was not identical. More importantly, the viewers at Columbia would have had no way to identify my artistic intentions without the contextualization from either static images or, conceivably, from sound (if rifle shots and breaking glass had accompanied the animation).

Finally, with respect to the fourth and last question (Can art train attention?), the results indicated that artworks have the potential to redirect attention and thus switch a viewer's "attention-set." At the least, most viewers expressed awareness that a perceptual problem had been staged, and a few noted that their attention was being manipulated. My results therefore answered the question affirmatively that art offers a training ground for attention. Nevertheless, on the basis of my experiment I must qualify an affirmative response to the question whether attention can be trained by art. The reasons for this qualification include the lack of a control group, occasional difficulties of recording data at the time the tests were taken, inability to control test parameters and maintain an esthetic setting, the need to speak with groups on occasion, and the lack of fully consistent circumstances of viewing.

IMPLICATIONS FOR LEARNING

Psychology has investigated learning and memory by dividing it into categories such as non-associative and associative (Thompson, 1986). An example of non-associative learning is habituation and it often involves a single event. By contrast, associative learning involves the conjunction of several events and is divided into Pavlovian conditioning (e.g., the ringing of a bell is associated with food) and instrumental conditioning (e.g., pressing a lever to obtain food). Classic psychological studies have determined that the amygdala complex impacts on the amount of attention an object receives; it assigns an emotional salience (significance) to objects or events through associative learning (Klüver and Bucy, 1997). Researchers (Gallagher and Holland, 1994) have provided evidence that a subsystem within the amygdala provides a coordinated regulation of attentional processes. This is pertinent to my study of inattention blindness because the cues that were supplied by the full installation were not neutral ones, but ones that referenced the war in Iraq and the destruction of a cultural heritage. I suggest that those viewers who made the associations between the targets and what they represented would have "learned" to associate the targets with the war and be more likely to recognize the targets when they returned to the animation. In other words, this learned association would have given a charged significance to the target and impacted the attentional system.

Posner and Petersen (1990) have shown that different operations within the attention networks are responsible for such activities as disengaging attention, shifting attention, and engaging a selective focus of attention. Routes of neuroanatomical connectivity between the amygdala and other brain systems allow some regulation over the attentional system (Gallagher and Holland, 1994). The role that emotion plays in regulating attention (and "capturing" attention through arousal) can and has been traditionally capitalized upon by educators – and by artists. Greater learning occurs with salient examples and associations.

In 2007, Posner et al. described how individual differences might account for differences in the efficiency of the attentional system, reflecting both genes and experience. Posner and Rothbart (2007) have suggested that we view learning as exercise for the brain, which might strengthen the neural circuits involved with memory work and attention. The basic idea about attention training is that the repeated activation of attentional networks through such training will increase their efficiency. They pointed out that early researchers (e.g., Thorndike, 1903; Simon, 1969) dismissed the idea of attention training because they had concluded that training is domain-specific and cannot be more broadly applied to the general training of the mind. The example provided was mathematics, which was not believed to involve transferable properties. However, Posner and Rothbart demonstrated that attention is an exception to being domain-specific and that attention training can, in fact, be transferred to other areas of the brain. They claimed, "Attention involves specific brain mechanisms, as we have seen, but its function is to influence the operation of other brain networks" (Posner and Rothbart, 2007, p. 13). Posner et al. (2008), also proposed that both memory and attention in children diagnosed with ADHD can be improved through art training. They identified some of the factors involved with improvement as including enhanced motivation and the fact that there are specific brain networks involving different art forms. The more general implication may be that viewers might derive indirect benefit from certain artworks to whatever extent the actions prompted by the artworks overlap with the formalized tasks of scientific attentional training and testing.

Psychologists Ellen Winner and Lois Hetland have challenged instrumental claims that study of the arts can lead to improvement in standardized achievement tests (Winner and Hetland, 2000). Their skepticism does not, however, negate other possible benefits of art with regard to learning. Winner et al. (2006) have pointed out the necessity of understanding the actual skills that are gained through art-making. They include experimentation, expression, problem solving, observation, and evaluation, along with understanding the art culture. It seems to me that, as I found in my own art experiment, galleries, and museums can also play a greater role in developing such skills.

THE ROLE OF ESTHETICS

Some objects, artworks, and performances draw attention not to informational data, but instead set in motion simulated events that may involve a qualitative transformation in the viewers. These objects can be thought of as boundary objects, which probe the

way the mind works. My goal was that the installation, *Stealing Attention*, would function in this manner and help the viewer see something that was otherwise invisible. As philosophers and artists (notably Picasso) have frequently pointed out, in order to get to a truth that is invisible, art must falsify vision in some sense. An important part of an artist's training involves the ability to contrive a believable scene or event with the realization that it entails a falsification of vision. In addition, an art student must learn how to manipulate a viewer's attention. These skills are not only part of an artists' training, but must also be developed in rehabilitative work involving the senses.

A true scientific study with strict experimental parameters and controls would have destroyed an atmosphere of esthetic contemplation, and this state was an important component of my project. As Kant pointed out over a century ago, the esthetic object offers viewers a way to experience pleasure through the "quickening" of their "cognitive faculties." This process involves "the active engagement of the cognitive powers without ulterior aim" (Kant, 1790/1951, p. 68). To create a minimal esthetic condition a viewer must realize that a formal event and staging of images are intentional. It must also be recognized that the dynamics of attention actually structure what is perceived as relevant. For my study of inattention blindness, I sought a balance between the sometimes-conflicted goals of creating a moving work of art versus designing an effective experiment. Despite these conflicts, what artists can provide to the study of attention are ways to design situations where self-discovery on the part of the viewer might suddenly occur as the viewer registers a moment of surprised recognition of something significant that was previously missed.

INATTENTION BLINDNESS AS VIEWED IN ART HISTORY

In addition to works by Caravaggio, de la Tour, and Bosch, another example of inattention blindness, although also not explicitly labeled as such by art historians, might well be Chardin's *The House of Cards*. According to art historian Fried (2007), Chardin called attention to "the telling juxtaposition of two playing cards in the partly open drawer in the near foreground." Fried noted that in the depicted open drawer in *The House of Cards*, which marks the plane closest to us, one of the cards (the Jack of Hearts) is fully facing the viewer and open to his or her gaze. Fried pointed out that this is in contrast to the second card, which is hidden. He then concluded that Chardin's intentionality is made apparent by his creation of the fiction of a card that is hidden to the depicted figures in the art work and responsible for the work's importance. The intentionality that Fried prized in Chardin is signified by the fact that in Chardin's work, a posed, painted actor looks like he is oblivious to the hidden card and to our viewing of him (**Figure 8**). As Fried has emphasized, we, the viewers, must accept what we know cannot actually be the case, since the likelihood is that this painting, like others, was made from a posed model. Fried's interest in the artist's intentionality is shared by some scientists and philosophers. A large part of the importance of a painting is how it reveals the intentions of the artist and thus is indicative of larger patterns of conscious attentional decisions (Roskill, 1989). Philosopher Rollins (2004) has suggested that the artist's intentionality in creating an artwork marks the difference between an art object and a non-art object that has similar esthetic traits. I suggest that what Chardin staged was an occurrence of what scientists might now identify as inattention blindness. This painting then confirms that training in the manipulation of attention is something that artists have long received.

FIGURE 8 | Jean-Baptiste-Siméon Chardin, *The House of Cards*, ca. 1737, oil on canvas, 82.2 cm × 66 cm, National Gallery of Art, Washington, Andrew W. Mellon Collection, Source: The Yorck Project, licensed under the Creative Commons Attribution-ShareAlike 3.0 license and the GNU Free Documentation License.

It would seem that, just as cognitive examinations can test for flexibility, art works might also foster learning. One of the tests used to help determine whether an individual has ADHD is the Wisconsin Card Sorting Test, a neuropsychological test of "set-shifting" (Berg, 1948). Stimulus cards that contain shapes of different colors, amounts, and designs are presented to the subject. The person administering the test asks the subject to match the cards by color, design, or quantity. To accomplish this, the participant is then given a stack of additional cards and asked to match each one to one of the stimulus cards, thereby forming separate piles of cards for each. The matching rules are changed unpredictably during the course of the test, and the time taken for the participant to learn the new rules and the mistakes made during this learning process are analyzed to arrive at a score. The test is considered to measure the flexibility in being able to shift mental sets, and it also assesses perseveration and abstract (categorical) thinking. It has thus been considered a measure of executive function.

The patient who has a frontal lobe deficit lacks a "supervisory attentive" system. According to Changeux (1994), when that patient takes the Wisconsin Sorting Card Test, he or she does not

become aware of the changes in the examiner's strategy and will perseverate, repeating the same mistakes. Significantly, Changeux has compared the difficulty held by such patients to their inability to intuit the intentionality of an artwork. He stated, "It would appear then that the frontal cortex intervenes both in the genesis of hypotheses and in the elaboration of critical judgment, both faculties being essential for viewing a painting, as we have seen" (Changeux, 1994, p. 192). In this way Changeux makes explicit the generally unrecognized ability of an artwork to test the viewer's mental flexibility.

ATTENTION SWITCHING

How might the repeated images have enabled many viewers to shift their attentional set? Perhaps art historian Jonathan Crary supplies part of the answer. In *Suspensions of Perception* (1999), he addressed the important issue of attentional alternation between engagement and fatigue. Crary's thesis was that that the poles of attention and distraction can best be understood as a continuum, pointing out that attention carries within it "the conditions for its own disintegration" (Crary, 1999, p. 47). But Crary also cautioned readers against viewing Cézanne's works as the results of faithfully portraying his "subjective optical impressions" (Crary, 1999, p. 301). He viewed Cézanne as recording attention, itself, during which time Cézanne's alternation between focused intensity and overall defocused viewing embodied his attentional gaze – the countless shifts, saccades, and blinks as the scene changed before the artist. To me his insight into Cézanne's work shows the advantage that accrues to some static works like paintings. They can memorialize the eye's activities, something that could not be accomplished in the same way if the artworks were themselves in motion. In addition, still works can be contrasted and contextualized with a medium such as animation that relies on movement. There is no need to make a choice between these modes. This is why *Stealing Attention* was a multimedia exhibition, utilizing a dark installation room, an animation, and collages: it offered the viewer several ways to confront and contrast information delivered both slowly and quickly. Static images might also offer the viewer the chance to refresh the fatigue that accompanies intense viewing.

The linking of alternating engagement and fatigue with inattention blindness finds some support in science. Dehaene and Changeux (2005) developed a model for inattention blindness that takes into account a neuromodulatory substance that causes the attentional network to exhibit a surge of activation, involving synchronized gamma-band oscillations of increasing amplitude. They proposed that this corresponds to a state of vigilance and also hypothesized a second state transition, involving a temporary increase in synchronized firing. They consider that this state of activity may compete with sensory processing and lead to an extinction of sensory processing that may account for the phenomenon of inattention blindness.

Attentional selection has been distinguished as either goal-directed (top-down) or stimulus-directed (bottom-up; Lamy and Bar-Anan, 2008). Top-down selection, a volitional act, is an executive function of experience and expectations. It is an endogenous control of attention that refers to the ability of the observer's goals or intentions to determine which areas, attributes, or objects are selected for further visual processing. By contrast, bottom-up or exogenous control refers to the capacity of certain stimulus properties to attract attention. Bottom-up attentiveness originates with the stimulus and is almost impossible to ignore. Neuroscientist Charles Connor and his team have speculated, "What happens in the brain when these two processes interact?. . . the complex dynamic interplay between bottom-up and top-down attention determines what we are aware of from moment to moment" (Connor et al., 2004). Research has focused on the relative contributions of these two sources of guidance. At one end of the continuum, neuroscientist Jan Theuwes proposed that "attentional priority" is entirely under the control of stimulus-driven factors, which entails that attention is directed to the "most salient object" in the visual field regardless of the observers' goals (Theeuwes, 2004). At the other end, neuroscientists Folk et al. (1992) have claimed that objects receiving attentional priority are contingent on attentional goal settings and that a salient object outside the observer's attentional set might not capture attention (e.g., a top-down approach). This issue remains controversial. More recent research has focused on the relative contributions of these two sources of guidance and investigated the extent to which the attentional set adopted by the observer can control which objects in the visual field receive attentional priority. In the absence of any particular intention, stimuli we happen to encounter evoke tendencies to perform tasks that are habitually associated with them.

Neuroscientists have contended that the cognitive task we perform at each moment results from a complex interplay of deliberate intentions that are governed by goals and the availability and frequency of the alternative tasks afforded by the stimulus. In task switching experiments, responses to the same set of stimuli differ depending on the goals of the individual at any point in time (Monsell, 2003). What is known is that a switch from one task to another brings about increased response times and increased errors.

As confirmed by psychologists Arrington and Logan (2005) in discussing switch costs, ". . .voluntary task switching requires subjects to choose the task to be performed on a given trial and thus ensures that a top-down act of control is involved in task switching. The voluntary task switching procedure inverts the usual question in task switching experiments. Instead of asking whether switch costs reflect a top-down act of control, it asks whether a top-down act of control produces switch costs." These researchers concluded that switch costs are incurred. They determined that top-down accounts typically focused "on the processes that enabled a new configuration of subordinate processes (or task set). The enabling processes may involve updating goals in working memory. . . or adjusting attentional biases and priorities suggesting that the extra endogenous act of control that occurs on switch trials can be initiated, and at least partially carried out, prior to the onset of the target stimulus" (Arrington and Logan, 2005, p. 684). Task switching has been found to take place under the circumstances of divided attention and also when viewers are instructed to ignore the task in favor of another. However, even voluntary (top-down) choices appear to be influenced by bottom-up factors. Experimental psychologist Nick Yeung has stated that ". . .present findings suggest that bottom-up factors may be a primary determinant of the costs associated with voluntary task switching. According to this interpretation, the switch cost does not directly index the time consumed by the process of activating or enabling new

task-level representations. Rather, the cost reflects a relative failure to activate such representations following a change of task, resulting in increased between-task competition and hence impaired performance" (Yeung, 2010, p. 360). It appears that relatively little is currently known about the extent to which bottom-up factors may contribute to voluntary switching performance. Apparently an asymmetry is involved in making a task switch; it has been attributed to "between-task interference" and explored in computational models (Yeung and Monsell, 2003). It may be easier to make a switch by performing an easier task (Mayr and Bell, 2006). It was found by some researchers that, even when more difficult in terms of the costs involved, participants favored task repetitions over task switches (Yeung, 2010).

The way in which this information pertains to the art experiment that I conducted is that, in *Stealing Attention* a task was assigned to the viewer. This made it likely that the uninitiated viewer would initially utilize top-down guidance in following the instructions. As documented, those viewers interviewed who did not initially remark on the relics disappearing (about half) were generally able to identify the disappearing antiquities after they viewed the entire installation and repeatedly viewed the animation. Apparently attention had been re-directed although I was not in a position to determine how. My hypothesis was that the emotional salience of the images may have played a role in addition to the repetition of the images. It also seems to me that you could account for the new ability of viewers to see the targets by top-down, bottom-up, or combinations of both mechanisms. If top-down, the viewers would now actively seek out those images of targets in the animation that were identical to those in the installation. If bottom-up, the salience of the targets would now have attracted the viewer's attention through priming. It is also recognized that task switching can occur under the circumstances of divided attention and during full attention (viewers are instructed to disregard the distractors).

SALIENCE

How can emotional stimuli direct the focus of attention? This question is very relevant to understanding how the emotional salience of looted antiquities might have helped bring about an attention switch when subjects re-viewed the animation. According to neuroscientist, Rebecca J. Compton, two stages are involved in the processing of emotional information. Compton has stated, "First, emotional significance is evaluated preattentively by a subcortical circuit involving the amygdala; and second, stimuli deemed emotionally significant are given priority in the competition for access to selective attention. This process involves bottom-up inputs from the amygdala as well as top-down influences from frontal lobe regions involved in goal setting and maintaining representations in working memory"(Compton, 2003, p. 2115). To me this suggests why a study of inattention blindness might profit by including the impact of emotional as opposed to neutral kinds of stimuli. If so, it would appear that examples of art works that have emotional impact upon viewers will become increasingly pertinent to scientific studies of attention.

CONSTRAINTS AND MODELS

In McMahon's (2003) view, when normal perception occurs, our attention is generally drawn to the literal meaning of a work. But she explained that if the work exploits particular strategies, it can draw our attention to focus on the phenomena themselves. The example she offered was Pollock's exploitation of the human capacity to pick out fractal patterns. This helped me to understand why many viewers could understand my intentions in my exhibition. In my own artistic study of inattention blindness, by exploiting the conflicts inherent in attention switching, the animation allowed viewers to experience the phenomenon directly and then be able to reflect upon it.

The term "bottleneck" is often associated with attention, emphasizing the physical limits of attention. What is the actual nature of this limit? Does it involve shape at all (like a physical constraint)? If so, exactly what is constrained? According to Posner the concept of constraint is a highly disputed idea about attentional function. Some do not believe in any physical limit but just various forms of interference. In an E-mail exchange (2011) Posner stated, "I believe the executive system imposes a kind of limit because its widespread connectivity produces a necessity for priority. Every other kind of view (e.g., attenuators, channel capacity) has also been suggested." My own experience with staging a study of inattention blindness was also filled with many constraints; not only were there the constraints experienced by viewers, but there were also spatial and time limits during the various exhibitions. What became evident is that all learning proceeds within constraints. This may reflect the fact that constraints force prioritizing to take place if an action needs to be performed.

Computational models of inattention blindness have tried to account for the many possibilities involved. The Block model of an attention capture framework as discussed by Gu et al. (2005, p. 183) relies on the cooperation of an internally driven top-down setting and external bottom-up input. The attentional set consists of a pool of task prominent properties that are maintained in memory. At any given moment only one object has a coherence map that can receive focused attention, and it is designated as the most compelling. This then drives a viewer's gaze. The "Contingent-Capture Hypothesis" relies on filters (Gu et al., 2005, p. 185). According to Gu, the attentional set held by the subject determines when an object receives attention. In addition, before an object can be considered for attention, a transient orienting response to the object must take place. This approach therefore explains why the likelihood of noticing an unexpected object increases with the object's similarity to the currently attended object.

According to Noë (2002), work on change blindness and inattentional blindness in the psychology of scene perception has provoked a new skepticism as evidenced by belief in "the grand illusion," which claims that the richness of our visual world is an illusion. Noë has pointed out that failure to notice change is a pervasive feature of our visual lives. Many of those who have investigated change blindness support the grand illusion hypothesis that the richness and presence of the world are illusions. Noë counters this attitude by pointing out that we are sometimes perceptually aware of unattended detail (amodal perception). He provides the example of our perception of solidity when experiencing a tomato as three-dimensional and round, even though you only see its facing side (O'Regan and Noë, 2001). He has concluded that the sensorimotor account can explain experience not represented in our brains. According to O'Regan and Noë (2001),

mastering sensorimotor contingencies generates our conscious visual experiences. These considerations are important to artists who tend to embed abstract concepts in the sensuality of the world. This is yet another reason that scientists might wish to further consider how the artistic staging of tasks that are rooted in salient, sensuous situations has affected the perception of viewers as compared with analogous tasks in scientific experiments that lack such embodiment.

CONCLUSION

Accumulated evidence has shown that attention can be trained. The additional question explored was art's potential to serve as an attentional training ground, examining art in the context of learning and motivation. This paper analyzed inattention blindness within the context of a gallery exhibition and compared it to scientific work on inattention blindness. "Looking" was explored under more natural circumstances as opposed to laboratory conditions. It also discussed how a top-down attentional set can determine which stimuli are processed to the point of recognition. My findings were that the attentional set could be changed by some viewers by careful looking and reflection upon the targets depicted in various settings. The fact that so many viewers could re-direct their attention to locate the target after going through the entire gallery installation was, to me, suggestive that learning had taken place; they could now compare the images of the targets they had viewed in static displays to the targets in the Flash animation. I concluded that art enhances mental flexibility and the viewer's ability to identify the underlying content of an artwork.

Scientists have recently explored how emotional salience can influence attention. Although there is increasingly methodological overlap between some scientific and artistic tests of attention, art works invariably stresses the social and metaphoric dimensions, calling forth memories and associations that might lead to a more impassioned response on the part of the viewer. Images assume an emotional resonance, which is quite different from traditional cognitive science, which deemphasizes emotion, motivation, and context (Kenrick, 2001). Much art can be justly characterized by (1) a refusal to compartmentalize feelings from cognition and (2) assigning high value to subjective experience and social and political context. These are issues of increasing importance to neuroscientists.

A kind of coding is apparent to those versed in art's history. Science similarly has its own history and methods, which must be learned by artists who want to contribute their expertise to scientists. Just as scientists can greatly expand upon their reservoir of images, artists can also benefit from looking at the variety of methods scientists use to represent structures that they cannot see and introduce different kinds of approaches to their installations. Attention cannot be owned by a single discipline like science since it is essential to most others, particularly art. Therefore both fields derive benefit from sharing their information, but this can only take place if bridges between them are erected and discourses opened that go deep into analysis.

It seems to me that by reverse logic the Wisconsin Card Sorting Card test supports the hypothesis that art has potential to train attention. This test identifies precisely those features some individuals do not have – the ability to discriminate among categories and identify artistic intentionality. These are the very qualities that art could likely promote. My own experience with testing inattention blindness suggests that these are abilities that, when engaged by a viewer, art may be capable of enhancing.

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