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Research Statement (2009)

Recent research in the psychology and cognitive neuroscience of art demonstrates that artworks can serve as limiting cases in the study of a broad range of cognitive phenomena and as a result can contribute to debates in the philosophy of mind and cognitive science about the nature of mental states. Cognitive science is concerned with the way organisms acquire, recognize, use, and manipulate information. Cognition can, in this context, be understood in terms of representational structures that encode information about the environment and computational processes that interpret and transform those structures. Artworks are, by virtue of the practical necessities of working in a medium, abstract and degraded stimuli intentionally designed to trigger ordinary perceptual, affective, and cognitive responses (e.g. realistic paintings are 2-D representations of 3-D scenes and objects). Questions about the production, understanding, and appreciation of art are in part questions about the way viewers, spectators, listeners, and readers acquire, represent, and transform information from these stimuli in order to recognize, categorize, and evaluate their content. In this regard, one can approach the understanding of art as an engineering problem. For instance, how does a painting convey its content? What components of its formal structure are critical to its performing this function? How does an artist determine what these components are? What do the answers to these questions teach researchers about the structure of the visual system, the nature of object recognition, or the processes underlying our affective responses to natural stimuli? What, if anything does the answer to these last questions tell us about the structure of cognition or the nature of mental representation? Discussions of this range of issues germane to a computational theory of mind draw equally on work in philosophy, psychology, computer science, neuroscience, anthropology, behavioral ecology, and art history.

The rapprochement between cognitive science, philosophy of mind, and art is a two way street. Research in cognitive science can contribute to our understanding of the way viewers, spectators, listeners, and readers engage with artworks. These studies can, in turn, contribute data to help clarify difficult concepts and adjudicate between competing theories in philosophy of art and philosophy of mind. This research model is not reductive in the sense the term is ordinarily used in the philosophy. Rather it is explanatory. It is an attempt to use research from one scientific domain to resolve competing assumptions in another.

Consider the following example. Theories of narrative understanding in the philosophy of art can be loosely divided into two types: *participant accounts* argue that our understanding of characters and narrative events is grounded in a form of first-person perspective taking, or simulation, through which we imaginatively project ourselves into depicted events; *observer accounts* argue to the contrary that our experience of characters and narrative events more closely resembles a third-person perspective. The structure of this debate mirrors debates in philosophy of mind and cognitive science between *Simulation Theory* and *Theory-Theory* accounts of the nature of interpretation and our understanding of other minds. Recent research in cognitive science suggests a means to adjudicate these debates. The apparent distance between an individual and a target changes when he or she anticipates performing an action. Furthermore, the magnitude of that change is correlated with task difficulty and energetic cost, e.g. distances look longer when one wears a backpack than when one doesn't. We hypothesized that if participant accounts were correct then these effects should generalize to picture perception. We tested this hypothesis by asking participants to make line drawing copies of pictures that depicted actions in two different energetic cost conditions. We controlled for the energetic costs of the depicted action by varying the story that we told about the depicted event (e.g. "Andrew Wyeth's *Christina's World* depicts a healthy woman lying in a field" or "Andrew Wyeth's *Christina's World* depicts a disabled woman crawling home"). We predicted that if participants adopted the perspectives of characters in the pictures, they would draw depicted distances as longer under more energetically costly interpretations of depicted events. This is what we found. This result can contribute to debates in cognitive science about embodied cognition, in philosophy of mind about the role of mental simulation in our understanding of other minds, and in philosophy of art about narrative understanding and our engagement with characters.

Current Research (2009)

1. Effects of interpretation of energetic & emotional costs in picture perception

Dennis Proffitt and his colleagues have demonstrated that changes in the energetic (task difficulty and physiological state) and emotional (fear and anxiety) costs of an action to an individual can modulate the spatial metric of perception (Proffitt 2006). Hills appear steeper and distances longer when one is wearing a heavy backpack than when one is not. Interestingly these effects are limited to energetic costs associated with an action the participant intends to perform themselves. For instance, walking on a treadmill influences the apparent distance to a target if participants anticipate walking to it. However, if they view the same target with the intention tossing a beanbag to it, there is no effect on apparent distance. Proffitt and his colleagues argue that these types of "misperception" are the result of action specific motor simulations and function as cognitive shortcuts which help perceivers tacitly relate opportunities and costs in action planning. We have developed a series of experiments to test whether these effects generalize to picture perception.

a. Theories of narrative understanding can be divided into two types: 1st person participant and 3rd person observer accounts. Participant accounts argue that we come to comprehend narrative fictions (e.g. literary texts, drama, film, and some paintings) by imaginatively projecting ourselves into the event depicted and adopting the characters' perspectives from a first person point of view. Observer accounts argue that our experience of narratives more closely resembles that of a side-participant, or 3rd person observer of the depicted event. Proffitt's studies suggest that, if participant accounts are sound then one should find similar effects across changes in the interpretation of energetic and emotional costs of events depicted in representational paintings. We asked college students unfamiliar with key biographical facts about Christina Olsen were asked to make line drawing sketches of the painting before and after learning that she was crippled and could not walk. Consistent with our predictions participants significantly expanded the landscape in their second drawings.

b. Freeman, Evans, & Willats (1988) reported that participants who lack drawing skill copy the horizon line (and non-tilting "obliques") in artificial one-point perspective drawings as two oblique projections sloping down from the vanishing point (see Willats, 1997, 188-9). We (Freeman & Seeley) hypothesized that this perspectival distortion occurs because participants mistakenly interpret the one-point perspective to depict a slope (a distortion due to energetic costs). Participants were divided into two groups and copied the same 1-point perspective drawing of a street scene. Group 1 was told that the scene depicted a familiar steep local street. Group 2 was told that it depicted a familiar level street. Consistent with our predictions perspectival distortions were greater for Group 1 than Group 2. However, we also observed perspectival distortions in a control group that drew upside down copies of the target image. One cannot engage with an upside down environment. Therefore, our results were inconclusive.

c. Electromyography (EMG) can be used to measure muscle action potentials (MAP) in muscle groups associated with the performance of particular actions. Previous studies have also demonstrated enhanced motor evoked potentials associated with motor planning and preparation, i.e. when participants anticipate an action but do not perform it, and with motor simulation, i.e. when participants imagine performing an action or even simply observe others performing an action (Fadiga et al, 1995; Umilta et al, 2001; Decety & Grèzes, 2006; see also Freyd 1983). If participants simulate, or imagine themselves performing, the depicted action in Christina's world one would, therefore, expect to find increases in MAPs for muscle groups associated with crawling while viewing the painting. We are currently conducting surface EMG studies to investigate this hypothesis. These studies will employ a range of stimuli including Wyeth's painting, photographs of irreversible actions (Freyd, 1983), and transpositional apparent motion displays exhibiting biomechanically possible and impossible actions (Shiffrar & Pinto, 2002). Although the results of an initial pilot were inconclusive, we did find heightened MAPs in the forearms of several participants while they viewed *Christina's World* and photographs of people throwing darts.

d. Results from EMG studies of motor imagery are inconsistent. An equal number of studies report MAPs associated with imagined actions as do not. However, previous studies consistently report MAPs associated with watching con-specifics manipulate objects with their hands (Fadiga et al 1995). In order to evaluate whether the results of our earlier study were due to problems of measurement as opposed to failure of effect, we recorded MAPs for forearm muscles associated with piano playing (dominant *extensor digitorum*

communis and *extensor carpi ulnaris* & non-dominant *extensor carpi ulnaris*) in advanced piano players and non-piano players while they watched and listened to video of hands playing familiar pieces of classical music. Extensor digitorum communis is associated with lifting and extending the fingers as in playing melody lines. Extensor carpi ulnaris is associated with the action of spreading fingers apart as in reaching to make a chord.

Participants were recruited from advanced piano classes and the general F&M population and divided into three groups: students in *Piano 282, Master Class in Piano* at F&M, expert piano players not registered in Piano 282, and non-piano players, A volunteer from Piano 282 was recruited to make video. The volunteer played short excerpts from familiar standards and her own repertoire from the class. We predicted that we would find correlations between MAPs, motor skill and familiarity across these three groups. Preliminary analysis of the data supports this prediction.

e. Jessica Witt has proposed that the effects of energetic costs on the spatial metric of perception are the product of tacit motor planning (Witt et al 2005). We hypothesize that, if motor simulation is the controlling mechanism, and then variations in motor skill should also affect apparent egocentric distance. We are currently conducting an experiment to test this hypothesis using scissors to control for motor skill. Participants use perceptual matching measures and verbal assessments to make distance judgments about a target in three conditions: a) after reaching with scissors to make a small precision cut with their dominant and non-dominant hands, b) while anticipating reaching with scissors to make a small precision cut with their dominant and non-dominant hands with the scissors beside them on the table, and c) while imagining reaching with scissors to make a small precision cut with their dominant and non-dominant hands (see Witt et al forthcoming, our experiment uses a modified version of the Witt's procedures).

This research has the potential to contribute to: discussions in the philosophy of mind about embodied cognition and the role mental simulation plays in our cognitive economy; discussions in the philosophy of mind and cognitive science about the role played by mirror neurons in interpretation and perception; debates between embodied and representational theories of perception and cognition; our general understanding of the role played by motor planning in attention, perception, and action planning; and to discussions of depiction, narrative understanding, and imagination in philosophical aesthetics.

2. Diagnostic recognition model for our engagement with art:

Recent research in object recognition (Schyns, 1998), inattentional blindness (Kovisto & Revinus, 2007), and the cognitive neuroscience of dance (Calvo-Merino et al, 2005) has demonstrated that how one categorizes a stimulus influences how one perceives it. Research in the cognitive neuroscience of attention suggests a mechanism to explain these effects (see Kastner, 2004). Endogenous shifts of attention modulate sensory processing in the visual cortex as early as LGN. This attentional mechanism both enhances sensory processing for target locations, image features, objects and/or object parts and inhibits the perception of local distracters. This model for selective attention suggests that inattentional blindness is the rule, not the exception, in ordinary perception (Chun & Marois, 2002). This suggest that art historically educated viewers, viewers who understand the conventions for categorizing artworks relative to the formal vocabularies and styles of individual artists, artistic movements, and/or art historical epochs, literally see different works than art historically naïve viewers. This, in turn, suggests that in normal contexts art historically naïve viewers fail to perceive critical formal cues that encode, or are *diagnostic* for, the meaning of a work. Aaron Kozbelt and I have proposed a schematic model to explain these expert knowledge effects in the perception and interpretation of artworks (Seeley & Kozbelt, 2008). Similarities between visual processing & auditory processing and the link between perception & action suggest that this model can be generalized to music and dance (Zatorre, Evans, & Meyer, 1994; Montero, 2006, 2007).

Our model has the potential to contribute to: research in the philosophy of mind and cognitive science on the nature of perception and the modularity of cognitive processes; research in psychology & cognitive neuroscience on selective attention; research in cognitive psychology on the inter-relationship between object identification and object recognition (see Schyns, 1998); debates between aesthetic and contextualist theories of art in philosophical aesthetics; and discussions of the role of artists' intentions in our engagement with works of visual art (see Rollins, 2004).

3. Artists' and non-artists' eye movements in out of focus picture recognition:

Aaron Kozbelt and I have developed a model to explain differences in performance between artists and non-artists in visual analysis and form recognition (see Cohen, 2005; Kozbelt 2001). Kozbelt and I hypothesize that as artists develop technical proficiency in a medium, they develop a novel class of object knowledge (Kozbelt & Seeley, 2007; Seeley & Kozbelt, forthcoming). This knowledge defines artworks in different visual media relative to sets of stimulus features sufficient for accurate depiction and the marks necessary to reproduce them. We argue that this knowledge is encoded in two ways: 1) as spatial schemata that represent these sets of stimulus features, and 2) as motor plans for rendering them in an artistic medium. Art historians and perceptual psychologists have argued that the perceptual cues necessary to support depiction in a medium are the same cues necessary for object identification. Recent research in cognitive neuroscience demonstrates that spatial schemata and motor plans function as the grounds for complementary attentional strategies which modulate sensory processing in the early visual cortex. We hypothesize as a result that artists' ability to selectively attend to image features for successful drawing is one mechanism that explains their enhanced performance in visual analysis and form recognition.

We are currently running an eye tracking study to test our model. The purpose of the study is to evaluate whether individuals with expert drawing skills employ different attentional strategies than naive viewers when asked to identify subject depicted in blurred photographs. Interestingly, baseball & softball players performed as well as artists in our pilot study. This spring we will conduct a separate eyetracking study to test whether there is a correlation between batting average and performance in basic visual analysis tasks and whether baseball/softball players employ different attentional strategies than naive viewers in the blurred photograph task.

This study has the potential to contribute to discussions of the nature of perception and embodied cognition in philosophy mind and cognitive science as well as discussions in cognitive science about the role of memory, attention, and motor skill in perception.

4. Brain mechanisms supporting the understanding of action sentences:

I am collaborating with Michael Anderson and Tony Chemero in the Psychology Department on a MEG study of the time course for the involvement of premotor cortex in language comprehension. This research is being conducted in collaboration with the *Cognitive Neuroscience of Language Laboratory, University of Maryland*. The study expands upon a model developed by Arthur Glenberg (Glenberg & Kaschak, 2002) It is designed to evaluate the role of tacit motor planning in understanding the meanings of action sentences.

This study has the potential to contribute to discussions of embodied cognition in philosophy mind and cognitive science. It also has the potential to contribute to debates between participant and observer accounts of narrative understanding in philosophical aesthetics. Our hypothesis about the role of motor planning in semantic comprehension supports the claim that motor simulation contributes to the understanding of narrative texts. It would also suggest that the effects of energetic/emotional costs generalize to fictional texts.

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