Touch of the Eye: Does Observation Reflect Haptic Metaphors in Art Drawing?

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Abstract
We present preliminary indications from an examination of the relationship between stimulus fixation and subsequent motor activity in art drawing. We utilize eye-tracking technology to observe the complex vision cycles of an artist's drawing process, and a digital drawing tablet to capture motor activity. Early results suggest that deeper investigation of the relationship of eye and hand movement during artistic drawing may help to extend access to cognitive processes involved in the behavior and embodied response of artistic practice. We propose that a synthesis of phenomenological and technological modalities helps extend creative interactivity in computationally mediated self-expression.

Author Keywords
Tacit knowledge; creative process; haptic perception; eye tracking the artist; eye-hand interaction in drawing process; metaphor theory; art-oriented-research, multi-modal analysis; sensory-motor interconnection.

ACM Classification Keywords
H.5.2 User Interfaces: Haptic I/O, Interaction Styles, Theory and Methods; J.5 Arts and Humanities: Fine Arts.

Introduction

The Drawing Process

Artists and designers work on the creation of cultural artefacts. These artefacts are shared by virtue of their externalized objective nature, but the more essential, internal process of creative intent remains elusive. There is a need to describe this pragmatic knowledge of the active *doing* in process, to be able to share experience with others. Practicing designers and theorists have developed techniques and methods aimed at motivating the designer's ideation [23, 28, 34], and many practitioners record the related but peripheral activities of the creative process during project development [19, 35], but there have been few studies observing and analyzing an individual artist's or designer's creative process, as it is *lived*. We propose that there is a benefit to the close study of individual process through computational technology, and the possibility of a phenomenological and cognitive study of creative intention. This case study functions as a prototype cognitive probe into the possible nature of the relationship between the observing eye and the expressing hand.

The Act of Observation - Neurological factors

Rudolf Arnheim argues for the fundamental *tangibility* of the poly-dimensional space of visual thought and theoretical reasoning. He points out that concepts derive from sensory experience and that in fact 'human thinking cannot go beyond the patterns suppliable by the human senses' [2]. This suggests that the creative artefact, the outward expression of pragmatic intention, encodes the trace of its formation in the placement of every element.

Cristoph Redies [26] has proposed a model of aesthetic perception wherein artistic activity reflects 'fundamental functional properties of the nervous system', suggesting embodied visual schema motivate artists to create compositions that induce specific neural states in the artist's central nervous system. He argues that intersubjective *resonance* arises in the viewer of the work, accounting for the degree to which multiple viewers share emotive response. The encoding of this design intent happens *through* a utensil or *technology of transference*, an interface, where the effect of an action is perceived as it is crafted (Fig. 1). We therefore ask how deep this resonance goes, is it stimulated by strictly compositional concerns, or might the crafting of each line factor into a neurological description of drawing?

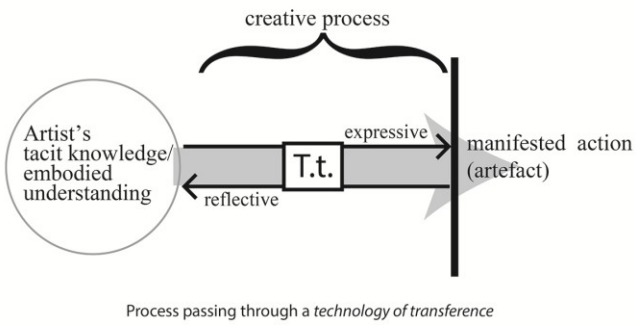

Figure 1. The expressive and reflective aspects of the creative process pass through a medium of abstraction, called in this research the *technology of transference* (© SK Choi, 2014).

The decision to act contains already the information required to direct that action, a haptic interchange that resonates with the elusive 'how' of process that has been called *haptic perception* [5, 8, 13, 16, 23]. Our model of the creative process therefore considers that

technologies of transference constitute extensions to the embodied knowledge accumulated in the practitioner and are only effective to the degree to which they enhance the cyclic nature of the creative process. We therefore investigate the means by which we may sense an artist's cognitive intention before it reaches the level of external manifestation.

Prior Work

The Artist's Eye-movements

There have been few studies examining eye and hand interaction during drawing activity [6, 31, 32], and very few studies working with artists as subjects. This is surprising given the vast amount of pragmatic, cultural, and historical knowledge that has been accumulated by artists, and the general cultural valuation ascribed to the arts.

Miall & Tchalenko attempted to use non-intrusive techniques to investigate the relationship between an artist's eye movements and the act of drawing. Working with portrait painter Humphrey Ocean, they conducted a series of close observations of Ocean's drawing process. Ocean worked with traditional media on paper and sat with a live model situated so that the eye-tracker could capture his gaze from model to paper. They conclude that information is not captured holistically but detail by detail - a correlation between fixation precision and frequency - and note that "each detail and each element is of intrinsic importance" [21]. This sequencing is essential in the artist's observation where, as noted by Miall & Tchalenko [21], "actions are essentially driven by the picture's progress—they are goal oriented rather than (...) stimulus controlled".

The line in drawing is *expressive*: It is observed for, and then drawn directly. The artist does not observe in one area of interest and subsequently draw in another. This processual sequencing is modelled by two fundamental hypotheses common in eye-tracking research. The first of these has been called the 'eye-mind hypothesis' by Just & Carpenter [9], who conducted eye-tracking studies of subjects reading text. The hypothesis suggests that fixation duration is linked to cognitive processing times required for comprehension. Secondly, based on what they call the 'immediacy assumption', they posit that the mind only processes what it needs to attend to at the current moment. This observation is sometimes expressed metaphorically in so-called 'folk language' simply as 'look where you are going'', where intention in observation is fundamentally equated with motion. This pro-active, feed-forward mechanism is also noted by Land [14] who notes "each type of action has its own specific repertoire of linked eye movements, *acquired in parallel with the motor skills themselves"* [15]. This parallel relationship suggests that process is embodied at a neurological level, and that the hand and eye conjointly embody the (tacit) knowledge motivating expression.

Pupillary response is an indicator of how intensely the processing system is operating and is associated with the degree of cognitive effort [10, 20]. These studies verify the common belief that pupil dilation is indicative of 'interest'; in Kahneman's words, the eye's pupil seems to provide a window on the 'intensive aspect' of attention [11]. The implication of all these studies is that the way we see directly informs our embodiment of how we will draw what we see.

Haptic Metaphors of Drawing

The expressive line, in drawing, is formed of a series of manually produced irregular weighted vectors that (re)constitute the artist's embodied description of qualities inherent in their observation of the world. These qualities imply cognitive processing of perceptual and reflective information streams, or an *observing response* to the current state experience. The reflective nature of observation in artistic practice imbues line with a sense of emotive valence particular to the practitioner. As famously described and modelled by master painter and theorist Wassily Kandinsky [12] the essential qualities of a line are *tension* and *direction*. The quality of tension is a property in which Kandinsky appears to include localized and continuous line width and its geometric relation to fixed endpoints, *as well as the emotive response engendered by such qualities*. We propose that *tension* is an experiential haptic metaphor and may be profitably compared with another formal metaphor in drawing, line 'weight'. Line weight in drawing is controlled by physical pressure on the brush or drawing implement. Weight, or tension, also describes how the line is received and expressed, the extent to which it 'moves' our awareness.

Research in haptic interface design has generally conceded that computational interfaces are advantaged by the extended facilitation offered by the ease, flexibility, and power of affective technologies [17, 18, 25, 29] but these studies are generally focused on the interaction affordances offered by haptic *feedback*. As we have described in our model of expressive and reflective process, a technology of transference should be equally cognizant of *feed forward* applications of affect. The motion of the eyes is fundamentally haptic, an intentional and fundamentally essential sensory-motor experience wherein lays the metaphor inspiring this paper's title, the 'touch of the eyes'. Haptic technologies promise the possibility of acknowledging multimodal expression of sensorial expression in human-computer interaction, a richness of interaction that has been defined as extending the 'expressive capacity' of a technology [18]. Barbara Montero [22] proposes that truly intersubjective experience (as in transfer of shared experience through a medium) relies on a third-person acknowledgement of what may lie below the producer's threshold of conscious awareness. How this access is possible may be hinted at by Alamargot et al. in their investigation of the movement of the eyes while subjects were writing text; "The sort of very fine-grained description made possible by measuring eye movements means that the temporal unit that has been used until now in order to analyze text production processes must be changed. One likely result of such a change is that psychological significance will be given to hitherto neglected temporal events" [1].

To date there has been little investigation of fine-grained temporal structures in creative expression. With this sense of the embodied temporal nature of expressive process in mind, we ask what of the haptic metaphor of Kandinsky's 'tension' might be observed in the movements of the artist's eyes?

This epistemic stance motivates our phenomenological probe into the possible evidence for resonant structure in subjective experience. [33]

Methods

Materials

An artist's drawing activity was recorded through a drawing tablet with live display and capture of line weight and velocity. Eye movement observing the stimulus was tracked with a SensoMotoric Instruments Red250 running the SMI Experiment Suite and BeGaze Analysis software. This device is independent of the subject and tracks the pupils with 'invisible' infrared frequency light, sampling at 250 Hz. The software outputs a text format database of events (fixations, saccades, pupillary response, blinks) and records a screen capture video at 1680 x 1050px of the eye's scan-path optionally overlaid with heat-maps of the stimulus fixations. Drawing activity was captured on a Wacom Cintiq tablet with 1024 levels of pressure sensitivity, capture resolution of 0.005 mm/point (5080 lpi), sampling at 136 Hz., with a 261.1 x 163.2 mm (10.3 x 6.4 in) active drawing area. The canvas aspect ratio of the drawing tablet was set to match the stimulus image presented on the SMI driven monitor (Dell P2210). The drawing software used was Corel Painter version X3 that is capable of recording and outputting a text format script containing stroke vectors and pen pressure. Painter ran on a 2.6 GHz. MacBook Pro with 8GB RAM. This laptop also captured the Wacom screen activity via Quicktime screen capture (H.264 1280 x 800px) at 60 frames per second; this capture included ambient room audio via the laptop's built-in microphone. Additionally, the artist's spoken words and overall body movements were recorded with a Sony video camera (NTSC 29.97 fps dropframe timecode) allowing for post-session access to the transient and long term actions of process.

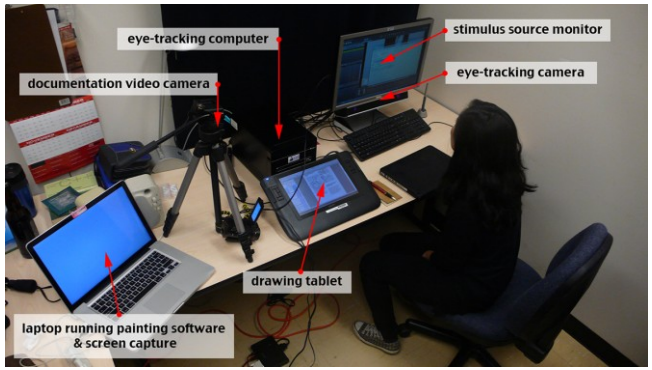

Figure 2. The artist in the research environment. We used a wireless remote eye-tracker so that the artist did not feel like 'things are attached', promoting a more natural interaction environment for the artist.

Study Procedures

The artist, (SK Choi, one of the authors of this paper) sat in front of an eye tracking system (Fig. 2) and did a series of line drawings of various durations (between 1min. to 10 min.) of a simple source image (photographs of the human hand, presented on a monitor). Seventeen (17) studies were conducted (not including two preliminary test sessions and one failed trial), in five sessions conducted over a one-month series of trials. This report focuses on a single study.

A multimodal environment allows for modeling of a reasonably rich data map of experience. We chose Adam Fouse's ChronoViz [4] for our qualitative analysis, a freely available research tool that supports navigation and analysis of multimodal time-coded data. Microsoft Excel is being used to organize and integrate the SMI and Painter quantitative data, and to create preliminary visualizations of data subsets presented here. The data collected were examined for evidence of relationships in patterns of movement of the eyes;

fixation duration and pupil dilation (Fig. 3) and the ensuing pen pressure applied when drawing what had just been observed (Fig. 4). Although the preliminary data are only indicative of the worthiness of further investigation, several observations suggesting interrelated activity between the observational and expressional cycles of the process were noted.

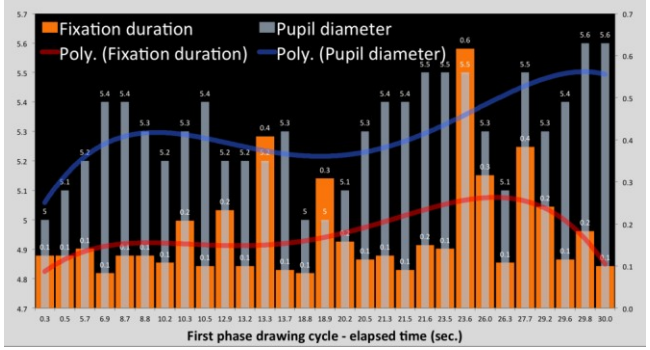

Figure 3. Drawing Phase 1 Eye-tracking data (fixation duration and pupil response).

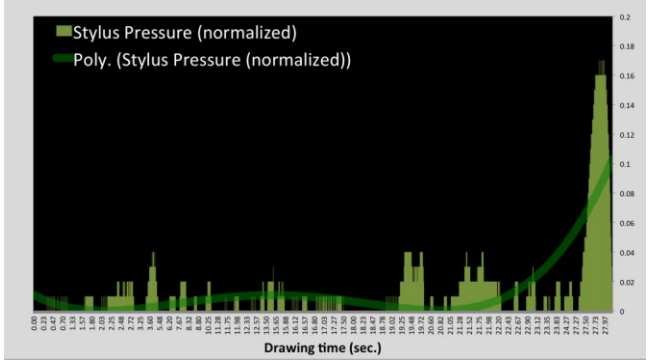

Figure 4. Drawing Phase 1 Stylus pressure data.

Observations and Preliminary Results

We observed three different global eye-hand interaction strategies in the drawing process. Although this was done with a single artist, this close examination of individual practice informs us how computational technologies may provide augmented observational access into the drawing process.

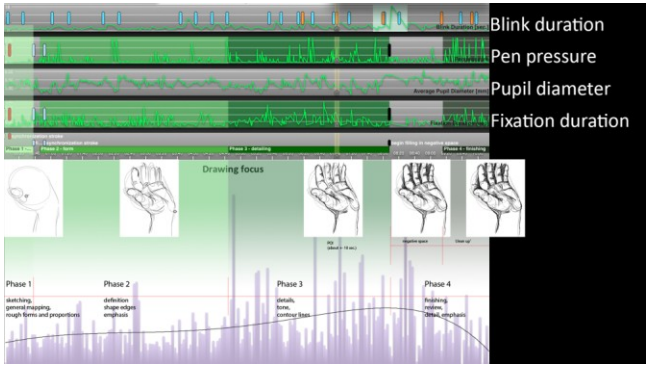

Figure 5. Distinct phases of drawing were observable, with marked changes of approach.

The first of these global strategies involved a clear demarcation between drawing phases. For example, the study under discussion here took place over 10 minutes: The drawing proceeded rapidly initially (Fig. 5), with pen pressure falling in the lower 10% of the available range, completing a loose topographical placement of the overall drawing space in less than 30 sec. Fixations on the stimulus during this phase were substantially shorter than those noted by Miall & Tchalenko [21], averaging 179.6 ms per fixation.

These quick fixations may be motivated by the desire to establish a rough framework quickly without the requirement to hold a lot of unnecessary information in

working memory. The second strategy involved a subdivision of this mapped space into recognizable form elements, not yet specific detail but indicative of placeholder lines for future development. This stage (duration 4 min.) involved almost entirely 'outlining' of future forms, elements such as fingers began to appear, but were only proportionally drawn, not volumetrically. During this phase fixation duration on the stimulus increased to an average of 272.7 ms while the pen pressure increased to an average near 25% of the available range with 5 notable spikes at 100% pressure occurring evenly throughout the phase. Pupil response remained almost flat during this phase suggestive of level concentration on the task at hand. The third 'finishing' strategy (at 5.5 min.) saw the emergence of the first truly volumetric lines, lines meant to bring the drawing into a representation of 3D space. Contour lines (lines denoting variation in surface direction, or tone) were drawn as part of this phase, as were small surface details. During this phase fixations on the stimulus again increased to an average of 322.9 ms, but the pen pressure slightly dropped to roughly 20% of the available range. This may suggest more 'sensitivity' is associated with the practice of finishing the drawing. Overall, the mean fixation length for the 10-minute drawing presented here was 290.65 ms, a total of 443 fixations on the stimulus were made with 566 individual strokes recorded in the Painter script.

Lest it be assumed that the quantitative aspects of these observations are of primary focus and overly reductive of the drawing process, or alternately, as yet insufficient for generalization, it should be reiterated that these data are at this stage of the research primarily considered as metaphorical signposts suggesting further questions. The intent here is to map out the possible landscape of an artist's embodied process by observing what resonates in its computational mediation.

We used the fixation and pen pressure data to derive a drawing fixation mapping ('drawing focus') and compared this to annotations made on the ChronoViz timelines about the gestural and technical features of the drawing.

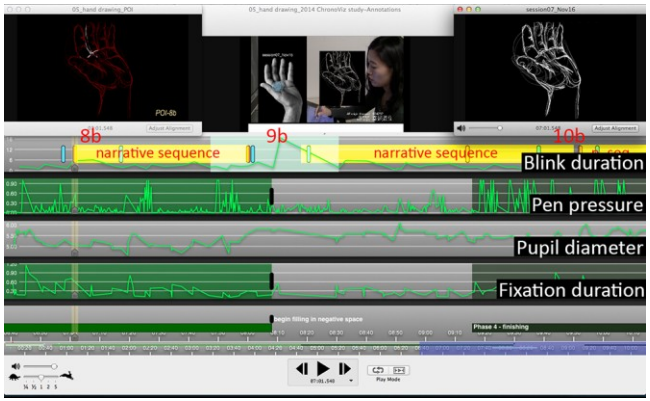

Figure 6. Drawing phase and narrative sequences. Small inset hand photo used as stimulus image © Joy Von Tiedemann.

We noted that changes in the interpolated curve direction (5th order polynomial trend) of the mean drawing focus duration occurred at or near perceived drawing phase changes, suggesting that different ways of looking are tied to motor-requirements in drawing (Fig. 5). We became interested in what factors resulted in several 'spikes' in the drawing focus data, signifying unusually long times spent looking at the drawing. Annotation of the audio track of the artist speaking about drawing as they worked revealed that short discussions of regional interest were carried on (Fig. 6).

These 'narratives' seem to coincide with the spikes, as if the artist focused on the information in the drawn visual cue to elicit a response, which carried on until the context changed, when another pause to look at the drawing longer occurs. This appears as if the drawing functions as external memory, although what factors play into the drawing contributing to this reflective behavior has not yet been investigated. It is intended that an on-going principle motivating these explorations will be that the artist's phenomenological response to this process-narrative should inform further investigation into how these factors might correlate with their representation in the biometric data.

Conclusions - In Reflection

We have briefly presented a prototype of an art-oriented-research methodology that utilizes computational technologies of transference to explore the multimodal nature of art drawing. The components of this methodology at present involve an artist's interaction with an eye-tracker and a digital drawing tablet in pursuit of traces of tacit knowledge in the production of the (digital) artistic artefact. We have proposed that a comprehensive methodology of investigation in the pragmatic arts would constitute a phenomenological reporting of embodied process, utilizing an interactive cycle of quantitative measurement during expression, and iterating that process through qualitative reflection. We have observed preliminary indications that a computationally mediated first-person approach to the study of artistic drawing reveals evidence suggestive of embodied global and granular cognitive strategies apparently aimed at organizing the integrated processes of observation and expression in art drawing. These observations must be extended both deeper into the data obtained and wider, across more cases, after indications of fruitful directions to explore are uncovered.

Useful future applications of further development of this research lay in its potential to inform development of perceptive user interfaces that, for example, allow for artists to 'hone' their tools to suit their practice, not only through WIMP interface parameters but in *the way the tools are lived*. From Matisse who speaks of the 'feeling' of spatial form in scissor line drawings [7] to the artisan who wears down his brush by it's particularly individuated usage (and for that matter, to the writer who wishes for a bashable digital typewriter!), technologies that are sensitive to creative intent will not only promote affect in digital interfaces, but will enhance their own development through the exchange of increasingly rich multimodal descriptions of experience. As a painter engaged with the interplay of the act of drawing and the description of the act, I find it intriguing to speculate that HCI interfaces capable of tapping into the sensory-motor flow of the creative process may allow for the development of technologies of transference that are able to become 'accustomed to their user'. Surely, such tools will require a careful examination of all that the subjective point of view is trying to express.

In a review of what they call *perceptual bandwidth* Byron Reeves and Clifford Nass note that "one of the most prevalent hypotheses about media this century is that more and richer perceptions make for better experiences" [27]. If we are able to capture and reflect upon these deeper levels of experience we will be able to more fully model and translate cognitive architectures of lived experience.

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