DOES SURFACE ELECROMYOGRAPHY REVEAL A ROLE FOR MOTOR SIMULATION IN PICTURE PERCEPTION

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The purpose of this pilot study was to evaluate whether Witt's model for the effects of the energetic costs of anticipated actions generalizes to the perception of depicted actions in static images (Witt et al, 2005). Recent studies demonstrate a positive correlation between the *energetic* (e.g. fatigue & expected physical demands) and *emotional* (e.g. fear or anxiety) *costs* of anticipated actions and apparent *orientation* (slope) and *extent* (egocentric distance) in the environment. These effects generalize to *virtual environments*, *imagining* performing the target action, and are limited to the energetic associated with actions participants intend to perform (Proffitt, 2006. Witt et al (2005) argue as a result that these modulations of the spatial metric of perception are effects of tacit motor simulations involved in action planning.

PICTURE PERCEPTION

Philosophical theories of narrative understanding in picture perception can be divided into two types. *Participant Accounts* argue that viewers come to understand narrative paintings by imaginatively projecting themselves into depicted events and simulating the perspectives of their characters (Goldman 2006). *Observer Accounts* argue that viewers infer the content of a narrative painting using their knowledge of the general structure of events and tacit folk psychological theories about the behaviors of others (Carroll, 1988). If participant accounts are correct, then the effects of energetic costs should generalize to picture perception. We tested this hypothesis in an earlier study by varying the interpreted energetic costs of the action depicted in Andrew Wyeth's, Christina's World. The introduction of biographical information about Christina's physiological state (she had been unable to walk since early childhood) caused naïve viewers to expand the extent of the depicted landscape in line drawing copies of the depicted landscape, $t(44) = 2.83$, $p < .05$ (one tailed).

SURFACE ELECTROMYOGRAPHY

We interpret our results to demonstrate that participants simulate Christina Olsen's perspective and so anticipate crawling home across the field depicted in the painting. However, we had no direct means to evaluate whether participants were actually simulating her perspective. Electromyography suggests an indirect means to measure whether our inference is valid. Motor simulation is associated with heightened activation in premotor areas. Activation of premotor areas in motor simulation produces low level myographic signals in target muscles (Guillot et al, 2007; Cacioppo et al, 2007). This type of premotor and myographic activity has been observed both when participants watch others perform actions and when they kinesthetically imagine performing actions themselves. Electromyography is, therefore, an indirect means to measure premotor activation correlated with motor simulation, and could potentially be used to evaluate whether participants adopt the perspectives of characters in the perception of actions depicted in static images.

A number of studies have demonstrated activation of the motion perception areas of the early visual cortex (MT/MST) in viewing *apparent motion displays* of biologically possible actions and *action photographs* (i.e. static images that depict objects involved in dynamic events) (Kourtzi & Kanwisher, 2000; Stevens et al, 2000). Apparent motion displays of biologically possible actions are of particular interest. At SOAs greater than 400ms participants are more likely to report seeing the biologically correct (as opposed to the shortest) motion path. These apparent motion effects cannot be attributed to abstract dynamic cues in the stimulus because participants see the shortest motion path in the same stimulus at shorter SOAs. Shiffrar & Freyd (1990, 1993) argue that these effects are due to longer processing time which enables access to processes subserving the perception and understanding of biological motion. Stevens et al (2000) supports this claim. They report activation in motor and parietal areas responsible for the perception and understanding of biologically possible motion only when participants report seeing longer, anatomically correct, indirect motion paths in these types of apparent motion stimuli We hypothesize, as a result, that these behavioral results are effects of tacit motor simulations involved in the perception and understanding of the depicted actions.

We predicted that, if the participant account is correct, we would find low level myographic signals associated with the perception of actions depicted in static images. We chose three target images for our study: a photograph of a young man preparing to throw a dart, a photograph of the same person throwing a dart, and *Christina's World*. Although action photographs like our darts images have been demonstrated to activate the motion detection areas of the early visual cortex and produce motion after effects (Winauer et al 2008), we know of no other studies focused on the role of premotor areas in the perception of actions depicted in static images (see Freyd, 1983; Shiffrar & Pinto, 2002).

Methods

Participants. 26 undergraduates (8male; 18 female) from Franklin & Marshall College participated for either lab credit or $5. All were naïve to the purpose of the experiment. Participants read and signed consent forms prior to involvement.

Materials. Participants sat in a stationary chair with armrests. Silver/silver-chloride electrodes were used to measure biceps and pectoralis major for the dominant hand. Electromyography was recorded at a sampling rate of 1000hz using a Biopac MP100 system and Acknowledge 3.9.1-100m software (Cacioppo et al, 1990; Kram & Kasman, 1998; Zipp). The Acknowledge software & Excel 11.2.3 was used for data analysis. The slideshow was projected in PowerPoint on an eMac with a 13x10" screen set to a resolution of 1280x960 pixels.

Procedures. We adapted a set of procedures from Lutz (2003). All participants underwent 4 throwing/imagining adaptation trials. Participants sat 56" from a dartboard that was placed approximately 10" above their line of sight. Participants threw 6 darts and then were instructed to close their eyes and imagine throwing six darts at the target for a bullseye. After the fourth trial participants were instructed to turn their chair 90 degrees to face the computer screen. Participants watched a 3 minute slideshow consisting of 5 images: an abstract painting, a hand holding darts, a person poised ready to throw a dart, that same person throwing the dart, and *Christina's World*. The first four images were shown for 7 seconds each. The final image was shown for two minutes while the participant listened to a passage describing salient biographical information about Christina Olsen and her relationship to Andrew Wyeth. Each image was preceded by a 5s black screen. All participants were evaluated for dart throwing skill. In addition all participants filled out a survey to assess experience with darts, familiarity with the painting, and rate the quality of their kinesthetic imagery

Results & Discussion

Differences between the MAX amplitude of the raw EMG signal for baseline & target regions of interest were evaluated in the imagining & slideshow blocks. Where differences in the MAX value reached significance we compared the mean value for a sample of the signal in each region of interest (see Tables 1 & 2) to a baseline collected from the same trial. We observed consistently significant EMG signals during *imagining throwing* trials from only two participants, $t(18) = 5.233$, $p < .0001$ (one tailed). We observed significant EMG signals in *slideshow* trials from only two participants for the *ready* image, $t(2160) = 4.40$, $p < .001$ (one tailed), one participant for the *throw* image $t(1191) = 1.68$, $p < .05$ (one tailed), and three participants for *Christina*, $t(9984)$, $= 9.15$, $p < .001$ (one tailed). There was no overlap between these groups of participants. The trends were promising for five other participants in the *imagining throwing* trials, and two other regions of interest in the slideshow for the *ready*/*throw* images. However, we did not generally find significant EMG results and there were no correlations between performance in the imagining throwing & slideshow trials, performance & report of imagery vividness, or performance & darts skill or experience.

General Discussion

Our results are consistent with the EMG literature. An equal number of studies of visualization report significant results as do not (Guillot et al, 2007). We attribute the inconsistency of our results to several factors. First, It may be that the bulk of our participants had trouble kinesthetically imagining the target. Kinesthetic imagery can be difficult. Many successful studies begin with long training sessions to acclimate participants to the task. We would use an imagery questionnaire to assess capacity for vivid imagery in the future. Second, none of our participants had significant darts experience which could have affected their capacity to imagine dart throwing. Finally, it may be that our stimuli were not sufficiently dynamic. This is certainly true of *Christina's World*.

The debate between participant and observer accounts of narrative understanding is a debate about which strategy has priority in ordinary and aesthetic contexts. Observer accounts argue that first person perspective taking is rare, and only used in radical cases where interpretation of the depicted event is difficult. Participant accounts argue that it is not necessary, but that it is more prevalent and plays a central role in aesthetic interpretation. Our results support the epistemic claims of observer account. They suggest that first person perspective taking is not a part our ordinary engagement with narrative pictures. However, they also suggest that the qualitative experience of imaginatively projecting oneself into a narrative is difficult. This corroborates the aesthetic claims of the participant account. Adjudicating this debate will, as a result, require further understanding of the qualitative aspects of aesthetic engagement with narratives.

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