

THINKING THROUGH DRAWING: PRACTICE INTO KNOWLEDGE

Proceedings of an interdisciplinary symposium on
drawing, cognition and education

Edited by Andrea Kantrowitz, Angela Brew and Michelle Fava



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Teachers College, Columbia University, New York

Symposium:
28-29 October 2011
Exhibition
Macy Art Gallery
October 24 - November 4, 2011

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Foreword

The symposium *Thinking through Drawing: Practice into Knowledge* brought together artists, neuroscientists, cognitive psychologists, medical practitioners, designers, and educators from the US and the UK, all with a shared interest in drawing and cognition. This trans-disciplinary gathering was held at Teachers College, Columbia University in New York City in October 2011 and addressed a broad range of concerns regarding contemporary drawing practice, theoretical analysis and education, in light of current scientific research.

Preface

Judith Burton
Teachers College, Columbia University

It is a pleasure to introduce what I hope will be the first in a series of publications on drawing that will grow out of conferences held on both sides of the Atlantic. This first publication emerges from a meeting held at Teachers College, Columbia University in New York City, October 28-29, 2011, in which American and British artists and scholars shared with each other the results of their practice and research. If we had assumed beforehand that the act of drawing had become peripheral, resistant to ideas of innovation and engulfed by the recent history of contemporary art, then this was robustly challenged by the conference presenters. As we see in their papers included here, drawing is an activity that is engaged in by a wide spectrum of individuals from artists to surgeons, psychologists to knitters whose serious investigations offer a fundamental re-evaluation of its practices as medium and discipline. Within this climate of re-evaluation drawing has migrated from a support practice within the fine arts tradition to that of an independent medium offering distinctive graphic possibilities altogether its own. Drawing has become many things.

While in many ways these papers represent a unique contribution to understanding art practice as currently unfolding, with hindsight we see that they bring into the contemporary arena ideas and commitments of longstanding import. Questions about drawing as invention, as thought, as personal perception, as engendering the idea of the form of things and about the relationship between inner and outer ideas have migrated over five centuries transposed from the mind of God to that of our

human selves. Similarly drawing as both a poetic-expressive and scientific-discursive discipline as explored in these papers has a long trajectory in western art practice and scholarship. If the papers call attention to ideas of long duration they also make the practice of drawing newly relevant by radicalizing the way we might ask questions about marks and lines on surfaces. For the artists included here present us with drawing not as representation, abstraction, description or self-expression but as drawing for-and-in-itself, a process of deep inquiry into that which it is possible to know yet impossible to say verbally. Cross-pollinating theories drawn from cognitive-neuroscience, emotional, perceptual and sensory domains researchers present drawings not so much in terms of the linear structures of language but as complex and layered processes of mind. Both artists and researchers transcend traditional hierarchies of value and knowledge and reveal to us practices of thinking and aesthetic commitment long suspected but never until now made transparent.

These papers invite us to consider seriously the role and purpose of drawing in the education of artists, children and adolescents. For by pointing to critical and intertwined habits of mind and practice we may consider how the process of drawing contributes to the creation and construction of important knowledge. For drawing offers artists in training a tool of thought and action that allows them to stretch widely in their investigation and sympathies, and for children and adolescents in school offer possibilities to peer into their world of

experience and imagine how it might be otherwise. Drawing is a fundamental and cognitive activity of the human mind, one that stretches across many and diverse subject domains. As these papers attest, lines and marks on surfaces are ways of having and constructing ideas equally as they constitute ways of expressing them.

Acknowledgments and thanks are due to Andrea Kantrowitz, Teachers College, Angela Brew, University of the Arts London and Michelle Fava, Loughborough University, whose trans-Atlantic conversations about drawing led to the idea for the Teachers College Conference. To Barbara Tversky and Seymour Simmons whose interests and research gave further impetus to the shaping of the event and, to Simon Betts and Steven Farthing, also from the University of the Arts London, who cut into their busy lives to share their “bigger picture” of drawing with us. Thanks to all contributors from both sides of the Atlantic for making this a most collegial and rich experience for us all and to Tree Williams, Eileen Begley, Alison Faye, Nicole Avery and the rest of the TC student volunteers who pitched in to make sure the event ran smoothly. Finally, and by no mean least to Razia Sadik, Rabeya Jalil, and the entire Macy Art Gallery team for their work installing the challenging and wonderful drawing exhibition that both lifted everyone’s spirits while offering plenty of scope for heated debate. We install them again here in these pages for everyone’s delight.

Judith M. Burton
Professor and Director, Art and Art Education
Teachers College, Columbia University

Drawing Connections

Angela Brew
University of the Arts London

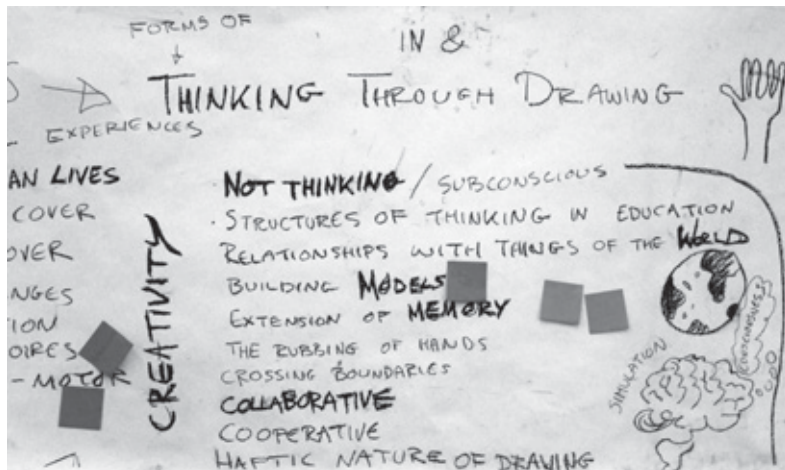
Michelle Fava
Loughborough University

Andrea Kantrowitz
Teachers College, Columbia University



If an object, idea, daydream, pattern, place, or experience can be drawn, it makes more sense to me, and can verify that I have experienced it. — Michael Moore

Lines, straight or messy, serve our behavior and our thought. — Barbara Tversky

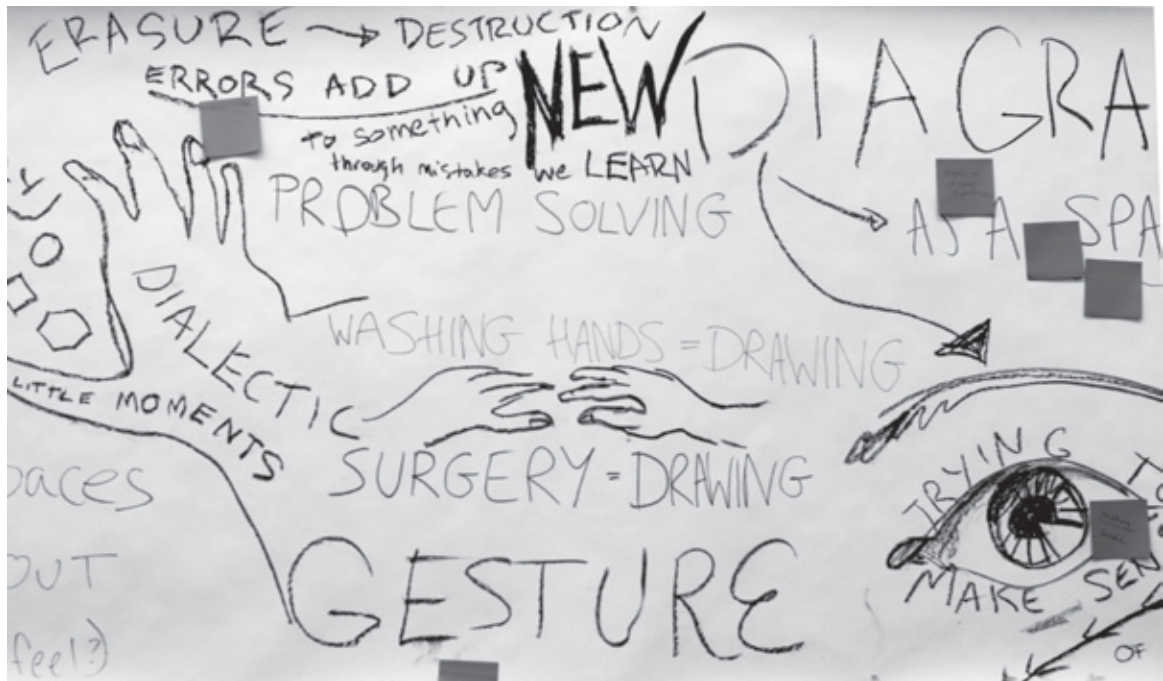


Drawing Makes Sense

Contemporary research questions demand a more fluid conception of where one discipline ends and another begins. The familiarity and directness with which artists experience the drawing process can complement scientific inquiry, with the potential to help generate hypotheses and interpret data. Artists themselves can be interesting subjects for case study, while findings from scientific enquiries can inform the practice and teaching of drawing. Philosophical paradigms offer perspectives from which to understand and critically consider these relationships and their significance. These factors

all point to interdisciplinary research and collaboration as the future of this emerging field. Some of the contributors to this volume straddle several camps, while others collaborate across disciplines. Below we introduce some of the common themes that engage our contributors, drawing attention to particular papers and connections between their research.

Moore and Tversky, artist and cognitive psychologist respectively, exemplify the spirit of this trans-disciplinary gathering. In her keynote, Tversky painted a picture of the vast potential of drawing to extend the mind, memory and understanding. Along these lines, the symposium explored the power and value of drawing. It looked at the boundaries of what might be considered drawing; the cognitive and perceptual processes involved in the act of drawing; the contemporary educational and professional relevance of drawing practices; the role of drawing in learning and apprehension and the application of new understandings of cognition to the practice and teaching of drawing. Common themes emerged; movement, timing,



perception, creativity and analogy in the drawing process.

This volume demonstrates how each discipline has the potential both to inform and be informed by the others. The work offered for discussion at the symposium covered new ground in many directions, through the links made between people and ideas. Theory connects with practice, in the sense of individual drawing practice, in the broader area of teaching practice, and finally in the very broad area of the practice of living.

What is Drawing?

As Fitch reminds us, the term “drawing” appears in many guises, and has a rich etymological past. Authors in this volume use the term “drawing” in many ways. Some inquire into specific practices, such as observational drawing, while others take a broader view of drawing, considering gesture, performative forms of drawing, or drawing as visual thinking and situated cognition.

Moffett sees drawing as “primarily a form of moving”. This proved to be of interest, with discussion of the micro-movements and synchronization of eyes and hands (see Coen-Cagli, Brew, Tresset and Fol Leymarie), and the cognitive significance of these physical movements (see Kirsch and Tversky). We saw inquiry into the cognitive processes underlying drawing skill, offering further analysis of the

components of perception and their roles in making and reading drawings (see Ostrovsky, Fava, Chamberlain and Riley).

The definition of drawing, particularly in educational contexts, raised further questions regarding contemporary notions of “skill” and “craft”. In *The Bigger Picture of Drawing* Farthing argues for expanding our definition of drawing, beyond the boundaries of traditional artistic practices. This classification is used by Betts as the foundation of a new transdisciplinary drawing pedagogy and curriculum. Farthing and Bett’s ideas resonated strongly with the conception of drawing as a thinking tool and a way to develop cognitive skills and processes, which surfaced in so many of these contributions. This position was contextualized by Simmons, who offered another kind of “bigger picture”, situating our drawing and teaching practices in a cultural, historical perspective, considering theoretical and practical perspectives on drawing in relation to philosophical paradigms.

Is Drawing Useful?

Drawing Surgery: The collaboration of Shah and Wright, surgeon and drawing practitioner, uncovers new ground in the practice and teaching of surgery, as well as in Wright’s own practice. Their reflective analysis of the gestural and performative nature of both surgery and drawing emphasises the

crucial need for practitioners to understand where they are, how they are moving, and how to respond to sensations: “tactile and visual cues are used to produce accurate, economic movement with two hands simultaneously in three dimensions”. Discussion relating to the physical movements of drawing enables them to further contextualise their work. Cognitive scientist David Kirsh describes sketching as a mode of thinking with our bodies, inviting analogies with the process of “marking” (a pared-down form of practice) in dance. His observational study of dancers explores how marking can enable an economy of movement towards efficient learning. Shah and Wright are able to relate these findings to their developing ideas about how drawing may be able to assist training of surgeons. Angela Hodgson-Teall’s drawing performance explores a different sort of interplay between medical practice and drawing, using splenic palpation in conjunction with drawing to heighten tactile sensation, awareness and empathetic response.

Teaching Drawing: Several contributions illustrate the applicability of insights from cognitive sciences to the teaching of drawing. Chamberlain and Riley’s work uses artists and art students as a resource for cognitive inquiry, while using cognitive models of perception to inform the teaching of drawing. Similarly, Geer shows how her understanding of novice students “stumbling points” benefits from a knowledge of perceptual processes. Our own research also demonstrates ways in which cognitive research can be a rich resource for educators. Brew’s presentation also demonstrated that cognitive research can be a rich resource for educators. Her drawing instructions apply recent findings about expert drawers’ eye movements, aiming to facilitate skill acquisition through greater awareness of eye and hand movement. Fava’s research utilizes methods from cognitive sciences to make an inquiry into cognitive aspects of drawing which is mindful of these potential applications. Taking a broader perspective, Kantrowitz’s teaching is informed by her own cognitive analysis of artists’ thought processes, focussing on the transferability and wider benefits of drawing and other art-making processes.

Manifestation and Invention

Drawing offers an extension of memory and a place to generate and play with ideas. Tversky describes drawing as “the manifestation and extension of internal thought processes” reminding us of the primacy of gesture, not only in communication, but also as a tool for thought. She writes:

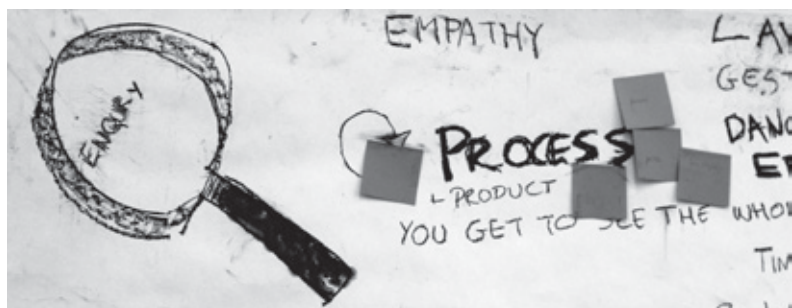
These cognitive artifacts, externalizations of thought, expand the mind. They enable thought, guide variations, allow play, discovery, and invention. They seem to be uniquely human.

Moore’s drawings demonstrate this. He describes how ideas emerge through the drawing process. Likewise, for Fitch drawing “fleshes out thought”, it is a way of “seeing things that don’t exist yet”. Wright, Tversky, Moore and Fitch all highlight drawing’s ability to respond, to offer something back, to have a conversation with the drawer.

The generation, articulation and development of ideas can be considered in relation to the creative process as a whole. Kozbelt offers a fresh perspective on creativity. He describes the development of artists’ ideas and techniques as analagous to embryological development, emphasizing the role of process in the origin of ideas and the nature of creativity.

Connections

Drawing, whether from life or from memory, involves relationships, articulations, connections. Following from movement, the temporality of drawing process features strongly. Rhythm, timing and patterns of perception are recurring themes. Of particular note is Shah’s subjective sense of an expanded time during pauses, when concentrating on surgery. Fine-grained temporal and spatial analyses were also made. Coen-Cagli dissects the



mechanical and cognitive underpinnings of eye-hand coordination in “atoms of copy-drawing”. Tresset and Fol Leymarie outline the depth of understanding, of the stages of perceptual processes, demanded of them in designing and building a drawing robot. The significance of timing in creative processes is also illustrated in Kozbelt’s analysis of creative development.

Intriguingly, McInnes considered both movement and temporality in his experiential investigation of knitting. While listening and considering what people were saying, he responded to concepts in the rhythm and motion of his hands, examining the impact of knitting on his thinking, and vice versa.

Reflecting on the symposium, Chris Moffett asks how we could think about thinking through drawing; how can we approach the question asked by symposium? We imagine the symposium itself as a drawing in progress, generating and exploring ideas, as a movement that will continue to evolve as new collaborations are fostered and new questions raised.

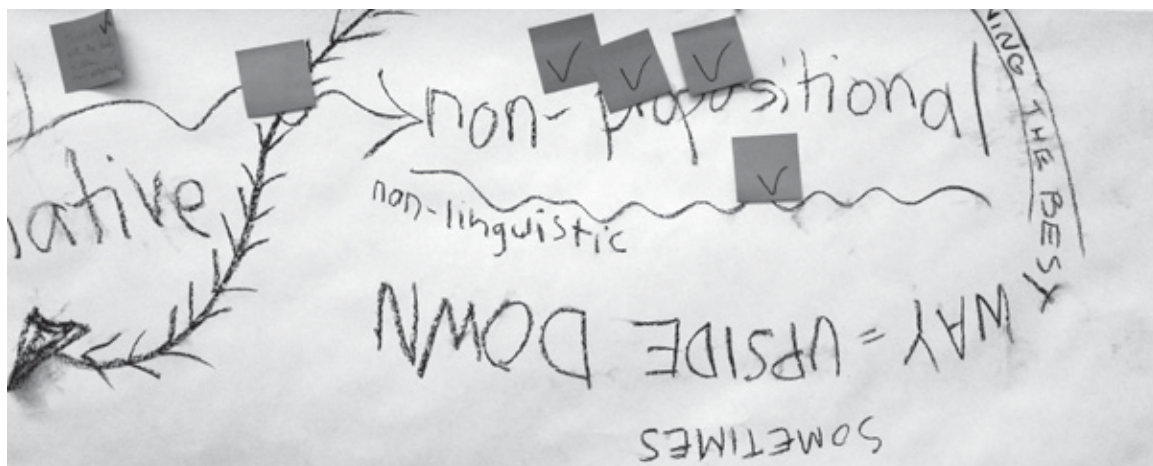
Drawing the future

The common themes of movement, change and transformation are fitting as industry and society are changing so rapidly, and disciplinary boundaries are brought into question. Exciting new ways to study cognitive and behavioral aspects of drawing are opening up, thanks to developing technology and recent work by cognitive scientists on internal worlds and states of consciousness. A greater clarity about the nature of drawing can contribute to the critical evaluation of drawing curricula, to the identification, and defense, of traditional models of

drawing education which are still relevant and useful, while it can also contribute to the innovation of new approaches to teaching – both the teaching of drawing skills themselves, and the use of drawing to enhance the learning of other subjects. It can also address more fundamental questions about the nature of perceptual and psychomotor skills associated with drawing, their transferability and value to the individual. Simon Betts writes:

What I really hope for is that the confidence to draw in whatever method is relevant to the individual student, not weighed down by believing that “good drawing” belongs to one particular group of practitioners, will ultimately allow our students to understand their past and construct their futures.

There is something invaluable about the study and practice of drawing. We hope that these proceedings, and the future collaborations fostered by this group, will demonstrate this. Our aim is to nurture the growth of an international community of researchers, to facilitate interdisciplinary collaboration and to disseminate research outcomes. After all, making unexpected connections and discovering unforeseen possibilities is what we believe drawing is about.





THINKING THROUGH DRAWING: PRACTICE INTO KNOWLEDGE

An exhibition accompanying an interdisciplinary symposium
on drawing, cognition and education



MACY ART GALLERY
TEACHERS COLLEGE COLUMBIA UNIVERSITY

October 24 - November 4, 2011

Reception: Friday, October 28, 5-7 pm

Curated by Andrea Kantrowitz

TC/AE TEACHERS COLLEGE
COLUMBIA UNIVERSITY
ART+ART EDUCATION



Image: Humplocked by Tara Geer

Artists:

J. Fiber
(with Jane Fine
and James Esber)

Tara Geer

William Holton

Jeesoo Lee

Michael Moore

Margaret Neill

Mia Pearlman

Sumru Tekin

Curatorial Statement

Andrea Kantrowitz
Teachers College, Columbia University

To make a mark or trace a single line upon a surface immediately transforms that surface, energizes its neutrality; the graphic imposition turns the actual flatness of the ground into virtual space, translates its material reality into the fiction of imagination.

— David Rosand, *Drawing Acts*

Thinking Through Drawing: An Exhibition

Macy Art Gallery
October 24 – November 3, 2011
Curated by Andrea Kantrowitz

The artists, in the exhibition accompanying the symposium on drawing, think through the drawing process in many different ways. For example, Tara Geer begins in a flurry of (almost) chaotic activity, drawing, rubbing out and redrawing, with graphite, chalk, and charcoal, until that nameless thing that she is looking for begins to emerge in the paper. In contrast, William Holton starts out with a few simple rules for himself, and through repetition, the traces of a multitude of similar marks evolve into complex and mysterious structures. Drawing directly on the wall, Margaret Neill transmits her perceptions and impressions of the gallery space in which she finds herself as she draws.

Rather than starting with a clearly defined pre-conception of what the final product will look like, all the artists in this exhibition ask “what if?” knowing how to draw themselves into an unpredictable situation through repeated acts of making their mark. Through this process, they surprise themselves and us, exploring unforeseen possibilities and unexpected connections. Jane Fine and James Esber exacerbate this unpredictability by trading their drawing back and forth, creating the work of a fictional alter-ego, J. Fiber. The urge to discover something new, something unanticipated, is often the reason to draw in the first place and may be part of what it means to truly “know how” to draw.

Cognitive psychology and neuroscience shed light on how, why, and what we know. Recent neuroscientific research, by Antonio Damasio at UCSD and others, demonstrates the close relationship between feeling and thought, and has shown us how our emotions have evolved to guide us, so that we can “feel our way” through the world. Others are showing us how gesture, those ill-defined yet surprisingly essential hand movements that accompany speech, help us navigate through concepts and understandings not yet completely within our grasp. Drawing, as the visible trace of gesture, allows us to see this process, and follow along the artist’s journey.

Obsessed by Lines

*Barbara Tversky
Teachers College, Columbia University
and Stanford University*



Lines are everywhere. The lines of the streets and the buildings where we live. The lines of the shelves on which we place our books, dishes, towels. The lines we draw on the page. The lines we gesture in the air. Those lines are not always straight: the lines of the paths we take meandering in the woods, the lines of the curves of the body, the lines scribbled on a page. Lines, straight or messy, serve our behavior and our thought. Let's see how.

How do we think about things that don't exist? Where do new ideas come from? These are not new questions. Sometimes it seems impossible, yet we can think of things that don't exist and we can have new ideas. There are two ways to invent new things: bottom-up, by altering or combining or rearranging old things, varying concrete instances; or top-down, abstractly, by starting with desiderata, goals, principles, or properties, and instantiating them. The advantage of the bottom-up way is that it gives us instances to start thinking about. It's hard to think in the abstract. The disadvantage is that those instances constrain and limit thought; we don't stray far from them. The advantage of the top-down way is that it allows flights of fancy; the disadvantage is that it doesn't tell us where or how to begin. Evolution has only one way to create new things, bottom up, by altering or combining or rearranging old things. People can—and do—do both. They can create new ideas and new things by using perception and they can create new ideas and new things using conception. In actuality, people go back and forth between perception and conception, using one to augment the other.

Thinking is hard. When thoughts overwhelm the mind, the mind puts them into the world, and has since antiquity. We use fingers, tallies, abacuses, computers to count and calculate. We gesture maps and routes in the air or draw them in sand, in stone, on paper, on screens. An overwhelmed mind puts thought into the world; even simple means help—talk, sketch, gesture, model. These cognitive artifacts, externalizations of thought, expand the mind. They enable thought, guide variations, allow play, discovery, and invention. They seem to be uniquely human.

Each of these tools for thought has different properties with different consequences. Here, we focus on actions that are realized in sketches, gestures, and arrangements of space. We'll begin with sketching, and lines. Lines are among a set of simple forms that acquire a range of readily inferable meanings, abstract and concrete, in context. A line in a street map is a path between one location and another; a line in a knowledge network is a relation between one idea and another. One-dimensional lines connect, and indicate a relationship between the points, places in maps or ideas in knowledge networks. Arrows are asymmetric lines, and indicate asymmetric relations. A diagram of a bicycle pump or a car brake or a pulley system that doesn't have arrows is interpreted by students as a representation of the structure of the mechanical system. When arrows are added, students interpret the diagrams as representations of the causal operation of the system. Similarly, when asked to diagram descriptions of structure, students don't use arrows,

but when asked to diagram descriptions of causal operation, they use arrows. Just as lines show relations, boxes show containment, so that students interpret lines in graphs as trends whereas they interpret the same data displayed as bar graphs as discrete relations. These simple abstract forms—dots, lines, crosses, arrows, blobs and more—have context-dependent meanings related to their mathematical or Gestalt properties (Tversky, 2011; Tversky, Zacks, Lee, and Heiser, 2000). Ample research has shown that well-designed diagrams help people to learn complex information and to make inferences about it.

Intriguingly, gestures use analogous simple forms, points, lines, directed lines, containers. Gestures are used communicatively, to explain things to others. Not only is speech understood better when it is accompanied by gesture, but certain gestures have dramatic effects on the thought of those who view them. Children understand algebra better when the hands cup each side of an equation on the blackboard, like parentheses (Goldin-Meadow, 2003). Adults grasp cyclical concepts better when the explainer gestures each stage in an imaginary circle than when the explainer gestures each stage along an imaginary line (Jamalian and Tversky, in preparation). More surprisingly, it turns out that gestures aid thinking in those who produce them. When people sit on their hands, they have trouble finding words (Krauss, Chen, and Gottesman, 2000). When people are alone in a room trying to solve spatial problems, they often gesture the structure of the problem, and when they do, they are more likely to solve the problem (Kessell and Tversky, 2006; Jamalian, Tversky, and Giardino, in preparation).

So far, we've talked about neat and orderly lines. They are used, on paper or in the air, to convey the essence of neat and orderly ideas, and they succeed. But messy lines, as designers and artists know, also aid thought, exactly because they are messy. Messy lines are ambiguous, pre-categorical, so they allow many interpretations. Messy lines promotes discovery of new ideas. Making messy lines allows play and exploration. Designers and others comment that they have "conversations" with their drawings, that their drawings "talk to them" (Schon, 1983). How might this happen? And how can it be encouraged?

Several studies elucidate how designers and artists get new ideas from their own sketches (Tversky and Suwa, 2009). Experienced architects were

asked to design a museum on a particular site, and later talked about what they were thinking as they drew. They reported getting new ideas when they regrouped elements in their sketches, as did designers and non-designers in follow-up laboratory experiments. Getting new ideas requires reinterpreting ambiguous sketches, but it also requires getting an idea. The first is a perceptual skill and the second a cognitive one. The perceptual skill is related to seeing smaller forms embedded in larger ones; the cognitive skill is finding meaningful relations in seemingly unrelated things. Together this process has been called "constructive perception," actively using perception, especially reorganization of perception, to innovate. It depends on messy lines.

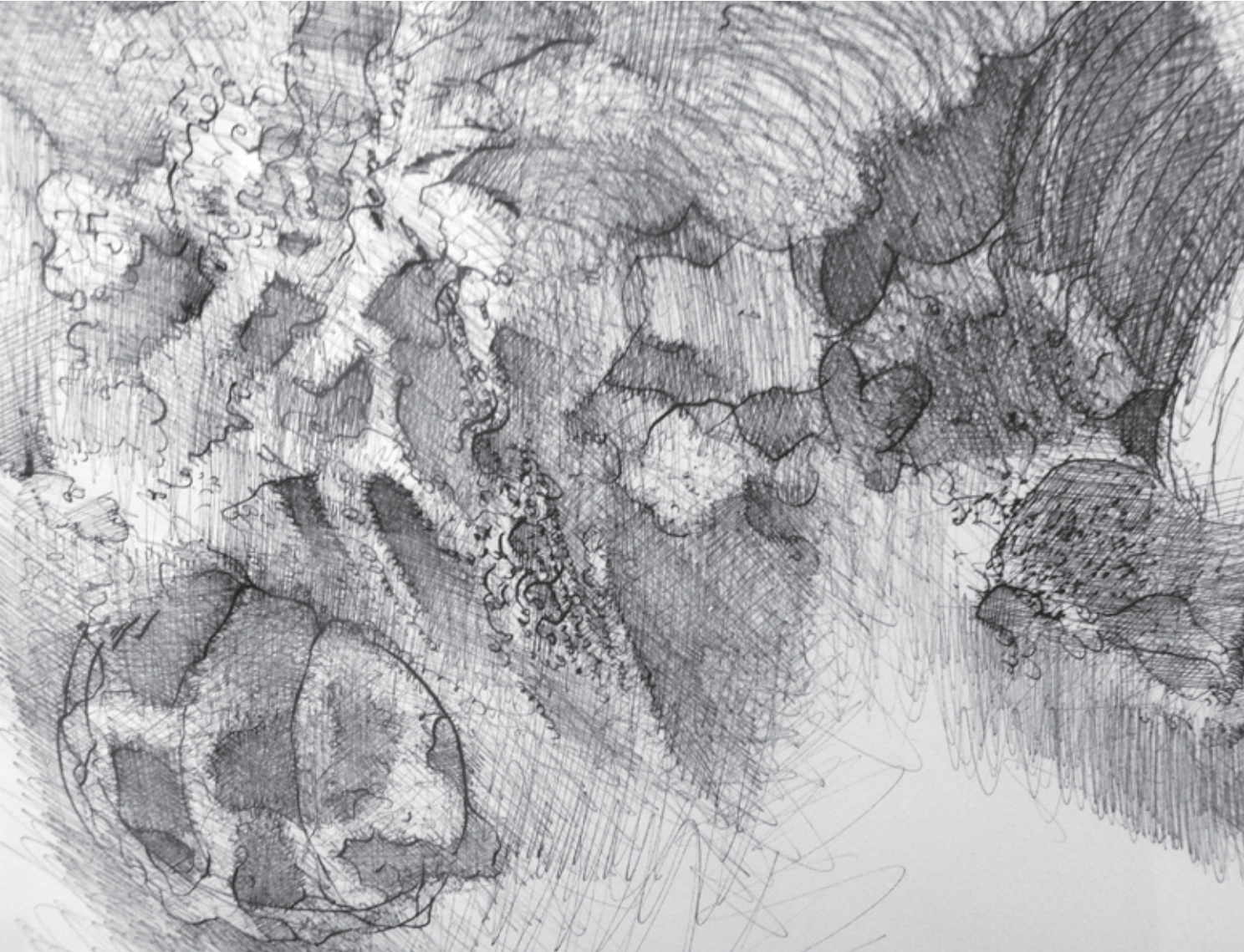
Orderly lines, ideas that are ordered; unstructured lines, ideas that are awaiting structure. Lines on paper, lines in the air. Now to the lines in the world. Some are orderly, usually imposed by people: books in cases, dishes on horizontal shelves and in vertical piles. They, too, express neat ideas that others can uncover. Books are likely to be grouped by topic, fiction and non-fiction; they may be ordered by year or by size. Dishes are likely to be organized in categories, plates and glasses, and sub-categories, small plates and large; water glasses and wine glasses. The world has messy lines, too, the chaos of clouds that let us see changing forms and shapes, the meandering paths in the woods that let us get lost and make new discoveries.

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Drawing Practice and Pedagogy



Michael Moore

The Bigger Picture of Drawing

Stephen Farthing
University of the Arts London



Any sustainable definition of drawing should, I suspect, look beyond the tip of the pencil and the materials and techniques used by draftsmen and focus on drawing as an intellectually driven process of translation. A process that, in common with writing, mathematics and other forms of notation, is driven by a need to both construct and reconstruct multidimensional events as readable two-dimensional matter.

An interest in creating definitions is usually aroused by the suspicion that a word doesn't have a determinate meaning. To my mind drawing is one of those words.

It's not that there is anything particularly confusing about the common usage of the word drawing, or that it is difficult to understand the physical processes and reasoning behind most drawings, it is just that peripheral words like: talent, giftedness and perhaps most of all **Art** tend to get in the way once we start trying to describe what drawing is.

In suggesting this I am not proposing a hierarchical system of differentiation, in fact quite the opposite. What I'm suggesting is that our ability to see and comprehend the bigger picture of drawing is too often obscured by a cultural preference for placing art in the foreground of drawing.

Once we get beyond the most basic acts of communication and start making marks (writing, drawing and calculating) with a view towards both making sense of and organizing where we find ourselves (physically, intellectually, emotionally, spiritually and financially), the two most important forces we bring into play are both geared towards

simplification. The first involves the removal of superfluous detail. The second, quite literally, the flattening of time and space.

What I think we are doing when we not only draw—but handle words numbers and notations—is translate multidimensional events, that may or may not physically exist, into **readable two-dimensional matter**.

As a way of trying to explain how (not just the drawings of artists but) all drawings fit into this concept, I would like to reflect for a moment on the word "Essay". For most, the word Essay is firmly attached to the written, it once however, had a much broader reach. Coming from the French, *essayer*, meaning "to try" or "to attempt" an essay wasn't always a short written summary of an individual's knowledge on a particular subject, it was also a preliminary drawing or sketch, "a try" a "possibility". Even today, a drawing made as a preliminary design for a postage stamp or banknote is referred to within the Mint and Post Office (in the UK) as An Essay. It doesn't matter if it is a nineteenth century design for a pavilion or the line in the dirt General Travers asked his followers to cross at Fort Alamo, when I use the word drawing I am thinking of essays, first steps, first attempts and prototypes.

So drawings, unlike banknotes, postage stamps and buildings, are provisional. They are ideas in limbo, designs waiting to be activated and made concrete.

What must be one of the largest drawings in the world, the road markings of North America, started life in Wayne County Michigan in 1911 as

a result of an initiative taken by the state employee responsible for road safety. Ever since Edward N. Hines ordered the first white line to be drawn down the centre of a Michigan highway, the drawing that became the road markings of North America has gradually increased in both size and complexity, and perpetually remained in a state of growth, revision and restoration.

Recognized today as one of the most important traffic safety devices in the history of highway transportation, the first line (which was apparently inspired by a leaking milk truck) had just one purpose, to divide a road in two in order to prevent vehicles colliding head on.

What started as a simple white on black line drawing, over time, became more complex, words, symbols and colours were added. The purpose of the drawing however, remains exactly the same, to facilitate the safe flow of road traffic and mediate between the driver, the pedestrian and a “narrative” provided by the Drivers Hand Book. By using a predominantly drawn, conceptually driven—rather than a concrete and steel object based—traffic control system, the highway administration not only maintained a flexible, easily revisable, ecologically sustainable and inexpensive control system, they improved road safety by providing the driver with less obstacles to hit.

A taxonomy

As Sarah Palin looks towards the Alaskan State Flag, she sees eight golden stars on a dark blue field.

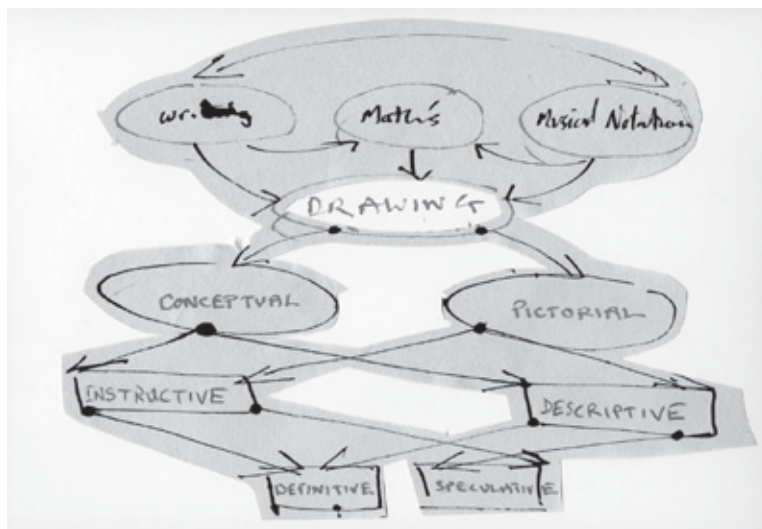


Figure 1. A conceptual taxonomy of drawing. Ink on paper, 2010.

During the process of looking I suspect she seldom if ever reflects upon the two very different kinds of drawing that from the very start enabled that flag.

The first is the drawing that Benny Benson made when he was a seventh-grader, that made him the winner of the 1926 Territory-wide contest for schoolchildren to draw a flag for what would become the 49th state of America. The second is the drawing every Alaskan makes without realizing it every time they look at their flag and most times they look up at a clear night sky.

Sarah Palin will recognize the image of the star top right as the pole star, she will also know the seven below as an asterism. She may or may not know the word *asterism*, or that the cluster of stars she is looking at are the best known part of the constellation Ursa Major. What we can rely upon however, is her knowing the common name of that star cluster.

Every time the ex-governor looks up at the Big Dipper, we know she completes a drawing. There are no pencils or paper involved. Her drawing is a rehearsed cerebral act, an act dependent on her first recognizing a familiar set of markers, then joining up the dots in her mind to produce a nameable drawn image.

There is, of course, a lot more to drawing than simply joining up the dots. Drawing throughout history has been driven by our need to measure, estimate, imagine, record and invent. This has resulted in drawing becoming an important force, not just in enhancing our understanding of our planet and solar system, but in helping shape our relationship with our environment. Drawing has, to put it simply, been critical in our relationship with discovery.

After our ability to make marks in the dust, estimate and accurately measure, the two most significant discoveries within drawing have been: first the realization that three-dimensional things can be represented in two dimensions by an outline; then that places, things, time, directions and quantities can be represented by marks that have only a passing relationship with what they represent.

So a village can be reduced to a circle and “X” can represent the position of anything we deem significant.

After these founding discoveries came a series of landmark inventions, each gradually shaping drawing into what we recognize it as today, these include: Writing, Geometry, the Invention of Paper, Perspective, Pencils and Erasers then the Cameras Obscura and Lucida, then Photography, CAD systems, GPS and finally, Digital Imaging.

The kingdom

Drawing is one of four species within a kingdom that is concerned with recording, communication and discovery, the others are Writing, Mathematics and Musical Notation.

The classes

The species Drawing has two distinct and different lines of descent: the **Conceptual** and the **Pictorial**. The Pictorial and Conceptual have parallel histories that have, at times, cross fertilized .

An example of a Conceptual drawing might be a cluster of dots drawn onto a window pane with a fibre tipped pen, that mark the position of the stars as they were in last night’s sky. An example of the Pictorial is a line drawn with the same pen around the edge of your own image on the surface of a mirror.

Although by using these specific examples I may seem to be suggesting that the difference between the two types of drawing resides in the difference between a sheet of glass and a mirror, what actually makes them different is neither their subject matter nor the materials they are made with, what makes them so different is how we “read” them.

Pictorial Drawings rely on our ability to recognize things by their outlines.

Conceptual Drawings rely on a more complex translation process that is dependant on our ability to read and make sense of abstractions.

The reading of both begins with us intuitively placing a given drawing into one or other of the two classes, then continues with us either seeing the need for an associated narrative, “key” or “legend” that will inform our reading, or with us forging ahead and relying on the drawing’s ability to offer up its narrative to us, as we read.

The real distinction between the two classes rests however, not simply on how we read them, but on us recognising where their respective narratives are physically located.

The conceptual

Conceptual drawings don’t have a built in narrative. Their narrative is either located in the margin or somewhere beyond.

An example of a conceptual drawing with a “beyond,” probably lost forever, narrative is the free-hand, geometric, linear cluster that was scratched some 77,000 years ago into the ochre rock of the Blombos Caves in South Africa. With three equally spaced horizontals forming a warp and a series of more or less equal length lines arranged as inverted “V’s” establishing a weft, the drawing has a layered woven appearance. Other than our ability to describe its appearance, everything else about this drawing is a mystery. We have, for example, no way of knowing if the drawing had a speculative, didactic, descriptive or defining function, or if indeed its author considered it meaningful or meaningless.

Seventy five thousand years after the Blombos drawing, a Greek mathematician resident in Egypt constructed a conceptual drawing whose accompanying narrative survived as text in a book. The drawing is an annotated line drawing, with a three-dimensional component that is activated in real time, by sunlight, to produce within the drawing a kinetic tonal component. Ptolemy arrived at his sundial through a mix of mathematics and practical experiments, then set out its “narrative,” the technical explanation of how it worked in a book he called the Analemma.

About one thousand years later, the French composer Baude Cordier made a far less pure, more hybrid series of drawings that span the space between the Conceptual and Pictorial. Bound into what is now known as the “Codex Chantilly”¹, his musical scores emerge today as early examples of the kind of free thinking musical notation that we refer to as “eye music.” Working with the standard musical notation of the day, Cordier drew a love song into a heart shaped stave, then a canonic round into a circular stave. By investing the music with a pictorial dimension he didn’t simply inspire his choristers to think beyond the words and notes to love and cycles, but in doing so he created a cross fertilization between the Pictorial and Conceptual classes of drawing.

More recently, in 1840, Emily Babcock, a young member of the Shaker Community in New Lebanon, New York made a drawing she called *The Narrow Path to Zion*ⁱⁱ. The drawing or “Gift”, (as in Gift from God), as drawings were called within Shaker

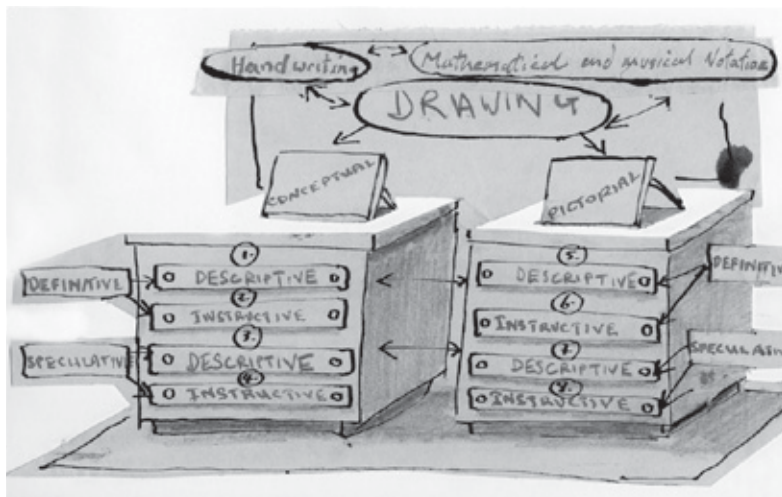


Figure 2. A pictorial taxonomy of drawing. Ink and pencil on paper, 2010.

communities, was a record of a vision. It was neither the product of Babcock’s imagination nor an image designed to speak for itself. It was intended as a factual record of a divine visitation that could be used in conjunction with a spoken narrative, as a visual aid and teaching tool.

The pictorial

The Pictorial relies for the most part on an embedded narrative, which, if it works, enables the drawing to speak for itself.

Although the 30,000-year-old drawings of quadrupeds made in the caves of southern France and Spain may appear as an attractive starting point, more straight forward (because we know their purpose) are the drawings made by recording artists during the European voyages of discovery between the 15th and 18th centuries. In 1660, for example, John White drew what Sir Walter Raleigh dubbed “the princess of fruit”ⁱⁱⁱ. At first, this very accurate, life-like, life-sized drawing of a pineapple would have required some explanation. Over time however, our familiarity with the exotic fruit allowed the drawing to speak for itself. Along similar lines John Webber, the official artist on Cook’s third voyage, drew a long-beaked, standing up straight, not very aerodynamic, bird. Even then I suspect his image of a King Penguin^{iv} spoke for itself. Another drawing that, in spite of its intentionally ambiguous aims remains clear cut and Pictorial, is the Joseph Jastrow duck-rabbit drawing^v. This is an image that Jastrow realized had the ability to support his argu-

ment that perception was not simply a product of the stimulus but also of mental activity. Over time this drawing may have developed an off stage narrative, but on the page both duck and rabbit function pictorially.

The orders

After the sometimes broken line that separates the conceptual from the pictorial comes a solid line that produces “The Orders” of drawing. The Order of any particular drawing is determined by its purpose which, within this taxonomy, will be to be either Definitive or Speculative.

When Class and Order are put together they produce four sub orders: The Pictorially Speculative, The Pictorially Definitive, The Conceptually Speculative and the Conceptually Definitive.

Depending on the job in hand, a draftsman will work sometimes towards a Definition. By this I mean, a drawing that presents its subject as a fact, as White and Webber did when they draw their Pineapples and Penguins. Other times, draftsmen work more tentatively towards Speculative outcomes, as Cezanne did when he drew Monte Sainte Victoire over and over again.

The modes

After the **Definitive** and **Speculative** orders come the Modes of drawing. Less concerned with approach than intent, The Modes sub-divide drawings into those intended as Instructional and the rest that simply set out to Describe. Road and sports field markings, and the icon on the lavatory door are examples of drawings made within the Instructive mode. Maps, David Hockney’s portraits made with a Camera Lucida, and White’s Penguin are all examples of the Descriptive Mode.

Within my taxonomy every drawing has three possible allegiances, first to either the **Pictorial** or **Conceptual**, then to being either **Definitive** or **Speculative** then finally to being engineered towards either an **Instructive** or **Descriptive** mode.

The taxonomy applied

Most maps sit quite happily on the **Conceptual** side of drawing. During their formative stages they will be to some degree **Speculative**. In their final version however, the expectation of the audience is that they should be accurate, **Definitive** and disinterestedly **Descriptive**.

A portrait of Jane Austen^{vi} cut as a profile into black paper with a pair of scissors is **Pictorial**. It is **Descriptive** of her appearance and, in so far as it conditions our view of what she actually looked like, it is **Defining**. As a cut tonal drawing it is **Pictorial, Descriptive and Definitive**.

The measured line drawing that is the football pitch is **Conceptual**, in that it functions in conjunction with a narrative – the rules of the game. Each sports field drawing **Defines** the area of play; it **Instructs** the players. It doesn't passively describe. So the drawn sports field is **Conceptual, Definitive and Instructive**.

A circle drawn freehand is **Conceptual**. Its shape may be **Speculative**, but if it is reasonably accurate it remains **Descriptive**. A circle drawn with a compass is also **Conceptual**. If accurately drawn it becomes **Definitive and Descriptive**.

The gender-based icon on a toilet door is **Pictorial, Defining and Instructive**. A landscape drawn by the English Landscape painter JMW Turner is always **Pictorial**, always **Descriptive**, but sometimes **Definitive**, other times **Speculative**.

To conclude

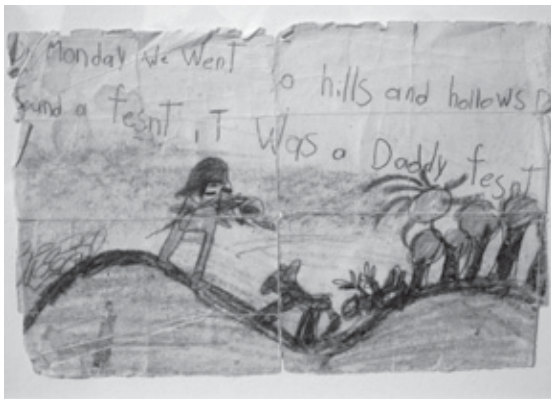
On one side there is the pictorial route that is concerned with the external appearance of things, on the other the conceptual that is dependent on us constructing images by joining up the dots we deem important, not simply the ones that prefigure an outline. The cut I make through the middle of drawing doesn't just enable a classification system, it also helps us picture drawing as an intellectually and emotionally driven compendium of possibilities, not simply a craft subject attached to the past by the life room and the future by digital modelling.

References

- i The Codex Chantilly is held at the library of the Musée Condé at the Chateau de Chantilly as manuscript 564 (older sources refer to it as '1047')
- ii The Narrow Path to Zion, Emily Babcock, New Lebanon, New York public library, Special Collections, Drawing on 8 sheets, ink on paper, 4 by 13 inches.
- iii Drawing of a Pineapple, John White 1580's, British Museum (BM 1906.0509.1.41)
- iv Drawing by John Webber during Cooks 3rd voyage 1776-1780. King Penguin *aptenodytes patagonica* Watercolour, over graphite 25.8 x16.1 cm, British Museum, AN389988001 acquired 1914 Previous owner/ex-collection Sir Joseph Banks
- v The duck-rabbit image was "originally noted" by American psychologist Joseph Jastrow in 1899, Jastrow's drawing was based on one originally published in Harper's Weekly (Nov. 19, 1892, p. 1114) which, in turn, was based on an earlier illustration in *Fliegende Blätter*, (Oct. 23, 1892, p. 147).
- vi Silhouette 4 x 3 inches c. 1810-1815 from the second edition of "Mansfield Park" inscribed "Laimable Jane" and presumed to be of Jane Austen, attributed to a Mrs. Collins who worked in Bath during the early 1800's.

The Bigger Picture of Drawing: A New Curriculum, A New Pedagogy

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To begin with, a small drawing.

This little drawing is 10 centimeters high and 15 centimeters wide. It is drawn with wax crayons and pencil. It is split in two, is about 48 years old and is now framed and lives in my bedroom. This drawing depicts my father and I walking with his dog. From a very young age I drew all the time. Looking at it now we can see that it is made, and I stress entirely un-knowingly, using drawing and writing where marks become words and letters become marks. It communicates a narrative and suggests that text and image might work together. It was made as a drawing to describe an event in my life and not as art.

Recently, and as an art and design educator, I have been reflecting on this little drawing. It has encouraged me to reflect on my own educational journey and how I learn. The point I would make here is that at School learning drawing and using drawing was entirely mediated through the art

classes. Drawing became something I “learnt” as part of an art curriculum; the act, process and use of drawing resided solely in the school art room. The learning and understanding of a wider range of subjects and disciplines through visualization, mark making and drawing was not an option. As a boy, the message absorbed was that drawing is something artists do; it belongs to fine art.

In her essay “Traces of Thought and Intimacy” in *The Drawing Book*, Tania Kovats writes of drawing and communication; “Part of the reason they communicate so directly is that drawing belongs to everyone. Acts of drawing occur all the time—someone applying eyeliner, doodling whilst on the phone, or making someone a map on the back of an envelope. We are all mark-makers.” (Kovats, 2005).

Furthermore, in his introduction in the new Wimbledon College of Art MA Drawing course handbook Professor Stephen Farthing wrote that drawing “doesn’t just belong to one discipline, profession or subject area, like writing, it is common property” (Farthing, n.d., p. 5). I really like this notion of drawing being common property; it implies a democracy of use and purpose and removes a perception of hierarchy or of belonging to one discipline. We all know that drawing can be a tool for research, reflection, analysis, investigation and experimentation. It can describe, record, map, plot, scrutinize, and propose. All of these are transferable skills and drawing as a process can support and enhance learning and understanding in many subjects and disciplines. Knowing drawing and experiencing drawing can enhance learning.

Background and context

However, in recent years, any conversation with colleagues in the UK teaching in pre-undergraduate art & design foundation courses would inevitably have focused on increasing anecdotal evidence of students' drawing weaknesses and their low confidence in their drawing ability. From 2005, all six University of the Arts foundation course directors were noticing in their course selection process an increasingly worrying trend in the applicants' portfolios. These concerns amounted to decreasing amounts of any kind of drawing in the portfolios, a limited range of subject matter and uses of drawing, and little speculative drawing for ideas development or research. Certainly, there would often be no observational drawing where a student had learnt how to look, analyze, scrutinize, and record visual information.

Furthermore, if there were any drawings evident in portfolios they were often a direct copy of a photograph, more than often poorly drawn and with no attempt to relate photography to drawing. While "copying" has an historical role in drawing, used without any contextualization as the sole method of drawing it does little to develop an individual's skills. I would argue that this lack of visibility in any kind of sustained drawing or ideas development through visualization, has its roots in the current UK national school curriculum that through an assessment driven process sees drawing relegated to the copying of second hand imagery (usually artists' paintings) and only to be done in workbooks.

In short, all the foundation course teams from the University of the Arts London were increasingly seeing application portfolios that lacked confidence and competence in drawing; lacked an understanding of the wider uses and purpose of drawing and lacked the rigor of sustained objective drawing. Furthermore they showed little evidence of drawing for research or ideas development, and were over-reliant on copying from second hand information. Our concerns were supported in conversations with national chief examiners.

I want to make clear that these problems were not common to all schools, and we also saw work from a number of schools where drawing was quite obviously and confidently embedded into the art and design curriculum. But our view was that these schools were increasingly in the minority. However, the issues I have described were critical on two points. Firstly, it made confident selection of stu-

dents more difficult, and secondly, once accepted onto a foundation course, this lack of skills and confidence put students at a disadvantage in their learning.

Writing and development

Increasingly aware of these problems, in early 2009, the University of the Arts London through the Centre for Drawing, with support from the Rick Hopkins Bequest, commissioned the designing, writing and development of a new drawing qualification that would aim to meet the needs of students and support progression. The Rick Hopkins Bequest were particularly keen that any new qualification should be targeted at school students aged 14-19, to increase the joy and use of drawing, and the University of the Arts was keen to promote proficient drawing for students wishing to apply to its foundation courses and enhance progression to undergraduate courses. The team of authors were; Professor Stephen Farthing, Kelly Chorpening (BA Drawing course director at Camberwell College of Arts) and myself. We were given a very clear brief to design and write a series of individual units that would form qualifications that could be delivered to 14 to 19 year olds; could be delivered as single units according to subject specificity or grouped to create a qualification; would promote and enhance cross-disciplinary drawing skills and finally, be validated by the University of the Arts Awarding Body.

I do think that drawing is now more recognized as being a common property, as there is an increasing acknowledgment of just how many professions, disciplines or subjects use drawing to explain, communicate and propose. Like writing, drawing is cross-disciplinary. So as authors we set out to answer two important questions. Firstly, if the aim of a drawing course is to be cross-disciplinary, how can a range of individual educational units cross disciplines and deliver skills, understanding and contextual knowledge? Secondly, what would make these units and qualifications relevant to the engineer, cartographer, scientist or theatre designer?

Our starting point for the University level 3 drawing qualifications (and indeed later the MA Drawing course), is the notion of purpose or use in drawing. The qualifications ask questions of how and why we use drawings as well as teaching drawing skills. So it was important in the designing of each individual unit that we challenged some old orthodoxies in how drawing is taught. We deliber-

ately avoided individual units that focused on a specific language of drawing, for example “tone”, “line”, “composition” “perspective”, and we also took the decision that individual units should not explicitly refer to culturally specific or historical subject matter (for example, “life drawing” or “drawing from still-life”). We argued that the reliance on a subject matter driven curriculum could reinforce certain perceptions held by students and tutors alike that would run counter to our view of the democracy of drawing. We wanted the qualification to reinforce that subject matter could come from the students wherever possible, and more importantly, any unit could be mapped against any subject matter.

A good example of this is life drawing. Following completion and introduction of the qualifications, one college in London demanded a life-drawing unit. Professor Stephen Farthing and I argued that the qualification did not preclude or diminish life drawing, but that what these individual units offered was the opportunity to scrutinize and question the life figure anew. For example, what kind of observation and understanding could come from using the life model alongside, for example, our Drawing and Mapping unit?

As authors, we saw this as an opportunity to write and develop a truly cross-disciplinary drawing course that would promote the purpose of drawing, encourage innovative drawing pedagogy, and establish the principle of learning through drawing, while simultaneously underpinning core transferable drawing principles of observation, analysis, recording, research and contextual understanding. Finally, and most importantly, we wanted to encourage, for a wide range of students, the pure joy of drawing.

So we began by creating a list of uses and applications for drawing across a range of disciplines and this list became the individual unit titles. Working from UK national qualification guidelines, we then developed an aim, learning outcomes and assessment criteria for each unit.

The Units

I will go through each unit to illuminate their core aims. To clarify, these units were designed for 14-19-year-old students. What I do want to emphasize here is that every unit has learning outcomes that focus on contextual understanding. We insisted that students research contemporary and/or historical contexts as part of their work as we believe this

would lead to greater knowledge and understanding of drawing.

Drawing materials and processes encourages the exploration of a wide range of drawing materials and processes, and the use of both traditional and non-traditional materials is encouraged. An open-minded approach is sought and students are encouraged to look beyond what is possible in the class or studio to scope a greater awareness of materiality and process.

Drawing and measurement. The use of appropriate systems of measurement, and accuracy of recording from observation underpins this core unit. Suggested learning comes via drawing from direct observation, for example, life drawing, architecture, landscape or large interiors. This unit has applications for any discipline involved with observational accuracy including architecture and engineering.

Drawing with light explores the role that light and dark plays in making images visible within drawing. Along with hand-made tonal drawings the use of photography can be explored via the pin-hole camera. This unit could be used by students of photography, film-making, theatre and painting.

Drawing and writing encourages students to be open-minded in exploring and understanding how words and letters on the 2D surface relate to each other and to images. This includes the exploration of ancient scripts and ornamental texts, a comparative exploration of pictograms and hieroglyphics. Investigations into concrete poetry and artists such as Cy Twombly and Mary Kelly might be included. Hand-made drawing and the use of digital media can be explored in students’ drawings.

Drawing as communication supports cross-disciplinary drawing in graphic design, animation, illustration, fine art and architecture. It explores signs and symbols from diverse cultures, and drawings from observation of signs and symbols found in road signs and flat-pack instructions. Students evaluate how and why signs and symbols precisely communicate.

Drawing for research. Central to this unit is the exploration and investigation of information, ideas, and research sources that encourage the learner to become competent in visual evaluation. It explores drawing as a research tool. Working from historical and contemporary sources the students are able to evaluate ideas and information, and apply research skills and methods in developing their own ideas.

Drawing and mapping suits students of graphic design, illustration, cartography, web-design or engineering. Approaches include researching maps, diagrams, plans, architectural drawings, ordnance survey maps and instructional guides. The students' drawings could explore distance, space, and 3D form or illustrate or describe a journey or activity, or direct a viewer or audience

Drawing and reproduction explores creativity through study of others' drawings and methods. Students are asked to recreate a drawing by identifying the individual gestures that the drawing is composed from. Students are encouraged to interrogate others' drawings from the world of comic books, mapping, fashion design, artists' and designers' drawings, or architectural plans and are encouraged to not merely copy.

Drawing surfaces and texture enhances analysis and drawing skills, and develops critical reflection on the possibilities of surface. The unit particularly suits students of fashion, textiles, costume design and interpretation, interior designers and cartographers. Students could forensically investigate a range of surfaces including observed, found, natural, synthetic, digital and photographic.

Drawing into three dimensions develops understanding in how a drawing can move from two dimensions to three dimensions. It supports students of three dimensional design, sculpture, set design, costume design, fashion, engineering, architecture and furniture. Investigations into thinking through drawing and making, and the use of three-dimensional materials as drawing media are encouraged.

To form a qualification a centre can select 2 units for the qualification, **Drawing Award**, or select 4 units for the qualification of **Drawing Certificate**. This level of choice supports individual centres and courses in aligning the qualifications to their students needs.

In academic year 2010/11, the qualifications first year of operation, a total of 3,562 students were enrolled across the UK. This academic year, 2011/12, we now have 4,942 enrolled, with the qualifications being offered in 6th form colleges, schools and further education colleges. It is also being offered as a stand-alone full-cost qualification in some centres. The rising take up across the UK I think illustrates the appetite for drawing, and the success of the qualification in delivering a drawing experience.

Pilot of the qualification at Wimbledon College of Art

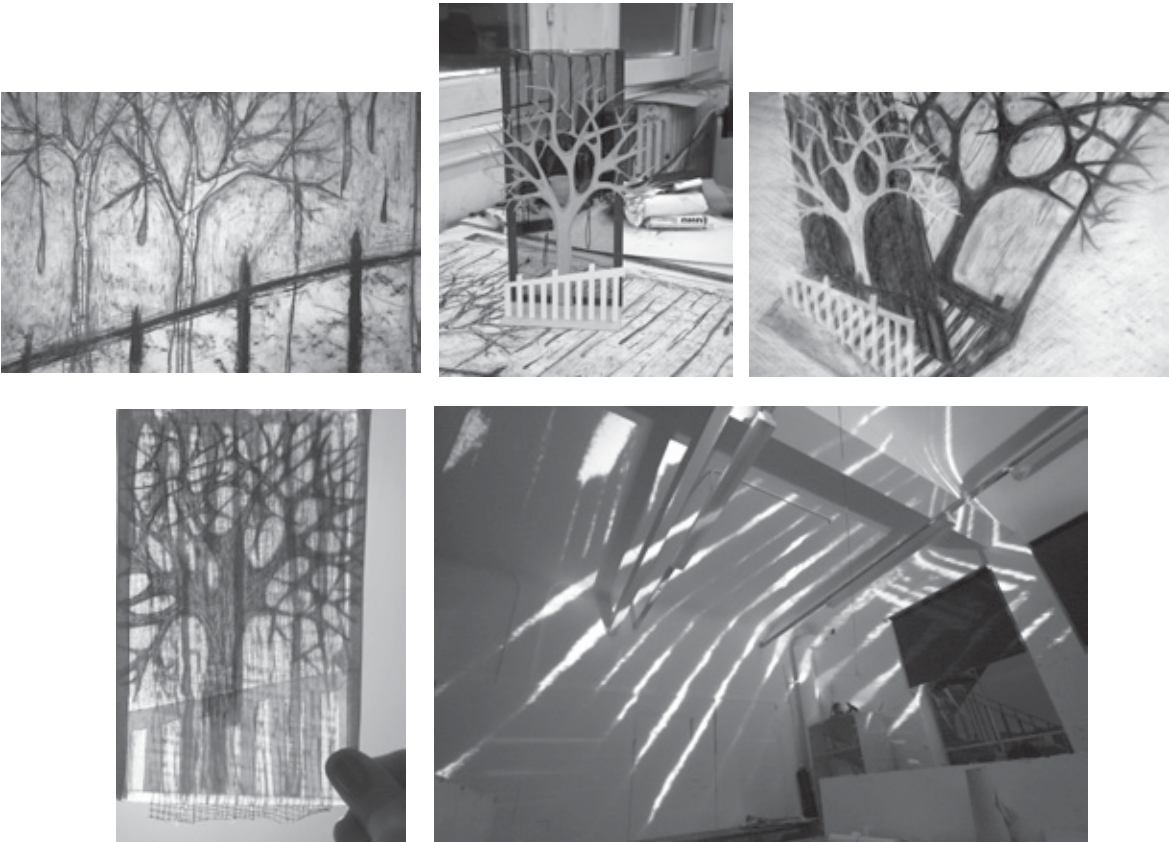
I will now discuss a pre-validation pilot project undertaken at Wimbledon College of Art on the foundation course Theatre Design pathway. This project allowed us to investigate pedagogical ideas and explore staff and students' responses to the units and project.

The Theatre Design Pathway chose Drawing with Light. This project took the students on a theatrical journey initiated by narrative and scenario. The project started with a lecture exploring how light and word has been used in history to emphasise dramatic content of subject or scenario. Listening to short passages of text, students responded with mark making and invented imagery to reflect the text. These were developed into 3 dimensional interpretations. The 3D sketches were then creatively lit, to produce dramatic shadows that were then drawn and photographed in order to create a theatrical visual narrative. Students explored experimental drawing with translucent mixed media, which then in turn allowed them to produce drawings with light and use larger architectural spaces. The project illustrated how the word and personal responses can be translated through drawing using light, scale, and media. Using these translucent drawings, the students were able to investigate larger, actual spaces and the dramatic theatrical potential of light and mark making.

MA Drawing at Wimbledon College of Art

As part of a key academic review, the development of an MA Drawing Course was initiated by Wimbledon College of Art during 2010, with a target start date of October 2011. At Wimbledon, we were clear that this new course should be a cross-disciplinary drawing course that would also develop research initiatives across the STEM (science, technology, engineering and mathematics) subjects.

In February of this year, and to signal the aims and rationale of the new MA Drawing Course, Wimbledon College of Art hosted an exhibition of drawing from across a range of disciplines. *Footprints Across Fresh Snow: drawing and mark making across disciplines* was selected by myself, Kelly Chorpening, Stephen Farthing, Trevor Hewett and Michael Pavelka and explored connections between practitioners and subjects through drawing. The drawings on show, made by practitioners from a range of disciplines, represented heart



surgery, forensic art, facial reconstruction, architecture, ceramics, dance and choreography, and performance. The work demonstrated that drawing is indeed “common property”, and that at its core drawing’s physicality, range and inventiveness make us alert to drawing’s democracy of communication.

The aims and distinctiveness of this new MA Drawing course signal its intent, and it was of critical importance that these aims built upon the University’s Level 3 qualifications I have just described. In linking these two levels of qualifications in terms of a drawing pedagogical philosophy, we are clearly aiming to build a sequential and integrated pathway of drawing education from school and further education, to Masters level and in time PhD level.

At the heart of the one year MA drawing course is *practice* and the *understanding of practice*. That is to say, drawing will define the students’ own work. As the handbook states, “The course promotes drawing for a purpose and cross-disciplinary dia-

logues. It focuses on process and ideas that centre on communicating ideas to an audience, client or user.”(Farthing, n.d., p. 6). The course provides a framework for each student to critically articulate a personal view or idea. Specific workshops on materials and technologies support the students’ investigation into defining a personal methodology.

The course handbook un-ambiguously states the course rationale from the start: “The course aims to bring together a range of disciplines where common territories can be explored through the use of drawing. These disciplines reflect the STEM subjects of science, engineering, mathematics and technology, and wider subject disciplines such as choreography and dance, architecture, archaeology, medicine, art & design may be included. This cross-disciplinary approach will encourage you to critically develop new methodologies and approaches to your drawing” (Farthing, n.d., p. 7).

A central plank of the construction and design

of the MA course was the idea to hold an annual seminar or course symposium at the beginning of the course, to define with the student group some key themes for the academic year. The themes articulated in the course handbook have a lineage to the Level 3 qualifications described earlier, and the aim of the seminar is for the students to select three themes that give a methodological or theoretical *umbrella* to their studies. The key themes are as follows:

- 3D space on 2D surface: plans, overlays, orthographic and axonometric projection.
- Diagrams, pictograms, flowcharts and mind maps.
- Cartography: Mapping places, things and ideas.
- Choreography: space and movement.
- Archaeological drawing and planning.
- Narrative Drawing: time based storytelling and storyboards.
- Drawing and writing.
- Developing ideas and solving problems.
- Communicating and convincing: selling ideas.
- Measurement: plotting spaces and objects.
- Working with Surface.
- Materiality.

The MA Drawing course is designed to be studied over 3 units. These units of study provide a project-based framework for the students to interrogate drawing and their own practice.

Unit 1: Orientation: This unit is designed to encourage the student to critically orient their practice. The core element of this unit is a series of student and staff led “high impact” workshops that introduce a range of approaches to materials and methodology, and to build upon prior skills and experience. Staff led workshops are from research faculty, college academics, and visiting practitioners from design, art, architecture or performance. Each student also leads a workshop that encourages them to illuminate their approach to drawing either through a focus on ideas and agendas or methodology. These workshops encourage risk taking and independent thinking. Furthermore, Unit 1 explores “the bigger picture of drawing” and the boundaries of practice. Therefore, specific taught sessions investigate the Key Themes and encourage students to interrogate their drawing skills and

contextual understanding. This unit provides a rich arena for making and practice while simultaneously supporting critical reflection.

Unit 2: Navigation: This unit encourages students to build upon the materials, media, and methodologies experienced in unit 1. Students are encouraged to challenge their ideas and begin to define new parameters for future practice. In short, and based on their experience and learning in unit 1, students are asked to re-orient their practice. Through risk taking, reflection and experimentation, they are asked to develop innovative methods and approaches to solving problems. Significantly, and we think uniquely, this unit calls for students to develop individual or collective collaborations either within the University of the Arts London, or with outside organisations or individuals, where each student seeks out cross-disciplinary partnerships. To date, Wimbledon College of Art has received agreement for collaborations with MA drawing students from the National Gallery London, The Laban Dance Centre and the structural engineering company, Alan Baxter & Associates. A 3,000-word critical paper supports the exploration of this intersection of disciplines, and lays out the agenda for continued personal research.

Unit 3: Presentation. Unit 3 gives critical space to the research proposal each student articulates during Unit 2; it gives definition to their collaborative work and strengthens their individual practice. During this unit, students may elect to continue with their collaborations or work individually. Either way, they are encouraged to extend their practice and define how they may take their practice forward beyond the course. Their critical knowledge is illuminated via a 5000-word definitive critical document. The final course exhibition or presentation is planned and curated by the student, acknowledging a range of audiences, and students will be encouraged to develop innovative approaches to presentation appropriate to their final outcomes.

Conclusion

When designing and writing courses, all any of us can do is provide a framework, or a structure predicated on a view or beliefs, that gives scope for the students’ imagination and investigation, and that provides a space for experiential learn-

ing. While Wimbledon College of Art was piloting some of the units of the level 3 qualification, I took the UAL Further Education Chief Examiner on a tour of the studios to see the work being produced. We got into conversation with one tutor and I was asking a lot of technical questions about the workability of the unit they were teaching, the aims and assessment criteria, as I wanted to know how it felt to teach the unit. The chief Examiner turned to the tutor and commented that they should not worry about my questions. His view was that what this all boiled down to is exciting teaching that motivates and inspires the students to become confident with drawing and enjoy drawing.

And he was right. The aim of good course design should be to promote and release good teaching. To support teachers in developing new teaching methods and new approaches, the University Awarding Body has been running Drawing Master Classes where teachers from schools and colleges are invited to one-day drawing workshops that explore project ideas. Furthermore, the annual Camera Lucida conferences, that Prof Stephen Farthing and I have been involved in setting up for the last two years, have provided teachers and lecturers from around the UK with a forum for debating issues and ideas around drawing pedagogy.

At Wimbledon College of Art we are currently working on a new academic plan that will put drawing, and cross-disciplinary approaches to drawing, at the very centre of what we do. With the possible creation of a central drawing lab, we plan to embed drawing in all our courses and stimulate cross course dialogues for our Theatre Design and Fine Art students where common or un-common territories can be explored. Building this laboratory further into our Post Graduate programmes, we want to expand our research into STEM drawing, thereby giving us a ladder of drawing experience from school to further education to post-graduate research.

By designing and developing the courses I have described in this lecture, we are seeking to build a framework of drawing education and drawing pedagogy that not only puts the purpose of drawing and its ability to cross disciplines and subjects at the centre of how we learn and communicate, but renegotiates the right of students to experience the pure joy of drawing.

What innovative teaching can give to students is an awareness of the relevancy of drawing to the

individual, and the confidence to use drawing as part of their everyday relationship with the world. What I really hope for is that the confidence to draw in whatever method is relevant to the individual student, not weighed down by believing that “good drawing” belongs to one particular group of practitioners, will ultimately allow our students to understand their past and construct their futures.

Simon Betts
October 2011

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Drawing Drawings

Michael G. Moore



During a lifetime, nearly everyone does some kind of drawing, even if it's no more than directions to a party, making shapes in the sand with a finger or a toe, or scribbling daydreams while listening to a panel discussion.

Drawings come from drawings, but they usually need to be about life, in some way, for anyone else to care.

Most of what I think I know, I know from having drawn. I often use drawing to verify the truth of things. If an object, idea, daydream, pattern, place, or experience can be drawn, it makes more sense to me, and can verify that I have experienced it. Drawing something into a drawing, draws it out of me.

The Haystack Mountain School of Crafts in Maine significantly influenced the way in which I think about drawing. Preparing to teach there for the first time, I felt obliged to think about drawing as a craft from which images could be formed.

I developed a preference for drawing toward, rather than from, phenomena. I saw that representational images could be made to emerge from a confluence of drawn lines, and that is what I have been working at ever since.

The Basic Principles of Drawing, from which to make all drawings – representational, figural, symbolic, personal, non-representational, abstract, decorative, schematic, diagrammatic, physical, perceptual, expressive, or any other – begin with, and from within, the dot. The liveliness of a line is its primary reason for being, so a bundle of lines in action have their own story to tell in advance of whatever else they appear to be. Intensity of feeling

can be realized through intensity of form. Actions precede observation, observation precedes reflection, and reflection stimulates imagination, interpretation, and meaning.

The drawings I prefer reveal some evidence of graphic life, regardless of the objects from which they were drawn. The appearance of life in the lines, however subtle, provides those drawings with a feeling of more than the sum of the parts, similar to how we feel about ourselves, as being more than the sum of our parts. We originate and end in perfection, and are also embodied beings, so I like drawings about embodiment too.

My drawings begin as drawings about drawing, using traditional techniques with pen and ink on paper. The lines can stand up straight, lie down flat, circle around, scribble around, wiggle and jump, scrunch up, be rough or gentle, be thick or thin, and have any variety of relationships with other lines. Each line is an idea in itself, with a beginning, middle, and an end – just like us.

I want my lines to reveal the rhythms, gestures, pressures, speed, and life of the hand that made them, as if drawn by nature, if nature drew.

The basic techniques are mixed, mingled, and juxtaposed in an effort to make a drawing that appears to represent some aspect of the physical world. Each drawing is made from the inside out, leaving a trail for others to follow from the outside in.

A line implies the coming together of two planes, or any two things, or events, so every line is already charged with implication. We may not see

the parts, but we can see their relationship within the line they share. The middle of one thing is often the edge of something else. Even spaces between lines show time, and that time becomes part of the drawing itself.

Like a single line, an entire drawing can show where it began, where it went, and how it ended, from the beginning to the middle to the end, through the past, present, and future.

An accumulation of lines may embody many unnamed things of graphic origin. In spite of the fact that the whole of anything is always part of something else, I try to make my drawings feel whole enough that they can become a credible fiction embodied within the fact of form.

The whole of anything is always a part of something else, so a part of anything is the only whole we have. We begin with a dot, and go from there. From dot to line to circle to sphere, with all of the shapes therein, we can turn pen and ink into anything we care to see. From dot to dots, to lines, to patterns, to shapes, to the semblance of forms, to representations, and references, we create simplicity through complexity, cumulative, rather than additive.

When we draw, we teach, and when we study a drawing, we learn. If we take the time to study our own drawings, we learn even more. I do believe that the best way to learn to draw is by intentionally drawing to learn.

Sometimes I think it would be nice to draw my final breath, but I have a lot more to learn before I try doing that.

Michael Moore



Most of what I think I know, I know from having drawn. If an object, idea, dream, pattern, place, fear, hate, love, fact or force of nature can be drawn, it makes more sense to me. Drawing can verify experience. My kind of drawing begins within the body – the kinesthetic self, from the inside out, combining what I see with what I know. Because a line can be itself and something else as well, the character of line and life are similar to me. Each drawing is made from the inside out, leaving a trail for others to follow from the outside in. Drawn lines show time. Even intervals, or spaces, between lines show time. I want my lines to reveal the rhythms, gestures, pressures, speed, and life of the hand that made them.

Top:
Crevasse, 25" x 26"

Bottom:
Round Stone, 28" x 25"

Philosophical Dimensions of Drawing Instruction

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At the same time that we were preparing to host the *Thinking Through Drawing Symposium*, Occupy Wall Street was making news each day, spreading beyond New York to become a nationwide movement. In response, the Arts and Humanities faculty at

Teachers College was asked to consider the following question at their monthly faculty meeting: “What is the relationship between Occupy Wall Street and No Child Left Behind?” Having just attended this meeting, a related question came to mind as I planned my presentation: “What is the relationship between Occupy Wall Street and Thinking through Drawing?” My answer, inspired by a bumper sticker I once saw, was that both were out to “subvert the dominant paradigm!” In the case of Wall Street and NCLB, the dominant paradigm was fiscal and educational policy imposed from the top down, disempowering, on the one hand, the 99%, and on the other, teachers and students. By contrast, Occupy was grassroots democracy supporting populist economics, and, by extension, education from the classroom up.

Applied to the Symposium, the dominant paradigm being subverted is the belief that drawing has nothing to do with thinking, and that, indeed, one necessarily impedes the other. This attitude is associated with the Modernist view that art is more a matter of feeling than thought, but actually goes

much further back. Initially, it comes up in Plato’s *Republic* (Cornford, 1941) where he rejects representational art on the grounds that realistic imagery excites the senses, thereby trapping the mind in the ever-changing world of appearance and distracting the intellect from its higher task of seeking ultimate Truth found in the unchanging, immaterial realm of the Forms.

More recently, Betty Edwards, in *Drawing on the Right Side of the Brain* (1989), suggested just the opposite. Based on recent neurobiological research, she claims people can’t draw what they see because the “left brained” intellect interferes with “right brained” observations by imposing predetermined schema over what comes in through the eyes. This Symposium, by its very title, *Thinking Through Drawing*, argues against all such assumptions. Instead, it identifies drawing both as a domain of thoughtful engagement within the visual arts, and as an aid to thinking across disciplines, including “left-brained” arenas like mathematics and medicine.

Supporting this position, conference presenters opposed any reduction of drawing to an anti-intellectual task, “right-brained” or otherwise. Instead, they drew upon their own evidence from cognitive science, psychology, and neurobiology, as well as practical experience in art and education, to offer a more comprehensive image both of drawing and thinking, in which they combine to engage the brain as a whole, along with the associated affective and physical functions. My presentation takes the argument into Plato’s camp by considering the philosophical underpinnings of different approaches

to drawing instruction. As I argue, major methods of teaching drawing embody principles associated with prominent epistemological traditions and may thereby be identified as ways of coming to know the world and the self.

Grounding drawing instruction in philosophy is not only a matter of theoretical interest. It serves a number of practical purposes. First, associating drawing instruction with the various philosophies helps provide reasons for teaching drawing in one way or another. Second, such associations allow teachers to relate drawing instruction to other fields of endeavor like mathematics, science, and literature, thus helping students “transfer” knowledge and skills back and forth between disciplines. Third, beyond the classroom, competent drawers can then use their knowledge of continuities across domains to apply drawing in various occupations within and beyond the visual arts.

This ability, to think through drawing across the disciplines, was famously exemplified in the notebooks of Leonardo da Vinci. Yet such skills were not unique to Leonardo and other acknowledged Renaissance geniuses. Rather they were emblematic of an educational and cultural climate in which drawing was considered of universal value and general utility, and so was widely taught to individuals at all levels of society, ranging from artisans to the nobility. Similar attitudes were found earlier, in Greece during Plato’s time, and later, in America from its founding through the Industrial Revolution and up until the middle of the 20th century (Simmons, 1988).

Based on my dissertation and subsequent research, I argue here that drawing undoubtedly contributed to the world-changing, cross-disciplinary creativity that characterized each of these eras. But it wasn’t always the same kind of drawing and it wasn’t taught in the same way. On the contrary, my research showed that drawing instruction and practice varied significantly in response to the dominant *zeitgeist*, thereby reflecting the predominant philosophy at the time as well as connecting to the most prominent fields of endeavor.

The most explicit example of drawing practice that reflected a philosophical world-view and its related paradigmatic discipline was the so-called “academic” methods, especially as practiced in the French Royal Academy. Modeled after practices used in the Renaissance art academies, which were essentially drawing schools, academic drawing

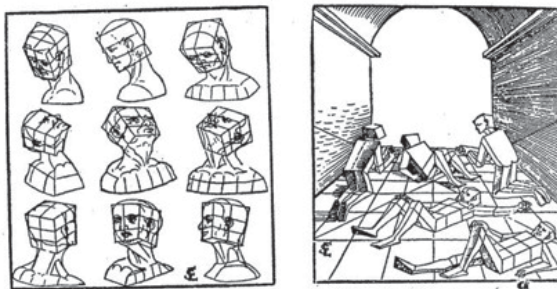


Figure 1. Erhard Schön, Schematic Heads and Bodies, (1538), *Underweisung der Proporzion und Stellung der Possen* (Nuremberg), Printed in E. H. Gombrich (1960) *Art and Illusion*. Princeton: Princeton University Press.

instruction in France was specifically linked to the Rationalist philosophy of René Descartes, thus linking drawing with mathematics and logic (Pevsner, 1973).

Rationalist aesthetics dictated that models were taken from classical and Renaissance art works, which idealized the human form according to pre-determined principles of proportion. Rationalist logic and mathematics were also evident in the way drawing was taught: as largely an analytical process by which complex organic structures were reduced to simple geometric solids—spheres, ovoid shapes, cubes and cones (Fig. 1). Perspective was also essential training, as was mathematically-determined principles of composition. Even facial expressions and bodily gestures were logically categorized even though their application was meant to serve expressive purposes.

Instruction in such programs was, of course, equally organized in a logical manner following a step-by-step curriculum, which began with simple problems and moved on to those of increasing complexity. Mathematics and philosophy were taught as complements to drawing instruction. And, just as in mathematics, there *were* correct and incorrect answers to drawing problems. Success was determined by adherence to the rules and in the resultant works’ similarity to exemplary models, not by inventiveness, at least not until mastery was achieved.

For better or worse, methods pioneered in the academies are still being taught at all levels, though generally without reference to their philosophical underpinnings. Perhaps ironically, they are most evident in simplistic “how to draw books,” where drawing everything, from dogs to dragons, from

comic caricatures to realistic figure drawing, begins as simple shapes or forms, advancing from the general to the specific in a logical, step-wise fashion. The same approach is used for teaching elementary-age children, for example, in Mona Brooks' *Drawing with Children* (1986). At a much more sophisticated level, the academic method is taught in art academies and design schools around the world, including in China where, under the Communist regime and its promotion of socialist-realism, artists are trained much as they were in the west several hundred years earlier.

Politics aside, the approach is particularly useful for training future architects, designers, and illustrators because it allows them to draw convincingly from observation and imagination. A comprehensive contemporary version of this approach taught at the School of Design in Basel, Switzerland is documented in Manfred Maier's *The Basic Principles of Design* (1977).

Although the academic method does facilitate drawing from observation, its compulsion to idealize what is seen, combined with its singular standard of right and wrong, good and bad, stands in stark opposition to more contemporary concerns for both realism and expressive/creative art. Reacting to these constraints, art instructional methods have since been developed to support drawing from observation in more direct and more individualized manners. Though rarely explicated, these methods, too, echo prominent philosophical attitudes from

the era in which they first emerged.

The most direct challenge to both rationalist philosophy and the academic approach to teaching came from Empiricism. Whereas rationalism assumed we enter the world intellectually equipped with ideal forms to be accessed by unaided reason, empiricists like John Locke viewed the infant mind as a "blank slate" to be written upon by sensory impressions. This theory was initially applied to drawing by the renowned art and social critic, John Ruskin, as described in his 1857 book, *The Elements of Drawing* (1904). Like Edwards, Ruskin used drawing as a means to train visual perception freed from the imposition of pre-determined schema. He called this approach "seeing with the innocent eye," which meant learning how to observe and draw with absolute accuracy, coordinating hand to eye. Toward that end, one of Ruskin's basic exercises had students draw the interstices between the branches of a tree (Figure 2). Whereas the branches themselves could easily be schematized based on a generic idea, rather than rendered based on observation, the "negative spaces" or background between them must be viewed objectively, as shapes with particular configurations.

Beyond facilitating representational drawing, Ruskin ascribed to seeing general educational importance, including moral and even spiritual value. On the moral plane, truly seeing another person enabled the perceiver to enter into a profound sympathetic relationship with his or her subject. On the spiritual plane, Ruskin felt that "truthful observation allows the pleasure of the eye to lead to the truth of God." He went on to say that (1904), "The greatest thing a human soul ever does in this world is to *see* something, and to tell what it *saw* in a plain way. Hundreds of people can talk for one who can think, but thousands think for one who can see. To see clearly is poetry, prophecy and religion, all in one."

Like the analytic approach favored by the academics, drawing from direct and unaided observation continues to be widely taught, especially as formulated in the book by Betty Edwards mentioned earlier. Like Ruskin, Edwards ascribes significance to observational drawing beyond its role in representational art. In this case, drawing activates hitherto under-valued functions of the brain's right hemisphere, including visual/spatial functions necessary to draw what is seen, as well as non-linear thinking and intuition associated with creativity. These are contrasted to supposedly left-brained



Fig. 4.

Figure 2. John Ruskin, *Elements of Drawing*. Interstices,

functions like logic, mathematics, and language skills typically taught in schools.

Because Edwards believes that such functions impede observational drawing, her initial exercises are designed to get the left-brain to shut up and let the right brain do its job. One such exercise involves copying a Picasso drawing of the composer Igor Stravinsky upside down! A similar exercise has students draw the outline of the object without looking at their paper.

Whether such methods are justified on the basis of contemporary neurobiology, or Romantic notions like seeing with “the innocent eye”, the goal of these drawing activities—accurate observation and representation—is more closely aligned with the objectivity of science than the subjectivity usually associated with art. In fact, through the 19th century, representational drawing was a fundamental tool used in natural science to document flora, fauna, geography, etc.

In the 20th century, another approach to drawing emerged which also was associated with scientific methods and principles. This time, it was experimental, as opposed to natural science, and the epistemological paradigm was pragmatism. Where empiricists acquired knowledge primarily through observations and induction, pragmatism as defined by C.S. Peirce, William James, and John Dewey, pictures knowledge as the result of experimentation. The most articulate spokesman of the approach in terms of drawing was Kimon Nicolaides, in his classic text on figure drawing, *The Natural Way to Draw* (1941).

According to Nicolaides, drawing the “natural way” requires more than just seeing. Rather, it involves “physical contact with all sorts of objects through all the senses,” including especially tactile and kinesthetic sensibilities. The difference is significant in theory and practice. As an example, Nicolaides, like Edwards, has students draw the edges of objects without looking at their papers. Moreover, both authors prepare students by engaging their imaginations as they study what they are about to draw. However, Edwards is concerned that students see, not the three-dimensional forms before them, but their more easily replicable two-dimensional shapes and, following Ruskin, the “negative” spaces around and between them. Therefore, she asks students first to envision their subject as if it was made up from pieces of a child’s jigsaw puzzle where each edge circumscribes a particular object: tree, sky,



Figure 3. Kimon Nicolaides, *The Natural Way to Draw*. Gesture drawing.

cloud, house, etc.

By contrast, Nicolaides thinks the purpose of contour drawing is to wed sight with touch. So, he directs students to imagine their pencil is actually touching the edge of the model’s three-dimensional form, and to reflect this imagined tactile sensation as they draw. This exercise reflects the pragmatists’ view that perceiving, and learning, was a matter, not of passive input of sensory data as the empiricist would have it, but rather of active *and* reflective engagement.

The pragmatist’s paradigm of knowledge acqui-

sition was thus the scientific method. It begins with a question or problem to be solved. This is followed by gathering data, sensory and otherwise. Reflection on this data then leads to formulating a hypothesis about a possible solution that is then tested through experimentation, leading to further observations and reflection, then, possibly, additional experiments. John Dewey (1910) explained the process more simply as a matter of trying something out and undergoing the consequences, which he claimed was the way creative people thought and worked, whether in science or art (1934).

The best example of doing and undergoing in Nicolaidis' book is the ever-popular gesture drawing (Figure 3). The exercise begins with a quick sketch to capture in a few lines the action or energy of the model's pose. This initial "hypothesis" is then continuously checked and corrected, based in part on seeing and measuring, but more on empathetic identification with the model's position and mood.

Compared with both the analytic and observational methods, Nicolaidis supports more individualized approaches, encouraging expression and experimentation. Still, he focuses on representational drawing of the human figure. There is no room here for non-objective imagery. This, however, is allowed for by a fourth approach to drawing instruction, which, incidentally, is also aligned with pragmatism, this time in its focus on semiotics as defined by C. S. Peirce (Short, 2007). Here the simple formula is that "marks have meanings," whether or not they are intended to represent some concrete substance.

Drawing, so conceived, is a symbol system, and as such, could be compared to other notational symbol systems such as written language, mathematics, and musical notation. Indeed, drawing is arguably more sophisticated than these three, because they are largely a matter of conventional signs, while drawing involves conventional vocabularies as well as completely invented ones, and everything in between. Moreover, drawings can signify, in Peirce's terms, in multiple ways: as icons (resemblances), indexes (indicators), and symbols (conventional interpretants), even functioning sometimes in all three ways at once!

Reflecting the Bauhaus principle that "less is more," Paul Klee's *Pedagogical Sketchbook* (Figure 4) sketches out how even minimalist abstract drawings (like his own) can communicate meanings of various kinds. A comprehensive approach



Figure 4. Paul Klee: *Pedagogical Sketchbook*

to drawing instruction, based on similar principles, was developed by another Bauhaus artist/teacher, Josef Albers. Albers' method (1969, Horowitz and Danilowitz, 2009) bridges the gap between abstract and representational imagery by beginning with the most simple elements, dots, marks, lines, shapes. These are initially explored as skill-building tasks, then explored as design problems, and finally applied to drawing from natural and man-made objects, the figure, as well as landscapes.

Although he did not specifically site semiotics, Albers situated his approach in the context of symbol systems by referring to drawing as a "graphic idiom." And, indeed, many of his exercises involved the representation of letters and words. Among the first exercises of the course, students learned to "draw" their signature, normally, backwards, upside down, and upside and backwards. Other exercises involved drawing/designing letter forms and projecting these onto three-dimensional forms. Toward the end of the course, students did "typofacture" drawings—depictions of newspaper pages using marks that resembled the particular newspaper's typeface in ways that looked realistic but involved no actual text.

Just as the philosophical foundations underlying the three previous instructional methods could serve to align drawing with mathematics, natural science, and experimental science respectively, Albers' semiotic approach connects drawing with written language. There is a logical connection here, because, as Tversky (2009) indicated, visual communication, of which drawing is central, "not only preceded written language but served as the basis for it." Continuities between written and graphic language, to name but a few, include graphic novels and illustration, graphic design and typography, as well as schematics and diagrams that complement even philosophical discourse. Examples include

Peirce's own existential graphs (Sowa, 2010).

In an earlier paper (1992), I thought of the semiotic approach merely as one among the other philosophical foundations of drawing instruction. Having now delved more deeply into the subject, particularly the formulation by Peirce, it seems more fitting to view semeiotics (Peirce's spelling) as an over-arching construct within which all other methods may be situated and categorized. Doing so is admittedly a daunting task, but one that promises to be worthwhile for various reasons and for various audiences. Art educators in pre-K-12 programs may apply semiotics to help them plan curricula that link drawing to other subject areas. Applied to drawing courses in higher education, semiotics may provide a conceptual framework and vocabulary with which students could learn to "read" their own and other people's drawings more accurately and sensitively, while helping teachers evaluate these drawings more reasonably and objectively (Note this issue in Fava, 2010)

For those outside the visual arts, semiotics may help explain how drawing engages thinking of various kinds, as applicable to various domains. This in turn may help support a claim that drawing, framed as "graphicacy" (Norman and Seery, 2011), should stand as an equal alongside literacy and numeracy as common "languages" of creation, communication, and learning across subject areas and over a life-span.

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What we Illustrate when we Draw: Normative Visual Processing in Beginner Drawings, and the Capacity to Observe Detail



Tara Geer

The question is not what you look at, but what you see. — Henry David Thoreau

As a drawing teacher

If you ask a room of a hundred people to draw 3 pears, you get 300 different pears. The first, say, 10 years I taught art I was overwhelmed by the uniqueness of all those drawings. After 20 years of teaching drawing, I started seeing patterns. It was the commonality of particular stumbling points that I noticed first.



Figure 1.

How beginners draw

Drawings are illustrations of what someone's brain has done with their world—the path from object to brain to hand. When people first come to a drawing class, without having spent time drawing, they tend to draw according to a reliable agenda, a set of heuristics.

These illustrations of tables come from the first day of my *Basic Drawing* class at *Columbia University* last Spring. Before any teaching happened I asked them to draw a table. About half will draw the tables in the room like the top two, and half draw a table from their mind, like the bottom two. These initial drawings are notable in that they tend to rely predominantly on edgelines, specifically the outside defining contour of the object. Even if that student feels insecure about where exactly those are—as on the top right—they are still using edge lines to define their table. Usually the identity or category of the drawn object is very clear—anyone could look at it and say immediately what it was. Decorations, details or elaborations tend to be secondary. (You can see the individualistic details here—the zig-zag and dot decoration on the round table, the slanted line, the little nails—are confined to the thinnest surface edges. In an art class, new students will vary elements as far as possible while still retaining recognizability, continuous edges and boundary clarity.) People just starting in tend to draw a continuous and closed bounded edge. The line itself is very even. Even if the internal space of that thing is not so clear—it looks flat, or awkward—their edges are quite clear. The drawings look like illustrations of Gestalt closure and good continuity: each object closed with an outline; proximate information not relevant to categorical definition is left out.

Drawing multiple objects

In first attempting your average still-life—each object still tends to be considered separately, and

defined precisely: Each thing conveys clear information about what it is. These are known recognizable objects, things we can all categorize easily and efficiently. They share as many aspects as possible with Eleanor Rosch's basic level prototypes (Rosch et. al., 1976)—a person will be drawn with two legs even if only one can be seen, teddy bears have two symmetrical rounded ears, no matter how battered and asymmetrical they actually are, and hands have five distinct fingers, no matter how folded up... The differences of *conceptually* distinct objects are intensified—say a cup and vase side by side of the same color, in the same lighting will be drawn, *and seen*, as lit differently. Boundaries between objects are also drawn even if they are not visible. In *Eye and Brain*, Richard Gregory writes, “the visual separations of objects are not given simply by borders of light on the retinas. Separation into objects is given by various rules, and by knowledge. Sharp borders are rather rare, except for line drawings, which are not typical.” (Gregory, 1997, p. 6) The categorical perception first illustrated in voice onset studies, seems present in the way novice adult drawers draw inside and between linguistically defined shapes: if they draw a shadow, they outline it, distinguish it from its neighbors and fill it in evenly dark throughout, something rarely apparent. The teddy bear's fur will be described by an unvarying pattern of mark from edge to edge, though textures appear and disappear with swells and in changes of light: non-drawers draw things categorical, logical, not random. They have difficulty seeing visual continuity between objects that they have separately defined: So though there may be no visible change in the shadow on the peach as it spreads over the table, we see peach *and* table. It is a monumental

step in drawing to be able to see the peach-table shadow as *one* thing. Novice drawers' images are cognitively economical, and privilege categorical information over visible. (The same tactics and line, can also be seen in the work of experienced drawers when they *first* sit down, or if they haven't done it in a while. And cartoon artists exploit an even line, clarity and recognizability brilliantly—think of Mickey Mouse, Charlie Brown, Spiderman—but with an idiosyncratic taste for specific details, and an overall control of composition not common in beginner drawings.) A non-drawer comes to a drawing class using vision the way they need to to function in the world, and this is illustrated in their drawings.

Normative visual clarification

I think that the way that untrained drawers draw probably reveals much more about mental representations (however one wants to describe them), or higher level visual processing, than their ability to observe raw data. In most peoples' drawings, a street of buildings is drawn with perfect squares, rather than sides that recede back in a squished shape; a circular wine bottle mouth is drawn with a circle rather than an ellipse. Often a beginner cannot see the discrepancies in their own representations of the external visible world—this was where I first noticed a pattern. They judge that it's “not good,” or “not right,” and they get irritated with their own drawing. I can point out the difference between what they drew and what is in front of them, but at first this is very, very hard to see, not quite believed, dismissed, and then though they might see it in an instance, for a while it does not transfer to other similar instances. Perhaps it's some kind of cognitive dissonance. I guess

because they are drawing what they perceive with their minds' eyes, it is difficult to see what lies out there. Perhaps this is an attentional bottleneck, or like superimposed images on a film, or the duck-rabbit, or other “ambiguous” images, we can only see one interpretation at a time. Or perhaps the magnificent capacity of the brain that allows for object and color constancy and

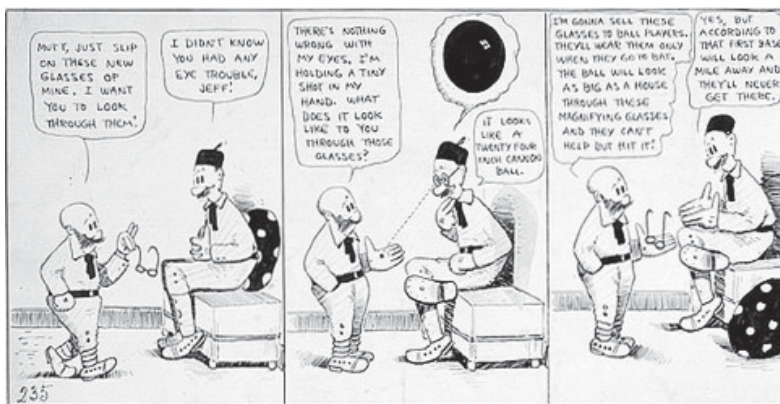


Figure 2.

viewer-independent viewpoints etc. is still at work, turning the specific visible into an internal template example. If our drawings are true, most of us cannot entirely see what is viewer specific, and one surprise to me is not that we are capable of perceiving constancy among such variable things, but that sometimes we cannot consciously see the particular details in front of us even as we are looking at them. As neural impulses move upstream through the visual processing network, cell responses become increasingly specific with respect to stimulus (orientation, edge, discontinuity, specific spectral composition, etc.) and more general with respect to viewing conditions. As Martha Farah describes it in *The Cognitive Neuroscience of Vision*, “in the broadest terms the goal of vision is to take the array of light that hits the retina and derive a representation of the things that give rise to it.” (Farah, 2000, p. 27) We think of vision as observation—and accurate observation at that, but in these drawings our vision appears to privilege shortcuts to categorization over the absorption of the specifics of what lies out there. Our eyes seem to be observing—preferring—the categories in our minds, the internal models, “the things” more closely than the outside world, or visible variable specifics. The details of the outside world serve rather like triggers to an internal visual identification than parts of external and possibly unknown wholes. These drawings seem to illustrate Semir Zeki’s point, “it is not as if perception leads to abstractions and concepts but the other way round: we form our percepts from abstractions” (Zeki, 2009, p.21). We make our drawings of abstractions as well. Selective observation, object distinction and clarification, the over-dependence on line are default forms of describing the world that I think of as a kind of documentation of higher lever visual processing. Because so much of what is seen by novice drawers is not exactly visually specific, it is tempting to imagine we start out drawing relying on something more like our inferotemporal cortex, and less like how we popularly imagine the eye. It looks like novices are illustrating images literally corralled and defined and edited by concepts, or abstractions—linguistic or visual or procedural I don’t know—and we all are looking down at them as if they were merely untrained drawings. I would argue that they are highly trained drawings, just not trained in the observation of external visual detail.

NORMATIVE VISUAL CLARIFICATION

- Even, consistent, usually complete bounded edge lines
 - Reliance on line as a descriptive strategy
 - Presents objects that are known and recognizable—that can be identified and categorized—unclearly meaningful information is secondary.
-

Lines

I should step back a moment to say that drawing is a completely outlandish activity. There are lines out there in the world but not nearly as many as we are capable of seeing, and not nearly as many as needed to make a drawing. Most “lines” are the meeting of two differently lit areas, or the meeting of areas with different textures or differing Gibsonian gradients, (Gibson, 1974) or the known edges of an object as opposed to the visible edges. It should be completely odd that we are so adept at seeing all the myriad visual changes around us as lines. Out there visible, I would say there is mostly lumps and texture. Turning the world into lines seems perfectly normal to us, but why? Why are we able to almost instantaneously see in lines whole worlds? In *The Dioptrics*, one of the first modern scientific analyses of human vision, written almost 400 years ago, René Descartes points out this odd mismatch between what we *see in* illustrations and what they are composed of. “Engravings which consist merely of a little ink spread over paper, represent to us forests, towns, men and even battles and tempests. And yet, out of an unlimited number of different qualities that they [use to] lead us to conceive the objects, there is not one in respect of which they actually resemble [the objects] except shape. Even this is a very imperfect resemblance” (Descartes, 1637/1954, p. 245). It may be that the center-surround organization of receptive fields, and the widening spread of these fields, biasing V1 and up towards edges, makes lines particularly legible to us. Before an image has left the eye it is laundered of absolute illumination, and replaced by an initially retinotopic map of differences, passed on to higher levels and amplified in various ways but it may be that those (electrically described) differences are best translated by or from line. Often I find it difficult to convey the oddity of what it is people are

doing when they make these clear, bounded, known things because it makes for images that are *so recognizable, so obvious, so processable* to us that it is hard to understand what they could possibly not be doing—or perhaps even to *see* them because they are digested so fast: They do everything normally we need an image to do.

Our visual confidence

We feel our vision is continuous, consistent, observant, reliable but the evidence for this is not convincing. In general, we use visual information in very economical, adaptable and abstract forms: categorizing an oversized beanbag as a chair, seeing expressive faces in emoticons, people in stick figures, the person we are talking to as unchanged (even if they have been substituted as we are speaking). An actual detail is held in focal attention so incredibly briefly, before it's triggered mental context is called in, and seen in that place. We add in our extrapolations, memories, knowledge and forecasts: seeing a dog behind a fence, a fight in a flicker of a spouse's eyebrow, a remembered barn if it's hinted at, or a perpetrator in a line-up, and we stick with what we've assumed—rabbit or duck. “Eyewitness” testimony, blindsight, phi illusions, identification of skin color, among other things should open big cracks in our confidence about our vision, but we are not much bothered. We edit or fudge a lot of the details: we aren't aware of our two blindspots; signals from the eyes seem to be inhibited during rapid saccades or movement—our world does not lurch or blur like a handheld camera would—doing what we do; when I get a migraine blind-spot, my mind fills it in with surroundings, and salt shakers can disappear into it, and then pop back out as I turn my head. Only seeing detail through the fovea, the world should look as if viewed through the circle of pointer and thumb at arm's length, the rest of the field functionally blind, and without much color. But this is *not at all* how the world looks to us: *we are filling it in somehow really quite a lot and all the time*. With fast moving objects—say a pitched baseball—we think we see that which is not physically possible to consciously see. “A fastball will travel about 9 feet before your retina transmits and your brain processes the initial notification of the ball leaving the pitcher's hand” (Burton, 2008). But we say “keep your eye on the ball,” and trust in some kind of simplified, forecasting system to recognize objects. This “vision” seems half baggage,

half clarification, half imagination, and rather minimal immediate local observation. In a world where we have to quickly interpret massive amounts of changing visual information this kind of clear sighted object identification seen in the drawings above is a very, very useful habit—probably a skill on which our survival has depended, and most of us, when we sit down to *Basic Drawing*, are using it.

Detail-access vision

But to *draw*, we have to take that absolutely essential way of processing information, and lay it aside. If there is such a thing, we have to just *see*, as we would feel air coming in from a window, or the heat from a cup of tea—as something precious that will alter in an instant, overflowing with richness and information beyond our ability to comprehend.

To draw what lies in front of us, it is helpful to see—almost really to feel—the vast ocean of detail that is out there. Though it may not help us navigate, or plan, or identify quickly, or do anything obviously useful or essential to survival, seeing lots of actual detail is very helpful in drawing. (It may not be necessary for drawing—there are lots of strategies and ways to draw—but I haven't found my way around it.) In the drawings of very experienced artists—Rembrandt, Raphael, Giacometti, Basquiat, Leonardo, Michaelangelo, Seraut, Van Dyck, Parmigianino, Ingres, Degas, Durer, Schiele, Hokusai, Kuo Hsi, Sun Long, Wu Chen, Li T'ang, etc.—the edges are not the only nor the most important lines. To describe seen changes, line *per se*, is not the overwhelming strategy. Of course most everything drawn on a page is line, but experienced drawers' lines tangle up, drift off, become textures, shadows, blobs, shapes, and patterns. Their lines do not stick to edges nor bind linguistically defined “things”—there is no necessary contour around head and shoulders, no neat oval of mouth—where the edges of a lip would be a shadow creeps down into a beard. Lines are uneven, twist, modulate, flake into divets and dots, and scratches and fields. The drawn lines are very sensitive to minuscule changes, rather than describing broadly. Experienced drawers also use the emptiness of the page—look at Rembrandt's nose and neck. They organize the whole space of the page: using inter-locking shapes, negative spaces, overall composition, design, the balance or relationships of texture, color, light and shadow. You can also see emotion, atmosphere, and point of view. These artists focus in on certain particulars that

interest them, and compose around that. The meanings, the “things,” in these drawings tend to be more ambiguous. Even known objects tend to seem more specific rather than iconic; a man is seen in the particulars of a moment, certain lighting, a feeling, a viewpoint, a conundrum, a task, an intimacy. In the 5th century, Wang Wei explained that painters must go beyond line, “The ancients did not make their paintings simply as records... to mark out the limits of towns, villages and watercourses. The [paintings] had their origin in forms, but these were made to blend with the spirit and to excite the heart. If the spirit had no perception of them, they exercise no influence; the eyes can only see the limits, but not the whole thing.” (Wei, 845)

DETAIL-ACCESS VISION:

- Edges are not the only, nor the most important lines
- Lines are multi-purpose and modulate, even disappear
- The meaning tends to be more ambiguous
- The objects are usually not bounded by linguistically or conceptually defined borders
- There are relationships of shapes and organization of space, including the emptiness
- Even known objects tend to be more spe-

cific rather than iconic, seen in the particulars of the moment, the lighting, a feeling, a viewpoint, specific irregularities

Associative Agnostics drawings

Another way of considering detail-access vision is through the drawings of associative agnostics. Associative agnosia is the rare loss or diminution of the ability to recognize familiar objects or stimuli usually as a result of brain damage. People with associative agnosia fail in assigning meaning to an object that they can see clearly. Most have injury to the occipital and temporal lobes. The clinical “definition” of the disorder is when an affected person is able to copy or draw things that they cannot recognize. What seems extraordinary is how capable they are at seeing detail, and how their drawings share qualities with those of experienced drawers –particularly a very sensitive line: If they are copying a tea bag, and the string bends twice, than theirs will too, whereas most people will think, this is a string, I’ll convey that with a quick line the bends are unimportant. When copying a shining ring, they copy the exact number of shine lines, which a normal person would never think of (see the images in Farah, Visual Agnosia.) Someone with associative agnosia is not able to name or recall objects –has no access to the identifying so clear in normative drawings—but they do seemingly have unusual access

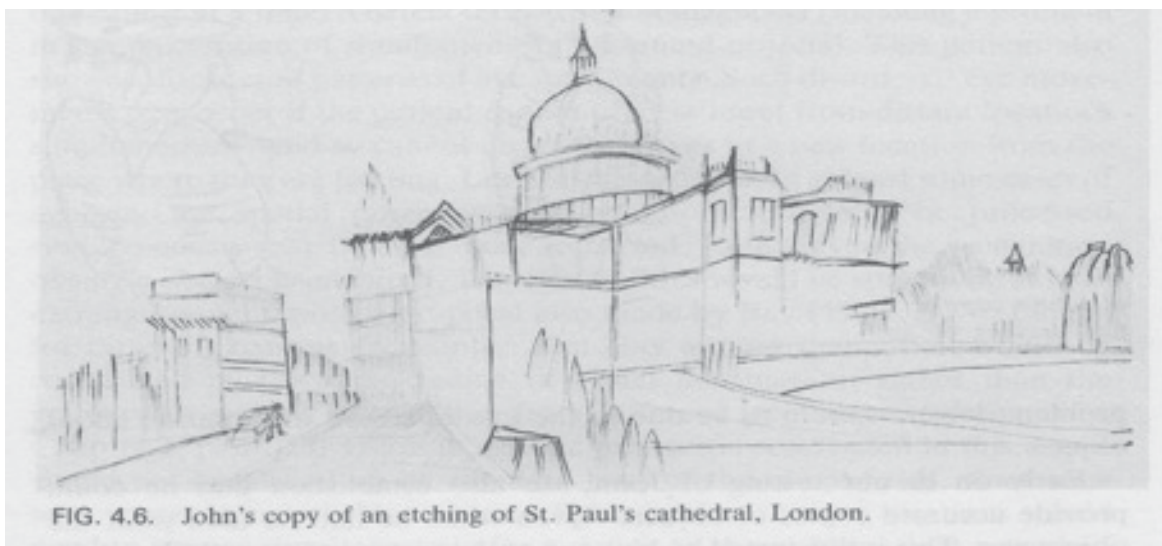


Figure 3. With permission from G.W. Humphreys and M. J. Riddoch, *To See But Not To See: A Case Study of Visual Agnosia* (London and Hillsdale, NJ, Lawrence Erlbaum associates, 1987) p.70

to observed detail. When asked to draw objects from memory, they can come up with odd, skeletal, maybe schematically reminiscent shapes. The fact that access to visual detail increases when the ability to name is lost, suggests that our ability to categorize may actually inhibit our ability to observe.

Normative vision, and a functional inferotemporal cortex (IT), somehow seem to get in the way of drawing the specifics of what is there in front of you. In most of my classes I spend my time nudging my students from their normative vision to their detail-access vision—trying to spark them to do the kind of observation we assume we are doing all the time. I tell them to draw less what they think and more what they see—less with their IT and more with their—I don't know—"array of light that hits the retina"? Right hemisphere? Sense of touch? Oddly, I don't think drawing teaches people to observe so much as it gives them practice in what observation actually is. I don't have the feeling I am teaching something they do not know how to do exactly, but something they are not used to accessing—perhaps a capacity inhibited by our normative processing needs. Often when the students finally "see" what I'm talking about there is a sudden, dramatic jump in the drawings. Their performance isn't a gradual shift in tendency but jumps back and forth between ways of seeing until they are comfortable enough slipping into their own ability to access detail. (I don't think it was not that they *could* see it, but did not have the technical ability to draw what they saw—the most common explanation for a "bad" drawing—because technical ability doesn't make those kinds of jumps back and forth.) Most of my job is moving them through the discomfort of those transitions, and believing that there is something to be gained from a world of details.

As a drawer

I believe drawing is about seeing. The more I look around me, as I am drawing, the more the world opens up as if under an old magnifying lens. The world is strange and beautiful. For me, drawing is about piecing apart all the named, known objects around me; not window, table, hand, but fat oily lines, shivering, hairline cracks, darkness... As soon as I begin to recognize what is on my drawing, *as soon as it raises up a known world*, I change tactics.

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Tara Geer

I believe drawing is about seeing. The more I look around me, as I am drawing, the more the world opens up as if under an old magnifying lens—the spoon in the cereal bowl and the floating bits of cereal lose their distinction—there is fuzziness, glassiness, still gray, belts of pale light. The world is strange and beautiful and full of awe. For me, drawing is about piecing apart all the named, known objects around me; teasing them into a pure meaningless visual field. Not window, table, wall, hand, but fat oily lines, shivering, hairline cracks, darkness...

As soon as I begin to recognize what is on my drawing, as soon as it raises up a known world, I change tactics. But I always draw from life, because it is all that stuff out there and the looking at it that interests me. I am not much interested in the images in my mind, nor in the tactics of drawing themselves except as a means to an end. I like looking out at the world and seeing things I cannot name—things released and glorious.



Top: Cloud Nest

Middle: Humpbacked

Bottom: Star Holder



Thickness of Clouds



Urging Eggs

Drawing and Cognition



Margaret Neill

All in the Timing: Using Embryological Principles to Understand Creative Thinking in Art



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In this paper, I examine creative thought in the context of drawing. The subject of creativity has been of longstanding interest to laypersons and scholars across domains. However, despite an upsurge in empirical research and theorizing about the nature of creativity over the last few decades, our understanding of the creative process remains impoverished. Here, I briefly identify several reasons for this impasse and attempt to redress some limitations of current models of the creative process. Building on several previous papers (Kozbelt, 2009a, 2009b), I here develop an analogy between the emergence of a work of visual art and well-established principles of embryological development in biology. I argue that drawing and painting represent an ideal domain for the development of this theoretical perspective. In this paper, I outline how the model can be developed and note its prospects as a framework for understanding creativity.

Inadequacies of current models of creativity and an embryological alternative

The creative process is complex; this is axiomatic. To make sense of this complexity, researchers have adopted several strategies. One is to divide the process of creation into several discrete stages or regimes of creative thought (e.g., Getzels & Csikszentmihalyi, 1976; Mace & Ward, 2002; Martindale, 1990; Wallas, 1926). In the most theoretically sophisticated models (e.g., Simonton, 1984; Ward, Smith, & Finke, 1999), one stage typically entails generating ideas; the other, elaborating them into finished creative products. Notably, each stage is

often treated as essentially a random variable, with little inherent structure. An alternative strategy is to emphasize component mechanisms (e.g., Mumford, Mobley, Uhlman, Reiter-Palmon, & Doares, 1991; Nečka, 2003) that interact in a thoroughly inter-connected manner. Both perspectives, stage and componential models, thus deprive the creative process of any systematic structure and fail to characterize the rich dynamics of the creative process in any detail. This impasse is compounded by the domain generality of virtually all models of creativity. Such models thus fail to incorporate any domain-specific particulars, which likely dominate creators' thinking as they work and which could also provide some natural structure to the creative process. Importantly, many existing models of the creative process are also biased toward regarding the generation of ideas as *the* essential engine of creativity; the elaboration of ideas is underemphasized and undervalued. In other words, even the best-developed current psychological models of the creative process perpetuate the cliché of creativity as a light bulb turning on.

I believe this point of view is misguided. Instead, I propose a perspective rooted in an analogy between art and embryological development. In both cases, the process starts with raw material—DNA in biology or basic ideas in art—that serves as the basis of later development or elaboration. If ideation is de-emphasized as the prime mover of creativity, some plausible mechanism must be articulated that would allow for novelty, and thus potential creativity, to arise in lieu of original initial ideas.

Here I emphasize the possibility of generating novelty *by modifying the creative process itself*, in terms of how ideas are elaborated. I propose as such a candidate mechanism the principle of “ontogenetic heterochrony,” a biological term describing how profound differences in the morphology of organisms can arise from small changes in the timing of developmental events (Gould, 1977). One biological example involves the profound morphological and cognitive differences between humans and chimpanzees—despite a 99% overlap in DNA—that arise through the relative retardation of certain developmental processes in humans. Another is that of Galápagos finches, whose highly varied beak morphologies result not from a large number of genetic differences, but rather from small variability in the timing of one “switch,” a segment of DNA that controls the activity of other genes (Abzhanov, Protas, Grant, Grant, & Tabin, 2004).

Baseline depictive heuristics comprising artists’ schemata

What does this have to do with visual art? I believe that domains like drawing and painting represent an ideal forum for the application of ontogenetic heterochrony. Activity in these domains is well-structured, with constraints from artistic media, from motoric movements, and from non-accidental aspects of depiction that partake of the basic operation of the visual system. Artists can be observed rendering, with the emerging work emerging before one’s eyes, and substantial process traces are often evident in finished artworks. Ontogenetic heterochrony can be best applied to the history of Western art between about 1300 and 1900, since throughout this time an overriding concern was the achievement of more realistic-looking images. A useful starting point is Gombrich’s (1960) discussion of artistic schemata—cognitive frameworks that help organize and interpret information—which describe how techniques for realism largely follow a structured hypothesis-testing dynamic. Over time, artists’ technical knowledge becomes both deeper and more streamlined, and depictive skill increases (Kozbelt & Seeley, 2007). Historically, professional artists have had to work very efficiently—since this is most conducive to fulfilling commissions and furthering their careers—and have used a number of heuristics as part of their depictive schemata. Details of such heuristics can be culled from studio training manuals from

throughout art history (Gombrich, 1960), as well as contemporary art instruction books, principles of drawing instruction pedagogy, laboratory observations of artists, and process traces from finished artworks.

Integrating across sources, a basic set of depictive heuristics can be proposed as a framework for describing the process of rendering in drawing and painting. These heuristics include, but are not limited to: plan compositions in advance so that little if any revision is necessary on the final products; first sketch important elements using linear denotation and only later fill them in; correctly establish an object’s basic proportions and position before adding many details; make the most important objects in a scene the most salient and distinct from the background; add the most detail to the most important objects, leaving subsidiary or background elements less elaborated; carry the degree of finish to a level consistent with current domain standards; in painting, establish a full tonal range at the outset, so recalibration of values is not necessary; in general keep process traces to a minimum. Such heuristics represent only a small portion of artists’ schemata. A richer elaboration would involve a hierarchical control system, with the above heuristics articulated at a high level of abstraction, commensurate with artists’ broad goals and strategies, and with lower levels addressing finer and more particular aspects of depiction, down to perceptual and motor programs for individual contextualized decisions and mark-making movements. A more detailed temporal ordering of basic heuristics and contingencies among heuristics would likewise be an essential part of a richer descriptive model. Overall, these heuristics capture *how* an artist depicts something, rather than *what* an artist depicts.

How heterochronies function in visual art

Such heuristics may seem simple and obvious. That is precisely the point—the baseline model is supposed to be boring, straightforward, and aimed at maximal depictive efficiency. More important for the enterprise of understanding creativity is that such hypothesized regularities can illuminate what happens on occasions when artists depart from the usual methods of working. Specifically, the relative timing of the components of artists’ schemata can be altered in many ways: heuristics can be condensed, truncated, expanded, added to, eliminated, or reordered, at any point in the creative process.

Such heterochronies can be implemented both to alter aspects of the usual hierarchical organization of artists' means and ends, as well as to change their usual temporal ordering. Finally, because emerging artworks may fluctuate wildly in both appearance and quality (see Kozbelt, 2006)—unlike ontogenetic development in biology, in which an organism must be viable throughout—artists can potentially introduce a very wide range of heterochronies into a single work.

The potential power of the mechanism of ontogenetic heterochrony as a means of creating novelty rests on the generative potential of timing-dependent changes to the depictive process. This claim presupposes a strongly non-deterministic dynamic whereby, for instance, an artist's action A followed by action B followed by action C would not yield the same result as that artist's action C followed by action B followed by action A. In other words, the mark-making moves of an artist are non-independent, and this is probably true at all levels of the control structure hierarchy of an artist's schema. At the relatively local level, even if an artist attempts to program and execute an identical mark-making movement multiple times, the results will differ (Gombrich, 1991, p. 101); this is likely to be exacerbated if the existing context for the executed move has changed due to the presence of other marks. At higher levels of an artist's organizational hierarchy, the presence of certain kinds of marks in an emerging depiction will influence an artist's choice of subsequent marks—their position, salience, and so forth—as a means of bringing the work to a satisfactory (if not entirely predictable) conclusion. In this context, I also note that some artistic media are probably more likely to contribute to this variability than others—particularly media that are somewhat volatile and difficult to control under any circumstances, but also media in which marks are more or less irrevocable and do not allow for easy correction, erasure, or undoing.

In considering this framework, it is useful to consider what the state of affairs would have to be like in order for changes in the timing of various depictive actions *not* to have an impact on the resulting rendering. If each action that an artist made was completely independent of other actions, and the artistic medium used was completely reversible in terms of error correction and also not sensitive to ordering effects, then the order in which a standard set of marks were made in the render-

ing of an image would have absolutely no effect. In that case, there would be a negligible role for certain categories of changes of timing, specifically those involving a reordering of a set of actions. I note, however, that even under such conditions, heterochronies involving the truncation of a standard depictive action or subroutine (say, filling in an outlined shape) or the greater elaboration of the level of detail of part of a depiction (say, a careful and uniform detailing of the texture of an object in an image), would still be means of generating variation, and thus potential novelty. Generally speaking, this framework suggests numerous empirical questions on the extent to which variability in finished renderings emerges from various categories of heterochronies, in different drawing contexts and media, at various stages of the drawing process, and at different levels of the organizational structure of artists' schemata—as well as the extent to which heterochronies are amenable to overt experimental manipulation in a laboratory setting.

Ontogenetic heterochrony and art history

Even without considering heterochronies, establishing a rich descriptive baseline in which artists' schemata are unpacked hierarchically and temporally would be highly informative. For instance, grounding Western artistic practice between 1300 and 1900 in a dynamically-oriented version of schemata *à la* Gombrich (1960), informed by constraints from various artistic media and contemporary research on perception, action, and goal-directed problem solving, would yield a rich detailing of the evolution of particular aspects of rendering within the Western realistic tradition. As schemata evolve over time, some heterochronies may be absorbed into artists' standard working methods. This may be particularly pertinent when new artistic media, which constrain the structure to the creative process in a different way, are introduced into a tradition. For instance, the introduction of oil painting enabled different visual effects, greater possibilities for layering, and a longer timescale for revision and reworking, compared to the faster-drying tempera and fresco media that were previously characteristic of European wall and easel painting.

Links between ontogenetic heterochrony and art history can also take the form of systematic relations between an artist's approach to rendering and the overall arc of his or her career. Great artists in the Western tradition show considerable variety in the

age at which they produced their most important and influential work (Galenson 2001, 2006; Jensen, 2004): some, like Raphael, Picasso, and the Surrealists, produced their best work early, in their twenties or thirties; others, like Leonardo, Velázquez, or Cézanne, produced their best work much later, in their fifties or sixties. Artists also show enormous differences in their creative processes. Galenson (2001) proposed that early-peaking artists tend to be known for significant conceptual innovations that rebel against tradition and fundamentally alter the rules of a domain; they also work with great confidence and focus on ideation as the means of garnering critical acclaim, using conceptual criteria in judging their work. In contrast, later-peaking artists are known for building on tradition, working in a more trial-and-error fashion, placing a far greater priority on execution than ideation, and using perceptual criteria in judging their work. Looking at these results through the lens of changes of timing to standard means of depiction suggests that early-peaking artists do not introduce heterochronies into their methods of production: unusual ideas or conceptual combinations are simply channeled through the standard efficient techniques for execution. In contrast, late-peaking artists frequently appear to have introduced important changes of timing into their depictive process, suggesting that such heterochronies represent important occasions for learning and the development of a kind of creative wisdom that allows these artists to continually improve (see Kozbelt, 2009a). Thus, ontogenetic heterochrony has the potential to inform the specifics of the creative process in predictive, as well as descriptive, ways.

I also note that the overt de-emphasis on ideation among “heterochronous,” late-peaking artists reinforces the need for a more balanced appraisal of the importance of the process of elaborating ideas for the creative process more generally. Indeed, artists themselves often make remarks that suggest that they have almost no idea of what they want to do when they begin a work. To wit: Richard Diebenkorn stated, “I don’t go into the studio with the idea of “saying” something. What I do is face the blank canvas and put a few arbitrary marks on it that start me on some sort of dialogue.” Willem de Kooning noted, “I see the canvas and I begin...It’s a necessary evil to get into the work, and it’s pretty marvelous to be able to get out of it.” Noyes Capehart Long wrote, “I rarely begin a work with any clear or pre-

determined ideas as to how the work should look. Even when I do, I seldom find the completed work matching up with the original projection” (quotes from Genn, 2011).

Conclusion

The fitful emergence of a great artwork through a rich, complex, interactive creative dynamic is a radically different way of conceptualizing the nature of creative thought compared to the standard “lightbulb” image. Applying the principle of ontogenetic heterochrony to this dynamic and to artists’ schemata represent a way of understanding artistic practice in a detailed, nuanced, and powerful way that redresses numerous shortcomings of existing domain-general, ideation-intensive models of the creative process. This novel approach also spans multiple levels of analysis, from micro-level mark-making moves through the career trajectories of the greatest artists in the Western tradition. Further elaboration and empirical testing will determine the extent to which this framework will enhance our knowledge of visual art and creativity.

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A Multi-Stage Attention Hypothesis of Drawing Ability

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Introduction

The behavior of *observational drawing* is a specific type of artistic production where a person attempts to render an external visual stimulus with the aim of achieving visual accuracy. Cohen and Bennett (1997) defined a visually accurate drawing as “one that can be recognized as a particular object at a particular time and in a particular space, rendered with little addition of visual detail that cannot be seen in the object represented or with little deletion of visual detail” (p. 609). One of the most fascinating aspects of this behavior involves the vast individual differences in the ability to produce visually accurate drawings (Cohen, 2005; Cohen & Jones, 2008; Cohen & Earls, 2010; Kozbelt, 2001; Ostrofsky, Kozbelt & Seidel, in press). When asked to draw a visible object or scene, most adults experience tremendous difficulty. The ability to produce accurate drawings normally comes only after great expenditure of effort through years of intensive training and practice.

Of central concern to this paper is the problem of understanding realistic drawing ability. How can we explain why skilled artists are capable of producing highly accurate drawings while unskilled non-artists are highly prone to making substantial drawing errors? What underlying skills and strategies lead to the ability to create more accurate drawings? Since the process of observational drawing starts with acquiring visual information from the model being drawn, psychologists have primarily focused on perceptual processing in explaining individual differences in drawing accuracy (e.g.,

Cohen & Bennett, 1997; Cohen & Jones, 2008; Kozbelt, 2001; Kozbelt & Seeley, 2007). However, the exact perceptual processes that are related to drawing ability are not currently well understood, and researchers’ continued focus on early stages of visual processing may well lead to biased or invalid conclusions.

In contrast, this paper outlines a *multi-stage attention hypothesis*, a tentative understanding of the perceptual processes that are related to individual differences in drawing ability. Briefly, this hypothesis argues that drawing ability is influenced by two factors: (1) what visual information is selected versus not selected to be included in the drawing; (2) the degree to which the visual system enhances the processing of selected visual information and suppresses the processing of non-selected visual information during the activity of drawing.

Some empirical evidence in support of this hypothesis stems from an experiment that was recently conducted in our lab (Ostrofsky, Kozbelt, & Seidel, in press). The experiment examined 15 trained artists specializing in observational drawing and 33 non-artists who reported no training or extensive experience in observational drawing. We assessed participants’ observational drawing ability by asking them to make a free-hand copy of a photograph of an octopus using pencil and paper. The participants were given 15 minutes to complete their drawing and were instructed to draw the octopus as accurately as possible using whatever techniques they felt comfortable with. To quantify the accuracy of these drawings, three trained artists indepen-

dently rated each drawing on overall accuracy using an 8-point scale. Unsurprisingly, artists' drawings were rated as more accurate than those produced by non-artists (see Figure 1 for images of the 3 highest-rated and the 3 lowest-rated drawings).

Selection of visual information

As our participants created drawings, a major problem they faced was the moment-to-moment selection of what information from the model to attend to and render—a ubiquitous problem for anyone drawing from observation. Individuals who draw from observation routinely look back and forth from the model to the drawing because only a small amount of information from the model can be perceived and drawn at any given moment (Tchalenko, 2009). Thus, observational drawing behavior involves a continual decision making process by which the drawer must decide what information to select to include in the drawing.

There is strong reason to believe that the particular information that is selected to be included in a drawing will influence the perceived accuracy of the drawing. Not all visual information is equally important in supporting the recognition of that object. For instance, Biederman (1987) reported an experiment where he showed subjects line drawings of different objects; in some, many line mid-segments had been deleted; in others, vertices that connected lines together were deleted. Participants

were significantly impaired in their ability to recognize objects when the vertices were deleted, but not when mid-segments were deleted. This suggests that some forms of visual information, like vertices, are much more important in supporting object recognition than other forms, like line mid-segments. If this is the case, then the type of visual information that is selected to be included versus excluded in an observational drawing should impact judgments of the drawing as a recognizable representation of the model stimulus. Further, since trained visual artists produce more accurate drawings than non-artists, skilled artists may be more sensitive to, and thus are more likely to select and include in their renderings, the visual information that best contributes to object recognition, compared to non-artists.

This hypothesis was tested in our experiment by administering to our participants a limited line tracing task (derived from Kozbelt, et al., 2010). This task emphasized participants' ability to select the most important information to include in a depiction. We provided participants with a grayscale photograph of an elephant that was placed inside a clear plastic folder. We asked participants to create a tracing of the elephant on the clear folder. Participants did not use pencil or marker to create the tracings, but rather, were given 30 short pieces of dark brown tape with which to trace the photograph. Each segment measured 2cm × 2mm. A piece of white 8.5 × 11-in. paper was also available, so that

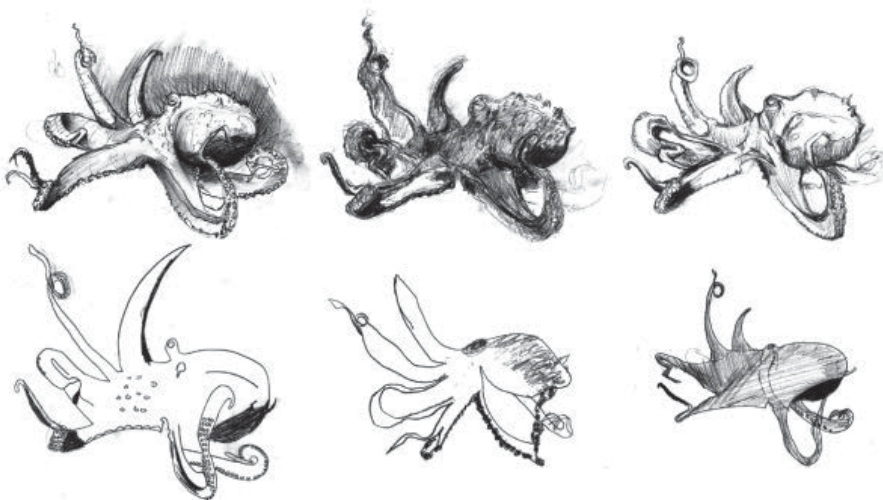


Figure 1. Examples of the free-hand drawings made by participants based on a photographic Model of an octopus. The top row presents the top 3 rated drawings and the bottom row presents the bottom 3 rated drawings.

participants could slide it between their drawing and the photograph to see what the drawing looked like without interference from the photo underneath. Participants were instructed to use the available line segments to create a tracing that was as accurate as possible, given the constraints of the medium. Accurate realism, rather than creativity, was explicitly emphasized. Participants were required to use all 30 pieces of tape. They could bend a segment if they liked but could not tear it into smaller pieces; they could also move a piece of tape after having used it in the drawing if they decided it would go better somewhere else. Participants were given 15 minutes to complete their tracing.

Based on extensive pilot testing, thirty segments appeared to be enough to make a potentially interesting drawing and to permit a wide range of depictions, but importantly, not enough to trace all the information in the photo. Thus, the limited number of line segments is an important methodological control intended to force participants to make careful choices about what visual information from the photograph to include versus exclude from the tracings.

We analyzed performance in this tracing task in two ways. First, we quantified the accuracy of these tracings by having three trained artists rate how accurately each tracing represented the photograph on an 8-point scale (see Figure 2 for the top 4 and bottom 4 rated tracings). The tracings produced by trained artists were rated as more accurate than

those produced by non-artists. Next, we calculated the correlation between the accuracy ratings for the tracings and the drawings of the octopus photograph that the participants produced, as described earlier. We found a moderate and statistically reliable positive correlation between tracing and drawing accuracy ($r = .39, p < .05$), indicating that tracings rated as highly accurate tended to be produced by individuals who made drawings that were also highly rated on accuracy. These results support the idea that the decision of what visual information should be included versus excluded from an observational drawing is an important process that contributes to the accuracy of a drawing.

The second analysis of the tracings compared the frequency with which artists and non-artists spontaneously used four different kinds of vertices in their renderings (derived from Biederman, 1987). This was done to examine what kind of information might be selected by skilled artists versus being relatively neglected by non-artists. Specifically, for each tracing, we counted the number of L-, fork, arrow, and T-junctions that were reproduced. Figure 3 shows that trained artists were observed to include reliably more T-, L- and fork junctions than non-artists. Although a trend was present for artists to trace more arrow junctions than non-artists, this was not a statistically reliable difference. These results suggest that skilled artists are more sensitive in selecting visual information to include in a



Figure 2. Examples of the limited-line tracings made by participants based on a photographic model of an elephant. The top row presents the top 4 rated tracings and the bottom row presents the bottom 4 rated tracings.

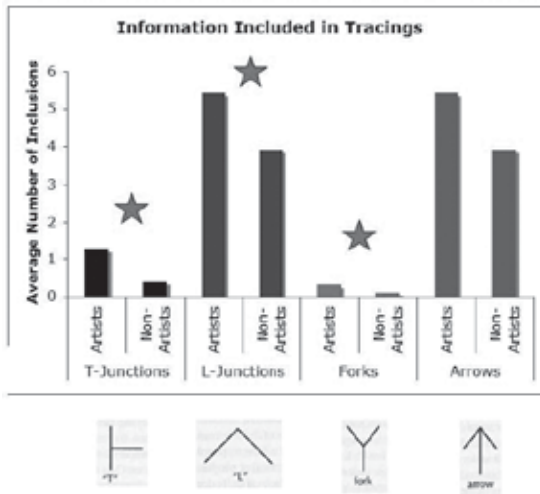


Figure 3. Displays the average frequencies in which artists and non-artists traced T-, L-, Fork and Arrow Junctions in their reproductions of the elephant photographic model. A star above a comparison indicates that the difference between artists and non-artists is statistically reliable at the $\alpha = .05$ level.

rendering that contributes to successful object recognition—exactly along the lines of psychological theories of object identification (e.g., Biederman, 1987).

In revisiting the question of what underlying skills and strategies are associated with better drawing ability, we suggest that one answer is simply more astute selection of what information from a model should be emphasized in a drawing. As argued by Gombrich (1960) and Kozbelt and Seeley (2007), artists, as a result of intensive training, develop knowledge about what visual information will best capture the illusion of the 3-D form of an object in a 2-D depiction. In this view, when trained artists view a model to draw, their visual attention is biased to focus on essential visual features that will most accurately represent the specific appearance of the model, while ignoring information that does not contribute to recognition. Our evidence (Ostrowsky, Kozbelt, & Seidel, in press) hints that vertices may be an example of such information, which is preferentially selected and emphasized in depiction. Future research may investigate other visual cues that are emphasized differently between skilled and unskilled drawers – a potentially fruitful direction of inquiry.

Enhancement of processing selected information and suppression of processing non-selected information

The results from our limited line tracing task suggest that *what* visual information is selected to be included and excluded in an observational drawing will influence how accurately the drawing recognizably represents the model stimulus. However, the *subsequent visual processing* of selected versus non-selected information can also potentially influence drawing accuracy. It has long been known that when a visual target is selected to be processed, attentional resources are dedicated to preferentially processing that stimulus, versus stimuli that have not been selected (Kastner & Ungerleider, 2000). However, if the perceptual resources that are dedicated to processing the selected target stimulus do not exceed the capacity of our perceptual systems, additional resources will be allocated to the processing of non-selected, ignored information (Lavie, et al. 2004). Under some circumstances, the additional processing of non-selected visual information can potentially cause errors in perceiving and acting on the visual information that has been selected for processing (Franz, 2003).

Perhaps nothing demonstrates this point better than visual illusions. Many visual illusions arise from perceptual judgments about a target stimulus attribute being distorted by task-irrelevant, non-selected contextual cues. Take the observation of size constancy, for instance (Murray, Boyaci & Kersten, 2006). Size constancy is observed when two objects of identical size and appearance are presented simultaneously in conjunction with a contextual background composed of depth cues such as linear perspective, texture gradients, and shading. The two objects are typically presented as being at different perceived distances from the observer. If individuals are asked to compare the optical size of these objects, most individuals tend to judge the “farther” object as larger in size than the “closer” object, presumably because the visual system makes the assumption that objects perceived to be farther away are larger in objective size than their appearance indicates. Since this misperception disappears when the objects are presented at equated perceived distances, this clearly demonstrates that the processing of the selected visual targets (the size of the two objects) is influenced by the processing of the non-selected, task irrelevant contextual depth cues found in the background. This also makes the more general point

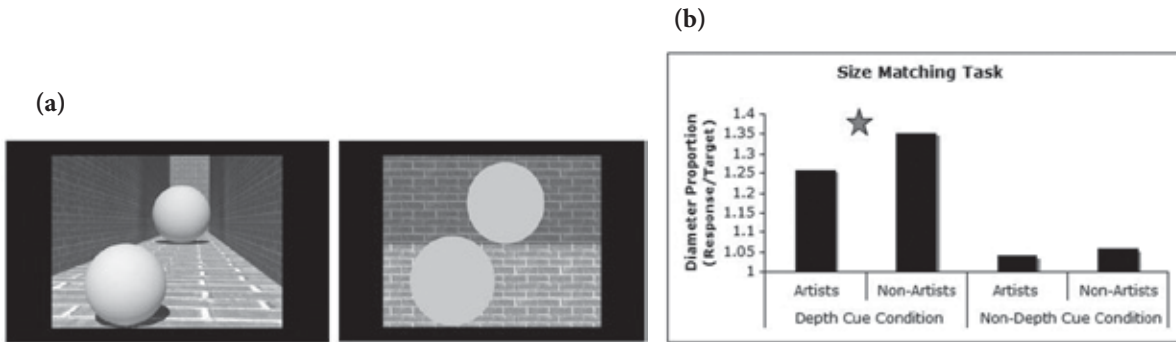


Figure 4. (a) Presents an example of the stimulus in the depth and non-depth conditions of the size matching task. (b). Presents average error proportions for artist and non-artist participants in the depth and non-depth conditions of the size matching task. The star above the depth condition comparison indicates a statistically reliable difference between artists and non-artists.

that just because some visual information has been selected to be processed, it does not follow that the information that has not been selected to be the focus of attention is not processed at all. In order to reduce the misperception and action errors associated with the processing of non-selected information, individuals would presumably have to more strongly focus their attention to processing the selected information while simultaneously suppressing the processing of non-target information.

Does the degree to which non-selected visual information is processed actually influence drawing accuracy? If the processing of non-selected visual information has the potential to cause errors in both perception and action, do individual differences in the ability to suppress the processing of non-selected, ignored information predict drawing accuracy performance? Some preliminary results from our recent experiment (Ostrofsky, Kozbelt, & Seidel, in press) speak to this point. Specifically, we measured the degree to which our artist and non-artist participants experienced the size constancy effect. In a size matching task (Murray, Boyaci, & Kersten, 2006), participants saw two circles on the computer screen (see Figure 4a); the upper circle on the screen was always the target, and participants used arrow keys on the computer keyboard to manipulate the size of the lower circle to match the size of the target. Participants were explicitly instructed to focus on matching the actual size of the circles—that is, if they were measured on the computer screen—rather than their interpretation of the size of the circles.

Two conditions were tested. In the *depth condition*, the circles were shaded to suggest spherical forms and were presented against a textured, converging perspective background to give the illusion

that the upper, target circle was more distant than the lower, manipulated circle. To the extent that viewers are unable to overcome size constancy, the manipulated circle should be made larger than the target circle, to offset the perceptual interpretation that a more distant object of approximately equal retinal size should itself be physically larger. In the *non-depth condition*, both circles were shown in a uniform shade of gray matching the overall value of the spheres in the depth condition. The background likewise maintained the same contrast of light and dark and included a similar texture as in the depth condition; however, no converging perspective or any other depth cues were included.

For both versions of the size matching task, the performance was measured by dividing the size of the manipulated circle by the size of the target circle. Thus, a proportion of 1 indicates a perfect size match and a proportion greater than 1 indicates that the participant adjusted the manipulated circle to be larger than the actual size of target circle, which would indicate the experience of a size constancy effect in that participants perceived the target size to be larger than it actually appeared.

Figure 4b shows the performance of artist and non-artist participants in the depth and non-depth versions of this task. As can be seen, both artist and non-artist subjects experienced the size constancy effect, as they made reliably larger size matching errors of the predicted direction in the depth condition compared to the non-depth condition. However, artist subjects made significantly smaller size constancy errors in the depth condition than non-artists. (Note that this is not a reflection of an overall stronger ability to match the size of two objects, as artist and non-artist subjects did not differ in their errors in the non-depth condition.) Further,

when comparing size matching performance and the accuracy ratings of the free-hand drawings, a reliable negative correlation was found between size constancy errors in the depth condition and drawing accuracy, but no reliable correlation between size matching errors in the non-depth condition and drawing accuracy. This suggests that drawing accuracy is related to the ability to accurately perceive selected target information while simultaneously suppressing the interfering effect of processing non-selected ignored information. Based on these findings, we argue that artistic skill involves the ability or fundamental capacity to strongly bias attention towards enhancing the processing of target, selected visual information and suppressing task-irrelevant, non-selected information (see also Kozbelt & Seeley, 2007).

Conclusion

In trying to explain how strategic and mechanistic forms of attention interact with one another to impact drawing, we advocate a broad, multi-stage *attention-based* theory of drawing skill and accuracy. We argue that the perceptual aspect of drawing involves a continual feed-forward and feedback interaction between the strategic selection of information and the subsequent biasing of attentional resources towards enhancing the processing of selected information and suppressing the processing of non-selected information. In this sense, drawing inaccuracies can arise through multiple stages of perceptual processing, including inappropriate selection of information to attend to as well as an insufficient biasing of attention toward selected information and away from non-selected information. We believe that unpacking the particulars of this perception-action dynamic across multiple stages of processing will be a fruitful route for future research, in order to understand the psychological underpinnings of skilled artistic drawing.



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Learning to Pause

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...the painter throws away the fish and keeps the net. His look appropriates correspondences, questions, and answers which, in the world, are revealed only inaudibly and always smothered in the stupor of objects. He strips them, frees them, and looks for a more agile body for them.

In *The Prose of the World* Merleau-Ponty (1973, p. 88) eloquently articulates the extraordinary perceptual approach required for observational drawing. The drawer takes time to weave a web between themselves, the object and the evolving drawing. How does the drawer learn to look for the “agile body” of an object? A crucial element of observational drawing is learning to pause. The pause offers a space, temporal and spatial, to reflect and to prepare your next move.

In this paper I briefly present findings from the Drawing and Cognition Project and from my PhD case studies, relating to the role of the pause in observational drawing. I observed, filmed and interviewed students on Betty Edwards’ 5-day drawing course—and also took the course myself.



Figure 1. Betty Edwards’ drawing students, learning a new way of looking at things

Van Sommers (1984), Tchalenko (2009), Miall (2009), Kozbelt (2001), Cohen (2005) and Coen-Cagli (2007) offer scientific findings relating to novice, intermediate and expert drawers’ behaviour and perception. However to date there is, to my knowledge, no longitudinal study of drawing students undergoing drawing training. I set out to explore transformations from beginner towards experienced drawer. I based my hypotheses on Tchalenko’s (2009) comparisons of novice and expert behaviour.

In the second part of the paper I describe a cognitively informed drawing instruction that I have developed and explored. The instruction hinges on the idea that during drawing there may be phases when the eye communicates with the hand spatially rather than using any form of visual memory. There occurs a physical translation rather than a perception-to-action or visual to motor encoding.

My research is practice-based, meaning that I have spent a lot of time drawing, as a way to think through drawing, both to think about the drawing process and using drawing to think, with the paper acting as a place to hold and play with ideas. This entailed taking findings from Tchalenko’s lab and testing them within drawing instructions. The instruction I developed aims to utilize our natural proprioceptive skills to synchronize eye and hand movement, and to explicitly focus on segmenting the process, both into small segments of line and into short episodes of time. This raises questions about how new scientific findings might better inform teaching practice.

I conclude with the proposition that the art-

ist both (A) learns, and works within, the limits of their perception, and (B) extends these limits by developing their perception. Central to the argument is an enactive account of vision, entailing that the way the body moves creates changes in perceptual awareness. From this view the role of the hand is always a significant part of the perceptual equation. Only by considering the dance of eye, hand, head and whole body can a complete picture begin to emerge of the drawing process, of perceptual style and transformations.

Extra-ordinary perception

Van Sommers (1984) argues, in the particular context of drawing a hand, “I do not believe that normal perceptual commerce with objects is adequate to this task” (132) and that while several styles of perceptual analysis “would be adequate for recognition... not all are equally suitable as a basis for drawing” (132).

What is an adequate and suitable style of perception for accurate drawing from life, and how do we acquire this style? My original proposal was to study how experienced drawers look at gaps between objects, referred to by drawing teachers as “negative space.”

The dominant paradigm in drawing teaching is that students need to learn how to look at things in order to draw them. The premise is that if you

learn to look then you can draw, implying that the mechanical act of the hand will follow easily. There is a bias towards isolating the eye as the sole perceptual tool in the task of drawing. The common view is that the eye perceives, and the hand follows. To a large extent experimental research has operated on this paradigm, adopting a sequential model with the eye looking and perceiving, and the action of the hand following information from the eye. My perspective, from my own teaching experience and research, is that students often struggle to integrate and coordinate their eyes and hands, and that being more explicit about how the hand and eye synchronize will facilitate learning. Cognitive scientists have begun a productive dialogue with philosophers about skill acquisition, embodiment, enactive vision and consciousness (see Jacob and Jeannerod, 2003; Seeley and Kozbelt, 2008; Varela et al., 1993; O’Regan and Noë, 2001) however this does not, I submit, reach drawing education in any effective way.

The first point to bear in mind is that the eye moves a great deal during observational drawing, making many fixations and weaving a web of connections.

The movements of drawing (a style) bring about a new style of perception. Crucially this includes eye movements, and phases of *not* moving.

Segmenting and pausing distinguishes experts from novices

Two behavioural factors distinguish experts from novices: pausing more often, and drawing smaller segments of lines. Tchalenko (2009) found differences in eye movements between novice and expert drawers when copying complex lines, and developed a drawing hypothesis relating to how people divide up the image into sections to be drawn. He recorded the drawing strategies of 16 subjects, with drawing experience ranging from novice to expert, while they copied a line drawing of a standing woman. He found significant differences between the experts and novices:

The experts produced accurate copies whereas all the beginners produced marked inaccuracies of overall scaling, proportion and shape. Analysis of eye and hand movements showed that the experts alone segmented the original drawing into simple line sections that were copied one

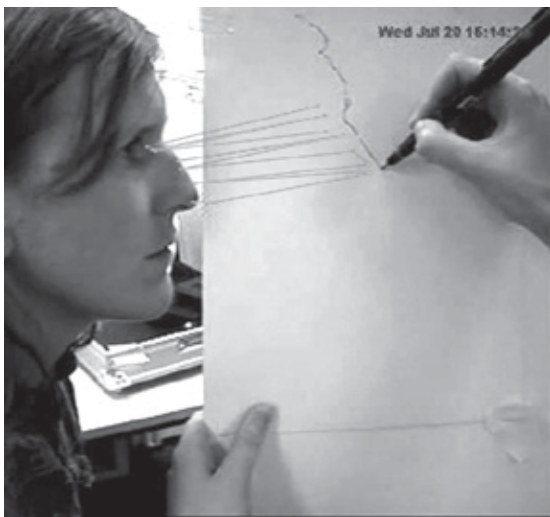


Figure 2. Still of eye tracking data imposed on video footage, showing the web the eye weaves between object and drawing (Brew & Fava, 2011)

at a time using a direct eye–hand strategy not requiring intermediary encoding to visual memory. The results suggest that segmentation into simple lines defines the task-specific process of accurate copying, and that this process is restricted to experts, i.e. acquired through training and practice. (p. 791)

Tchalenko and Miall’s (2007) findings from parallel eye tracking and fMRI studies suggested that drawing from life relies on the encoding of visual information into motor plans. In other words the drawer converts what they see into a plan of how to draw it. I used these two findings, relating to segmentation and pausing and the use of motor plans, to form hypotheses for the experimental element of my PhD and for development of my new drawing instruction.

Learning to segment and pause

I filmed students copying a continuous line, before and after the 5-day intensive course of drawing training, and analyzed the footage frame by frame to see whether they began to draw smaller line segments, paused more and specifically paused between segments. Footage of each test was analyzed in terms of changes in a) spatial and temporal interaction of eye and hand (performance) and b) the line drawn (output). The study asked *does the hand need the eye?* And if so in which situations, i.e. *when does the hand need the eye?* This then poses questions about *why* the hand may need the eye and whether the drawer knows this explicitly or implicitly.

Tchalenko and Miall (2007) found that for the hand to achieve accuracy in drawing the shape of simple lines, the eye does *not* need to look at the hand as it draws or to check the drawing as it emerges. However, from results of copying tasks in which participants did not look at the paper, or their emerging drawing, they found that the hand *does* need the eye in order to piece together the segments of lines accurately in space on the paper. They stated that “...precise positioning of these shapes required periodic references back to the paper” and “in copying tests, the eye focused on the paper to continue drawing that line while controlling its spatial position.” (Tchalenko, 2009, p. 791).

My hypothetical model for copying a single complex line was:

- Step 1. Subject looks at the original (O)

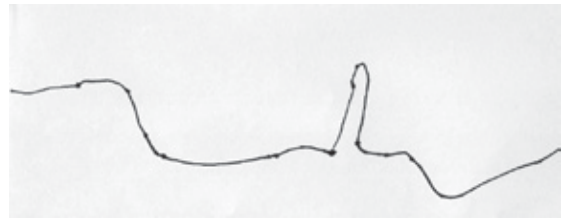


Figure 3. Showing the usefulness of drawing on poor quality paper—Ink pools reveal pauses in drawing action.

- Step 2. Some drawing is executed “blind”, while looking at the original (Do)
- Step 3. Drawing continues while looking at the paper, to control the spatial position of the line (Dp)

I developed a way to record visual traces of the pauses, using absorbent paper and felt pens. I defined a pause as $\frac{1}{4}$ of a second by correlating observable pauses in the video footage of the hand with ink pools on the paper.

It was found that after 5 days of drawing training and practice subjects took longer to copy the same original line drawing, drew at slower speeds per mm of line and looked back and forth between the original and paper more times, looked at the paper more whilst drawing, and broke up the drawing into more, and shorter, line segments. For subject A, the most detailed case study, the mean pause length increased by 247% from 0.44s to 1.09s.

Results relating to “drawing blind” (with eyes on the original) raised interesting questions about when blind drawing may be an appropriate hand-eye strategy, when used in conjunction with a strategy to monitor the evolving drawing on the paper.

A cognitively informed drawing instruction

From Tchalenko and Miall’s (2007) findings relating to motor planning and blind drawing, my own case studies of Betty Edward’s drawing students and reflective drawing practice I used a synthesized profile of expert behaviour to develop a drawing instruction. This is grounded on the finding that experienced drawers pause more and draw shorter segments of line, and on an enactive view wherein perception is developed through action. It focuses attention on the role of physical practice in the perceptual learning required for drawing.

Transformations of perception come about through movement and knowledge of movement, through physical engagement with the external world. As Alva Noë (2004) emphasizes “perceiving is a way of acting” and “not something that happens to us, or in us. It is something we do” (p. 1).

I thought about skills that are easy to acquire and come naturally to most people. To this end my first instruction focuses on the unity of the body, proprioception and our ability to synchronize movement. Preliminary eye tracking data from a recent strand of my research suggests that there may be phases when the eye communicates with the hand spatially rather than using any form of visual memory. Rather, the hand is moving along the line at the same time and at the same speed as the hand, creating a physical motor translation rather than a perception-to-action translation.

The instruction

Based on the finding that short simple segments of line can be drawn without looking at the paper I begin by asking students to practise moving their eyes slowly along a line. Then they practise syncing their eye and hand by moving the eye down a short simple segment of line and at the same time draw an equivalent line on paper with the hand. I explicitly describe this as drawing two lines of the same length in space. Once this mode of drawing simple lines is established, I introduce a way to locate the segment on the page. I instruct them to look to the paper just as they are completing the drawing of each segment of line, to monitor the “landing” of the line. Next I instruct them to pause before drawing the next segment, to give time to assess accuracy and choose a starting point for the next segment.

The premise is that the eye behaves like the hand, offering a direct translation of movement. The hand moves at the same speed as the eye, drawing equivalent lines superimposed on the object-being-drawn and on the drawing. This establishes a way to draw an accurate line from life and encourages students to draw only short segments of line. This smooth slow way of moving the eye is easily learnt, in contrast to some drawing instructions relying on using an external measuring device e.g. measuring with a pencil, which require mental calculations and a less direct way to map from vision to the hand movement. The instruction hinges on our proprioceptive awareness, rather than attending to looking alone. We start to learn to draw by attending to our

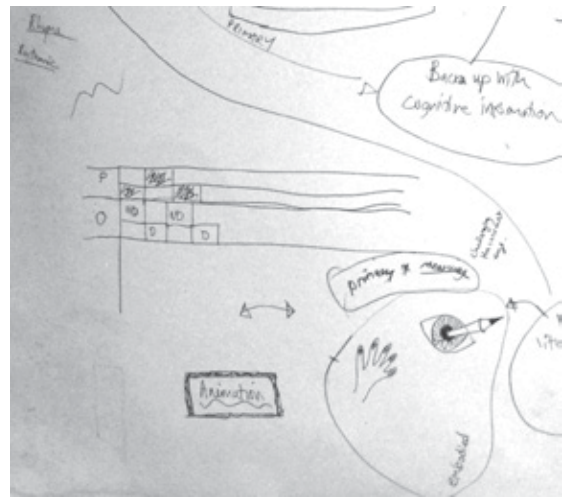


Figure 4. The HandEye / Handsight – dancing together, sharing sensory and perceptual roles, learning from one another

whole body and how it engages with the object.

As a first step towards learning to draw, this divides cognitive and executive elements of observational drawing into two distinct phases. The instruction establishes a clear division between drawing and assessment behaviour, and establishes the pause and the drawing of short simple lines.

There are two aims of the instruction: firstly to explore whether this separation and explicit explanation works well as an instruction, and secondly as a model for further scientific testing. It has been difficult for psychologists to break down the complex intertwining of processes involved in drawing. The contrasting roles of the eye in the two phases may facilitate studies of brain activity during drawing.

Concluding thoughts about event structures, the drawer's mind and attention to parts and whole

The instruction splits the drawing process into two distinct phases, one executive and one cognitive, i.e. drawing, and not drawing, wherein the thinking takes place while not drawing, while pausing. This is given as an explicit verbal instruction to the student: to not think while they are drawing and to think while they pause. On a micro-level, the eye moves and pauses during each phase of movement—the eye pauses and fixates and then saccades to another spot. The conventional view is that this

is the role of the eye, to capture information. My drawing instruction attempts to use the eye in a radically different way, sidelining visual capture and using the eye to draw the line.

Van Sommers' (1984) statement below about copying (the first step in learning to draw) resonates with Merleau-Ponty's description of the artist's way of looking:

The fact is that copying, like imitation in language, is not a matter of item-by-item matching of perception to action, but a translation process, extracting relationships and using available skills to reconstruct them.

My instruction looks for direct and appropriate translation skills, entertaining a more fluid and integrated view of the play between senses and perception and between the eye and the hand. Does the hand see?

Without practice this kind of sensation is rather confused and dim; but if you take men born blind, who have made use of such sensations all their life, you will find that they feel things with such perfect exactness that one might also say that they see with their hands

(Descartes, 1637, *Dioptrics*)

Descartes' insight about touch is beginning to be supported by scientific research of sensory substitution. The hand can anchor perception, and teach the eye; they can search together and instruct one another. Bridget Riley (2009) writes of drawing "It is as though there is an eye at the end of my pencil, which tries, independently of my personal general-purpose eye, to penetrate a kind of obscuring veil or thickness."

The aim of interdisciplinary research is to contribute by linking theory and understanding from domains of research – in the same way that the drawer tries to attend to and relate the parts and the whole in order to articulate a new idea, an innovative approach and new knowledge. My view, from in between domains, is that scientific research has developed some useful provisional models of the physics and cognition of observational drawing. These need further elaboration and testing, including longitudinal study of drawing students and

micro-level studies of brain activity. This will significantly contribute to research of brain plasticity and learning, and, through our interdisciplinary collaborations and communication, to the practical educational application of new knowledge about drawing and cognition.

Playing in an orchestra requires constant awareness of all the other voices, expressing one's own while listening to the other.

Daniel Barenboim (2007:133)
Everything is Connected.

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Visuomotor Atoms of Copy-Drawing

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Abstract

It has been argued that the function of art and the function of the visual brain are one and the same, and that the aims of art constitute an extension of the functions of the brain (Zeki 1999). In this article we address a broader picture: that of art making as an extension of visuo-motor coordination. We focused on copy-drawing, because the ability to draw lines to represent the perceived, or imagined, visual appearance of objects in the world is a building block of visual creativity; a fundamental question is that of understanding how humans coordinate vision and action to achieve this. We studied concurrent hand and eye movements of naive subjects as they performed a simple copy-drawing task. Despite considerable variability among individuals, we were able to isolate some key features of the drawing strategy that were shared across all subjects, and provided a window into the underlying neural processes. A computational model that incorporated those features qualitatively reproduced the data.

Introduction

Cognitive science, and in particular the analysis of human vision and visual attention, have always paid some attention to the visual arts. The latter have provided a rich source of images that are situated somewhere between natural images — such as pictures and videos of landscapes, animals, humans — and synthetic images—the kind of visual displays realized specifically for the purpose of experimentally testing some visual behavior. Visual artworks

share some properties with both classes, because a) they possess some degree of artificiality, being images produced by humans and therefore possessing the kind of features that have been called artifactual properties [88]; and b) they are as common in our visual experience as natural images, since we are exposed to visual artworks very often in daily life (think of museums, books covers and illustrations, advertisement). Furthermore, drawing is an old practice (the oldest cave graffiti dating back to about 30,000 years ago), that is present in almost all geographical and cultural areas.

The pioneer recordings of eye movements made by Buswell (1935) and Yarbus (1967) used famous paintings as the test image; many later examples exist of analyses of the visual activity in response to paintings and drawings, and recently visual artworks have been used as well in neuroscientific studies of the visual brain. The groundbreaking work of Zeki (1999) proposed to not only use artworks to probe human vision, but, conversely, to gain an understanding of the aesthetic experience on the basis of our knowledge of the neural processes involved in perceiving artworks. Zeki argued in (Zeki & Lamb 1994) that understanding the neural correlates of artwork perception could give not only some insight on aesthetic experience, but also a deep understanding of the brain processes involved in artwork creation — by comparing the work of the artist to that of the neurologist, whose ultimate aim is to induce specific patterns neural activity (and therefore specific perceptual effects) in the viewer.

However, this “inverse” approach cannot be just taken for granted, because of two reasons at least. First, the perceptual experience that artists have of their own artwork is undoubtedly biased by their experience of the whole process that led to the result. Against this objection it could be argued that at least the so-called Early visual analysis, which is thought to be cognitively impenetrable (Pylyshyn 2000), should be common to the artist and the perceiver. It is well known however that even the perception of basic image features such as contrast and orientation, which are processed in the early steps of the visual system, can be strongly modulated by top-down factors including visual attention and task performance (Reynolds & Chelazzi 2004). Furthermore, perception of a visual scene is known to be determined also by how overt attention is deployed, i.e. via eye movements, and it is plausible that the attention of the artist would be directed to regions of the image that are critical during the creative act, but that are not necessarily the same that perceivers will attend to. The second, more general reason is that there is no evidence, at present, that the perceptual process and the creative process share the same neural mechanisms. At least two different positions could be taken here: a) according to recent formulations of the dual vision theory (Milner & Goodale 1995), two separate pathways of visual processing exist in the human brain, one implementing perceptual functions (e.g. object recognition) and ultimately delivering to us a coherent visual experience of the external world, and the second one subserving the control of motor actions. According to this view, it could be argued that mainly the Vision for Perception pathway is involved during artwork perception, while the Vision for Action stream is the one upon which the visual creative process relies. b) following the sensorimotor approach to perceptual experience (O’Regan & Nøe 2001), and even more profoundly in view of the existence of mirror neurons (Metta, G., et al. 2006), it could be argued that the perception of a visual artwork involves an internal simulation of the actions that produced that specific image, which would provide a common ground to artwork creation and artwork perception.

In this work we do not commit to any of the above-mentioned positions; we propose instead that a grounded, “direct” analysis of the creative process itself is a much-needed approach in the scientific debate on visual creativity. Creative processes can be regarded, from the vantage point of

cognitive science, as a goal-directed activity involving several human skills and abilities: sensorimotor coordination, evaluation and decision, memory and emotion. In this perspective, we surmise that the analysis of the creative process by scientific means can prove itself a powerful methodology for the understanding of human capabilities such as those mentioned above, at least as much as the analysis of visual artwork perception has proven fruitful for the understanding of human vision.

In order to narrow down our field of analysis, we focused on sensorimotor coordination, namely the problem of how sensory and motor resources are integrated to give rise to efficient behaviors for the solution of specific tasks. In particular, as explained below, our analysis concentrated on eye-hand coordination in the task of performing an accurate drawing from observation, namely copying an original image on an initially blank canvas. The issue of eye-hand coordination in drawing has been addressed by a number of authors (Viviani & Flash, 1995; Cohen, 2005; Land 2006; Gowen & Miall, 2006; Coen-Cagli et al. 2009; Tchalenko 2009). On a global behavioral level, a consistent feature of representational drawing strategies is the following execution cycle: fixation on the original image; saccade; fixation(s) on the canvas; saccade; fixation on the original image. The specific kind of visual processing that takes place when fixating on the original is still unclear in general, but two main positions have been outlined: 1) fixations on the original serve to encode image features to visual working memory, and such mental image is later recalled and converted to a motor plan (Tchalenko et al. 2003); or, 2) the visuo-motor mapping from image features to hand motor activity takes place during fixations on the original image, without the need to invoke working memory (Coen-Cagli et al. 2007).

This last view is consistent with results from our eye tracking experiments, which explored how eye movements of human subjects involved in drawing, differ from those obtained in free viewing control experiments. The results can be summarized by the observation that not only are eye movements in drawing strongly biased by the task, but also a precise dependency can be established between the peculiar motor constraints of the task and the gazing behavior. In particular, we show that the observed eye movements represent a precise strategy to meet the hand motor constraint of graphical continuity.

Experimental Methods

Eye scan records were obtained from 35 subjects (29 for the copy-drawing experiment, 6 for the free-viewing control). All subjects had normal or corrected to normal vision; none had specific previous training in drawing or painting. The experimental setup is shown in Figure 1. Subjects were presented with a horizontal tablet 40 cm x 30 cm, viewed from a distance such that they could comfortably draw. In the left half of the tablet hand-drawn images were displayed, while a white sheet (canvas) covered the right half. The original images represented simple contours. One image per trial was shown, and the subjects were instructed to copy its contours faithfully on the canvas, but the instructions did not make explicit mention of eye movements and did not constraint the execution time (the average execution time was 17 ± 9 sec). For the free viewing experiment, original images were digitized with a scanner, and displayed on a 19-inch computer screen for 10 seconds each, interleaved with a 5 seconds blank screen. Screen resolution and viewing distance were chosen in such a way that the images subtended a similar visual angle as in the drawing trials.

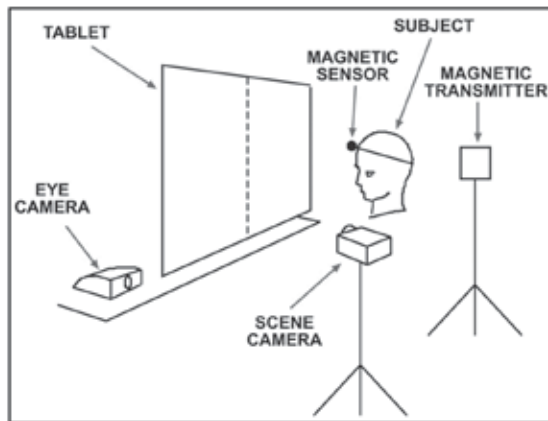


Figure 1. Experimental setup for eye tracking recordings during the drawing task. The Subject sits in front of a horizontal Tablet. In the left half of the Tablet, hand-drawn images are displayed while the Subject is instructed to copy the images on the right half. The eye tracker integrates data from the Eye Camera and the Magnetic Sensor and Transmitter. Eye position is then superimposed on the Scene Camera video stream, which takes the approximate subjective point of view.

The subject's left eye movements were recorded with a remote eye tracker (ASL 5000 series) with the aid of a magnetic head tracker. The eye position was sampled at the rate of 60 Hz. The instrument can integrate eye and head data in real time and deliver a record with an accuracy of less than 1 deg in optimal light conditions. *Fixations* were defined by periods during which the gaze position was stable: they were detected from raw data with the standard dispersion algorithm, with threshold set to 2.0 deg of visual angle and minimum fixation duration of 100 ms. We refer to rapid eye movements between fixations as *saccades*, and to the temporal sequence of fixation points as the *scanpath*. See Figure 1.

Results

Local processing bias and "edge-following" scanpaths, in copy-drawing but not in free-viewing. Qualitative analysis of the data in the drawing experiments revealed that all of our subjects used graphically continuous hand strokes (this was not required by experimental instructions); this is a natural motor constraint that subjects had to contend with by means of some eye-hand coordination strategy. We explored the individual strategies adopted, and found that there were remarkable similarities across subjects. First of all, there was a striking effect of the drawing task (as opposed to free viewing) on the length of saccades as well as on the distance between fixations separated by more than one saccade, which indicated a strong local processing bias.

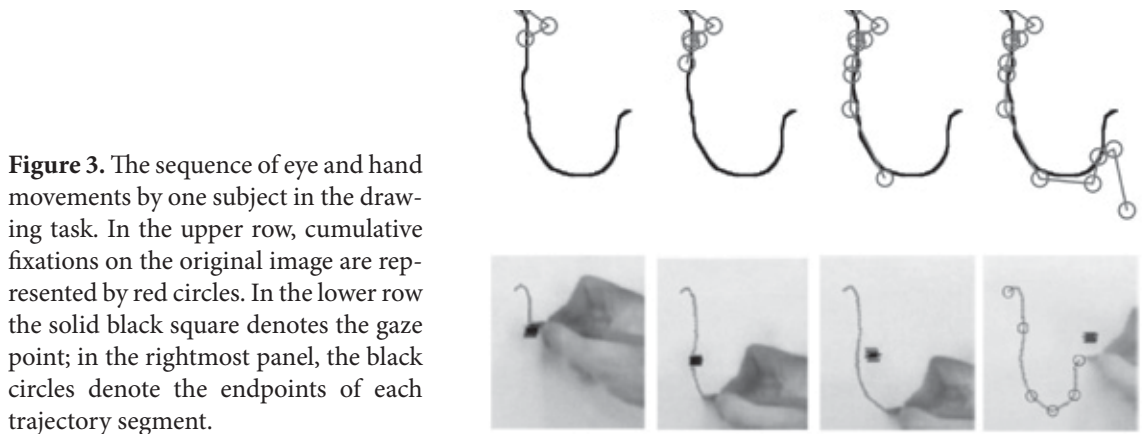
This effect is quantified in Figure 2: the mean distance between fixation points separated by few saccades was significantly smaller in the drawing task; in particular, the average saccade length (corresponding to the first point on the horizontal axis) was almost halved in drawing. In addition, most drawing scanpaths approximately followed the image contours (edge-following behavior). While this could be thought of as a strategy to obtain a higher-resolution sampling of the image, which may be needed to accurately reproduce it, we argue that instead the effect is largely a consequence of the constraint posed by motor continuity.

See Figure 2.

Edge-following was coordinated with graphically continuous hand movements. Figure 3 depicts the cumulative plot of fixations, and the corresponding hand positions, of one subject at four subsequent



Figure 2. a) Average distance between pairs of fixation points as a function of the number of saccades, in the two conditions, across all subjects and trials. Distance is expressed in pixels, with 1 pixel corresponding to ca. 0:05deg. Error bars denote 95% confidence interval. b) Example scanpaths superimposed on the original image; red circles denote fixation points, the black circles denote the first fixation.



stages. The snapshots correspond to the following observed sequence: hand stops—fixation(s) on the left—saccade—fixation(s) on the right—hand moves. We interpret the points where the hand stops as key points, at which the hand’s action needed to be reprogrammed and thus fixations on the original image became necessary. The general tendency of the gaze to move orderly along the image contour (Figure 2) and to do so in parallel with hand movements, suggests that this peculiar form of the scanpaths is a precise eye-hand coordination strategy in support of graphical continuity of drawing gestures. See Figure 3.

A computational model of visuomotor coordination reproduced the copy-drawing scanpaths significantly better than image features alone; but both performed not better than chance under free-viewing.

The scanpaths discussed above were the result, we argued, of a dynamical coupling between eye and hand movements. To further specify this intuition, we introduced a computational model of eye movements that combined two main sources of information: 1) low-level image features, analogous to those processed in early levels of the visual system (e.g. local brightness, contrast, orientation), were combined according to an established model of visual saliency (Itti & Koch 2001); 2) association probabilities between planned eye and hand movement directions, in response to the visual input, were learned by the model via supervised training on the drawing task. Further model details were provided in (Coen-Cagli et al. 2008).

We tested variants of the model on the same images used in the experiments, and quantified the similarity between the resulting sequences of eye

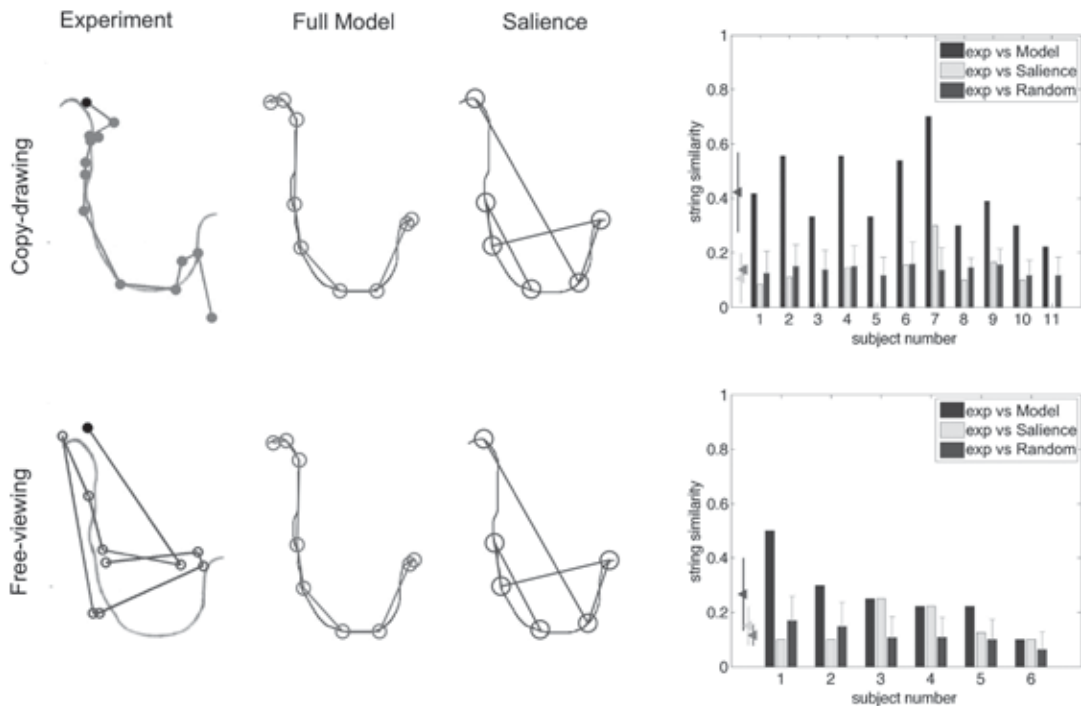


Figure 4. Left: example scanpaths obtained in the experiments, and by the full model and the saliency model. Right-top: The similarity, as measured by the Levenshtein distance, between experimental scanpaths in the drawing task and those simulated by our model (blue), by a saliency-based algorithm (green), and randomly generated (red); bars denote the values for each subject, while triangles denote mean value and standard deviation across subjects. Right-bottom: same as above, but with human data obtained in the free viewing condition.

movements and the experimental scanpaths. Figure 4 summarizes scanpath similarity values obtained by comparing either the drawing task (Fig. 11(a)) or free viewing scanpaths (Fig. 11(b)), against: 1) (red bars) the sequence of gaze-points generated by our model, which implements the edge-following; 2) (blue bars) scanpaths generated by the saliency-based algorithm; and 3) (green bars) random scanpaths (averaged over 10000 samples). The full model performs significantly better than chance, as well as better than a purely saliency-based model, in the drawing task; conversely, the control experiment showed that both versions of the model were, on average, as poor as chance in capturing free viewing scanpaths. See Figure 4.

Discussion

We studied eye movements during copy draw-

ing and observed a local processing bias and “edge-following” scanpaths, markedly different from the patterns observed in the free-viewing condition. With the aid of a computational model that computes low-level image features, and also learns the coordination of eye- and hand-related variables, we showed that the latter piece of information was necessary to account for the observed data in the copy-drawing experiment; conversely, neither image features nor visuomotor coordination could explain the free-viewing scanpaths better than chance. Our observations suggest that the *direct* transformation of sensory inputs (visual and proprioceptive) into motor plans (for the eye and the hand) is a core process of the activity of copy-drawing in non-artists.

Future work should address how the results presented here differ between naive and subjects and experienced artists. This could include fac-

tors such as the larger repertoire of motor gestures or graphical schemes; better selection of visual landmarks that correlate with kinematic events; the extent to which trained artists rely upon visual working memory. Assessing such differences will be an important step in addressing the more general question of whether the drawing practice effectively alters the sensory representation at the neural level. Further, we speculate that an analysis of the strategies deployed when drawing from memory and imagination may provide a window into the mechanisms of mental imagery (Kosslyn et al. 2006).

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Developing a Cognitive Model of Observational Drawing

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Introduction

The aim of this research is to contribute to understanding the underlying cognitive processes involved in observational drawing, and further consider the relationship between drawing and thinking. The model under development aims to both elucidate and inform practice. It is proposed that models of these processes can inform drawing pedagogy and curricula, by explicitly (if only partially) acknowledging the role of drawing in apprehending visual information, and the nature of the learning entailed in developing observational skills.

A grounded theory framework is followed (and briefly described here) in order to derive the model from primary evidence. Case studies of five artists' drawing process were used, excerpts from which are given to illustrate examples. Behavioural analysis of video footage is used alongside verbal protocol analysis, to elicit concurrent and retrospective reports of drawing process and identify significant behaviours.

The model is not intended as an exhaustive description of cognitive process. An emotional dimension might be added, for example, or a more detailed consideration of the role of memory. The model offered focuses on thought processes, rather than knowledge, required for drawing skill. It suggests a temporal dichotomy between strategic thought and visual attention, as a framework in which to consider learning.

The model can be used to describe artists' drawing behaviours and strategies. It is also intended as a framework for considering existing theories of

drawing and cognition, and for considering the relationship between observational skill and broader transferable skills and approaches to learning.

The study is ongoing, and the model is under development. Therefore, this paper is also an invitation for discussion regarding the consistency and applicability of the model.

The need for a cognitive account of drawing

Drawing skill is essentially tacit, visual and multi-faceted, and therefore complex to talk and write about, in theoretical and teaching contexts. Practitioners' accounts of what they do, and how they do it, differ on a number of levels: their practices differ, the terminology they use is idiosyncratic or dependent on training, and their awareness of their own thought processes also differs.

The extent of conscious awareness of one's own thought processes changes with practice. Skills become proceduralized and working memory is freed. Fewer details need present themselves to consciousness. This phenomena is explained in Anderson's (1982) "three stage" model of skill acquisition (based on Fitts' 1964 model), also in cognitive load theory (Sweller 1994) and in Kahneman's dual process theory (2003). Cleeremans' (1997) description of implicit learning (incidental learning without explicit teaching) presents an absence of consciously accessible knowledge throughout the learning process.

Drawing process is therefore a problematic subject for discussion—not only is it essentially non-verbal, but expert practitioners may not be aware

of, or able to fully articulate, their thought processes (or that of other artists). The language used to describe such skills may be ambiguous or inconsistent. A cognitive model may therefore contribute to articulating drawing skills, and inform teaching and assessment practices.

It could be argued that any written account of drawing skill will be incomplete; teaching also occurs through demonstration, non-verbal communication and feedback, in the context of teacher-student relationships. Yet there remains a need to describe drawing; those to whom teaching practices and curriculum choices must be justified require concrete reasoning and written material (for example, learning outcomes and level descriptors). My recent paper (2011) explores these issues in more detail.

Developing a model of drawing and cognition

The study uses an observational methodology, in a grounded theory framework, to study five artists. Two members of the royal society of portrait painters, and three PhD students. Footage of observational self-portrait drawing was recorded, and concurrent and retrospective verbal reports were elicited using methods outlined by Ericsson and Simon (1993)¹. The resulting rich data were analyzed using a grounded theory approach.²

A grounded theory approach to data analysis.

Rather than pre-determine a coding scheme based on a specific hypothesis, the schemes for analysing the transcripts and video data were generated using grounded theory methods, which allow for an exploratory inductive approach.

In this approach, the coding scheme “emerges” from the data itself. Through successive iterations, the coding scheme is developed openly. Each time a new code or category is needed, it is added. If new data cannot be assimilated, the scheme is modified. This process is repeated until the coding scheme reaches “saturation point,” that is, new data can be assimilated without further amendments. At this point, all transcripts are coded again, using the final scheme. (This process is outlined in Charmaz, 2006: 42.)

While it was originally intended that the coding scheme would be developed with the purpose of describing and comparing observed behaviour, it became clear that the scheme itself was becoming a significant product of the research.

Development of the coding scheme.

The process of developing a coding scheme from the concurrent report transcripts distinguished two types of cognition. Many of the statements were easily categorized according to their role in problem solving strategies; goal setting, evaluation and decision making; or they revealed meta-cognitive processes such as rationalisation. For example:

“I’m still right in the middle of the eye. Just trying to coax it into something that I like.” (Concurrent report, AC)

Here the artist is monitoring his progress against a subgoal: to redraw the eye in a satisfactory way. However many statements only demonstrated evidence of apprehending, for example:

“The glasses. There’s the bridge over the nose. The two side pieces that are more obvious than the glass, they help also describe the angle of the head.” (Concurrent report, DC)

While these types of statements are the result of underlying thought processes, such as decisions about what to include in the drawing and routines for locating salient features, it is nevertheless possible to categorize them at face value.

In some instances it was clear that the features apprehended were used to inform evaluative processes, as in the first example, while in others the artists were simply looking and drawing. Initially it seemed that the problem could be solved with an additional category—“input” in which the artist was simply apprehending features to be drawn. Within this category the various types of features could be categorised and nested as a further level of coding. In this way, data about what the artists reported attending to would be included. However, this nesting was problematic, as while not all statements mentioned features, all types of statements sometimes mentioned features, often more than one. This created the need for every type of statement to include this nested level.

A solution presented itself, which was simply to parse and code twice using separate columns. For example, AR makes a decision to change a portion of the drawing:

“Ok. So that’s the sort of compositional size that I want the head to fill. That’s the sort of space I’m gonna use on the page. Ok. The problem there is I’ve just gone too long. So I just need to reassess the shape of the nose, the chin and the mouth in relation to the eyes, so it’s that sort of triangle bit (gestures) in the centre of the head.” (concurrent report, A R)

Statement	Strategic thought	Visual attention
Ok. So that's the sort of compositional size that I want the head to fill.	Evaluation (against subgoal)	Compositional size
That's the sort of space I'm gonna use on the page.	Decision	Overall composition
Ok. The problem there is I've just gone too long.	Evaluation (of part)	Global view
		Relative length
So I just need to reassess	Decision	
the shape of the nose, the chin and the mouth in relation to the eyes,	Subgoal	Shape
		Feature
		Configuration of points
so it's that sort of triangle bit (gestures) in the centre of the head.	Input only	Constructed shape
		Global view

Figure 1. Example of coded transcript with two categories³ (AR)

Here the artist has evaluated the accuracy of her measurements, and is making a decision to change a portion of the drawing. She mentions many separate features, and spatial relationships, so there is a complex interaction between perception and decision making. Figure 1 shows an example of how the double coding was employed.

This solution allowed each transcript to be coded twice. The two coding schemes were separate but related, suggesting two distinct but interrelated types of cognition. These are (provisionally) labelled “strategic thought” and “visual attention.” These categories are described in more detail in the following section, in which the codes and categories are considered in relation to time.

A working model of drawing and cognition

We can consider the example of transcript from the section above in relation to time. This is illustrated in Figure 2. It is clear that strategic statements relate to the immediate past or future, while visual attention (while often employed in strategy) takes place momentarily. This dual temporality is represented by the two axes of the model.

The model below in Figure 3 is constructed in the same way, using the commonest types of statements from the dataset of transcripts from all five artists. It does not include all the categories from the coding scheme, as these would be too numerous for clarity, particularly in the visual attentive dimension.

The horizontal arrow represents the time spent making the drawing. Statements reflecting meta-cognition are more general, or refer to moments in time outside of that time-span, for example they might judge the difficulty of the task, the progression of the artists own skill, or compare the drawing with one made previously. For this reason, they are not directly linked to the timeline. It is unclear whether they should still be considered part of the horizontal axis.

Using the model to describe expert behaviours

While the incompleteness of verbal reports as data mean the model cannot be used to exhaustively describe, or quantify the frequency of, thought processes, it is still useful in a number of ways. It provides a structure within which to describe drawing strategies, and to consider other theories of drawing and cognition. It allows us to consider the aforementioned dichotomy as two domains in which learning happens (in addition to other domains, e.g. schematic knowledge, psychomotor, and affective).

Two expert behaviours were identified. These are skills relating to meta-cognitive control in these two domains: evaluative strategy, including periods of non-judgemental cognitive activity; and control of visual attention (or “attentional strategy” to use Kozbelt’s (2010) term). I will briefly describe these two skills in relation to the case studies.

The existence of periods of non-judgemental

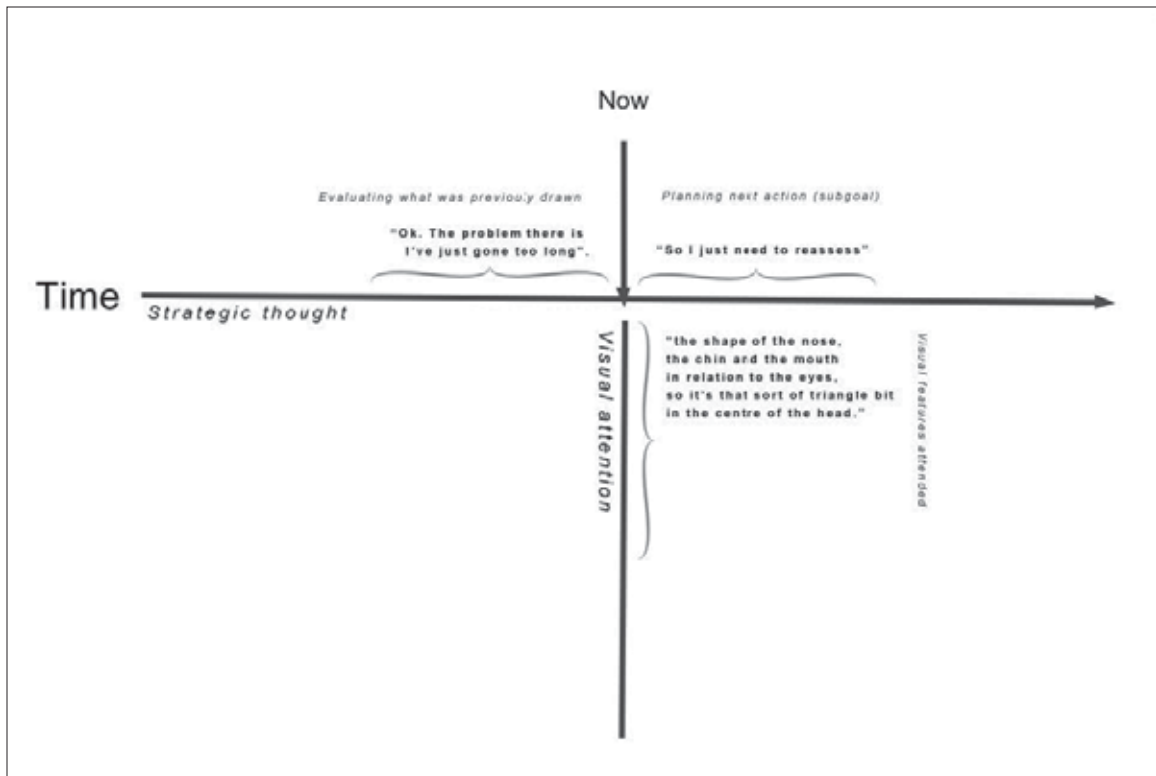


Figure 2. Example of concurrent transcript considered in relation to time.

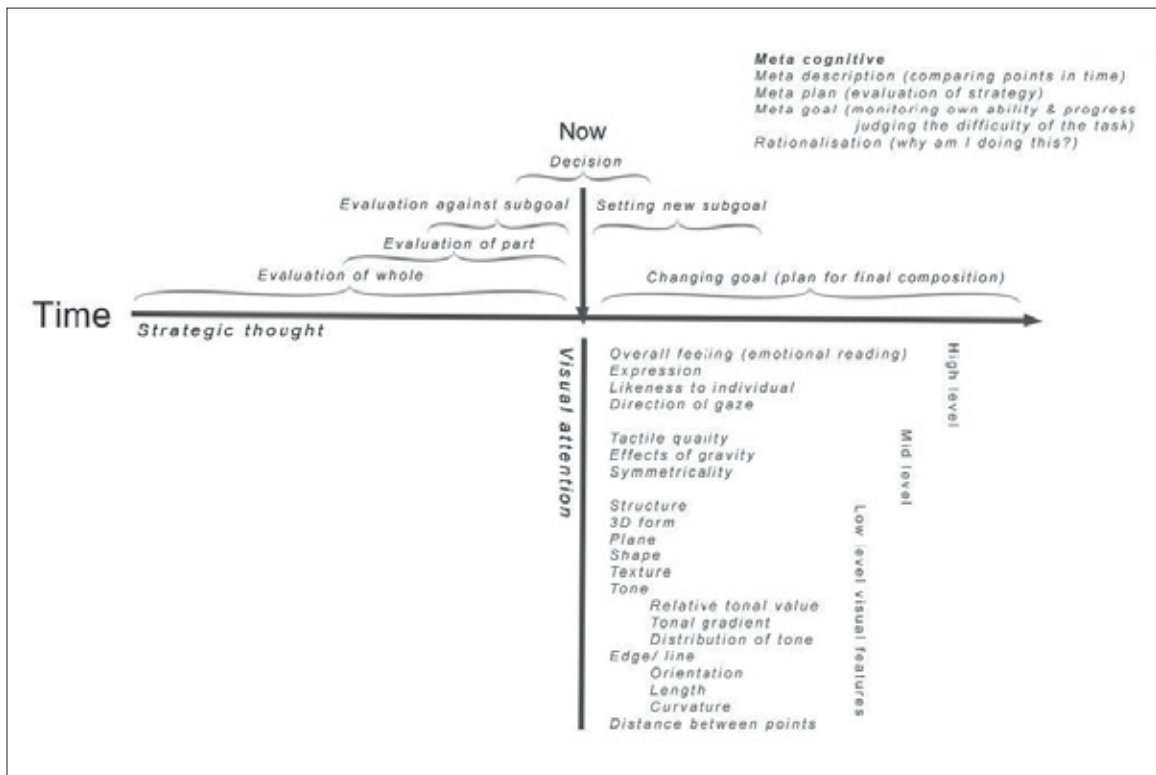


Figure 3. A cognitive model with two temporally distinct categories.

	evaluating	not evaluating
verbalising	<i>possible</i>	<i>not possible</i>
chatting	<i>not possible</i>	<i>possible</i>

Figure 5. The relationship between verbalising and evaluating in AR's drawing process. At first, this did not seem consistent with the behaviour of the other artists in the study.

cognitive activity was most clearly observable in artist AR. It was observable via the types of verbalisation that were possible during different phases through the drawing.

Initially AR objected to the verbalisation task on the grounds that it affected her drawing. That is, she would draw differently while trying to verbalise. She explained that in her practice of drawing female nudes, she would hold conversations with her models, occupying her mind with matters other than the drawing. She felt that this gave her mark-making a spontaneous quality that was lost when the verbalisation task was attempted. Interestingly,

she was able to chat while drawing, but not verbalise the process.

However, there were exceptions to this rule. AR described how there would be moments during the drawing in which she would be unable to chat, and she had to ask her model for a moment of quiet, so that she could look at the drawing. During these moments she would be re-assessing the drawing and making a decision about how to proceed. These evaluative moments were easy for AR to verbalise, and we tried a new approach in which she would only verbalise what came naturally, and would not feel obliged to talk continually.

This new approach revealed pauses in drawing accompanied by evaluative judgement and decision making, interspersed with longer, quiet periods of continuous drawing, during which she rarely paused.

Two polarities can be identified in this behaviour: chatting and verbalising, evaluating and not evaluating. The relationship seemed to be that verbalising was not possible during the continuous drawing (not evaluating) and chatting was not possible during the evaluating, and vice versa (figure 5).

At first, this did not seem consistent with the behaviour of the other artists in the study.

However, this is likely to be due to differences in the drawing processes rather than to differences in the underlying cognitive mechanisms. The other artists' evaluative strategies took place much more frequently, and were interspersed throughout the



Figure 6. Sample of timeline showing timing of AC's drawing behaviours

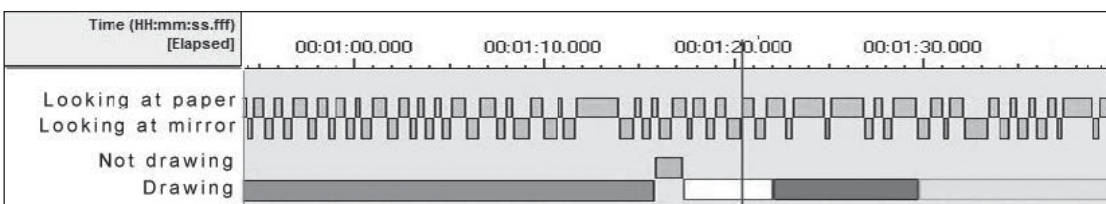


Figure 7. Sample of timeline showing timing of AR drawing behaviours⁴.

drawing process, making it more difficult to pinpoint exactly when evaluation was taking place.

For example, AC paused frequently (roughly every two seconds) usually holding the pencil close to the surface of the paper, as if rehearsing the marks while observing features in the mirror. He would then watch himself draw a few marks and review them for a fraction of a second before returning his gaze to the mirror. This pattern of behaviour was very consistent and can be observed in the behavioural analysis (see figure 6). It is clearly distinct from AR, who tends to draw continually for several minutes, before pausing to evaluate (see figure 7)

It is unclear whether the relationship between evaluation and verbalisation in Figure 5 is present for AC, but there is clearly a strategy which segregates periods with and without evaluation. He is first apprehending features, then monitoring the progress of a single mark before reviewing it in the context of the surrounding drawing. Periodically he might also step back from the drawing for a more comprehensive assessment.

Distinct attentional strategies can also be identified. Each artist showed deliberate control over their attentional modulation; this might be referred to as top-down attentional control or selective attentional tuning. This can be seen in the progression of the types of features apprehended during subroutines (including drawing subroutines and evaluative subroutines), as well as over the course of the drawing as a whole. Concurrent reports of attentional strategies were supplemented by retrospective reports, in which the artists were able to give more detail about what they were attending to during the process.

Evaluative subroutines usually progress from high level to low level visual features, For example the artist might initially look at the whole drawing and ask “does it look weird? Or, Is it a good likeness?” If somehow it feels wrong, they will drill down to look for the cause by comparing the drawing with the original to identify the part that contains the error, before re-measuring or reconstructing that part from low level features.

Drawing subroutines usually included longer periods in which one or more types of features were sought exclusively, and this would differ at varying stages of the drawings. For example, AR roughly phases her drawing activity in this way, attending first to spatial relationships and sizes, followed by planes, structure and tonal relationships, only later

looking for fine detail and texture.

The significant thing in both evaluative and attentional activity was the level of control the artists demonstrated. These skills are likely responsible for the kinds of “perceptual advantages” Kozbelt measured in artists (2001, 2010), and can be considered transferable in this sense.

Significance of preliminary findings and observations

I would like to propose that the distinction between evaluative and attentional strategies can be useful when considering how to facilitate learning. Drawing facilitates the development of metacognitive control in these domains. We can think of drawing instruction “as a training in thinking” (Archer 2011), and can be mindful of a space in which many approaches and conventions for drawing exist. Students can be encouraged to navigate their own strategies for “thinking through drawing” that are appropriate for their own aims, rather than merely learning conventions such as the Coldstream method. In doing so, they can gain awareness and control of cognitive strategies which are widely transferable.

It is also possible to use the model as a way of considering other theories and accounts of artists’ thought processes (during drawing), although this is outside the scope of the current paper. I would like instead to address an issue that was raised several times during the symposium; a perceived widespread decline in drawing skill among UK school leavers, and the phenomena of not feeling able to draw, or an anxiety about drawing ability. I believe these problems relate not only to the amount of drawing in the curriculum, but might also be symptomatic of the atmosphere in which attitudes to learning are nurtured, in which assessment is (in my view) overemphasised. This view is speculative, but I will try to articulate it below, in order to invite responses.

Arts education is often celebrated for developing critical judgement and problem solving abilities. But the ability not to judge—to deliberately postpone critical thought—is overlooked. I would like to propose that this ability is an important skill in the drawing process, as well as more broadly in creative and learning processes. To run with an idea before judging it can foster divergent thinking and reveal unexpected outcomes, while drawing a line non-judgementally can enable spontaneity and

directness in the resulting marks made (as we saw in AR's drawing process), which can be stifled by continuous self-judgement. I feel that a widespread overemphasis on assessment in UK schools and colleges engenders this type of anxiety. Of course, some assessment is necessary, and formative feedback can inform learning, but it is possible that a continual sense that all one's work will be assessed and judged (against often ambiguous criteria) might be unhelpful, perhaps giving rise to an excessively self-judgmental attitude that is detrimental to spontaneity.

Assessment may be extrinsically motivating in the short term, but it is important to also think of the bigger picture. For a young person to have spent the majority of their lives in institutions that give quantitative feedback on every piece of work, must have a substantial effect on the way they relate to themselves and the world. McLuhan's (1964/2001) dictum that "the medium is the message" seems particularly apt in this scenario. What kind of attitudes are we conditioning young people to leave school with, as a result of our teaching methods? And how many of these are unintended?

While addressing this issue would be a very complex task, both in terms of addressing the research questions implied, and the possible ramifications, it is nevertheless possible to consider how we might develop teaching resources which account for the skills of spontaneity and postponement of judgement. I would like to invite responses to this proposition.

Footnotes

- 1 Please contact the author for an account of the procedure.
- 2 There are a number of issues with the use of verbal reports as data in studies of drawing, such as the possibility of post-rationalisation, the incompleteness of the reports, and the effect of the verbalisation on the drawing itself. The study proposes also to explore the extent to which these methods can be useful, although these matters lie outside the scope of this paper.
- 3 Contact the author for details of definition of

codes and rules for parsing.

- 4 Different shades in the drawing categories represent different types of drawing behaviour not discussed here.

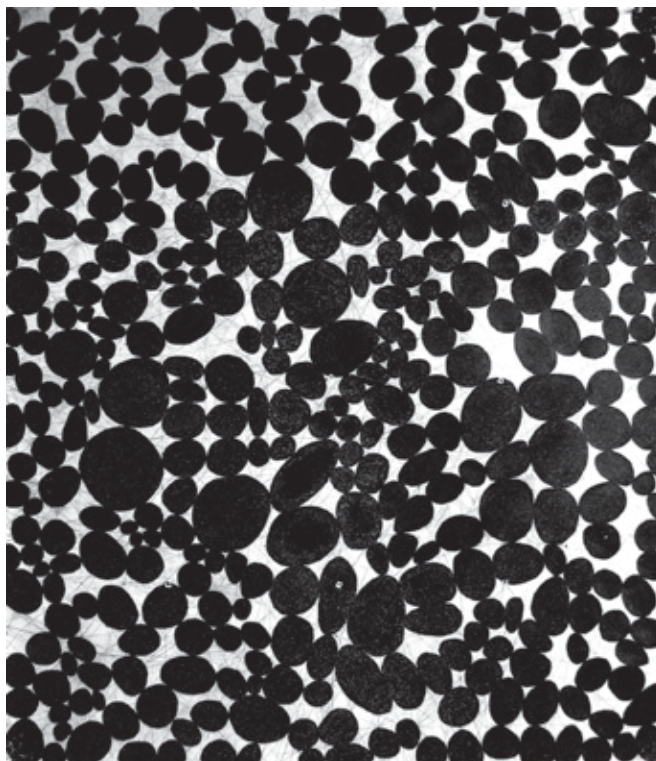
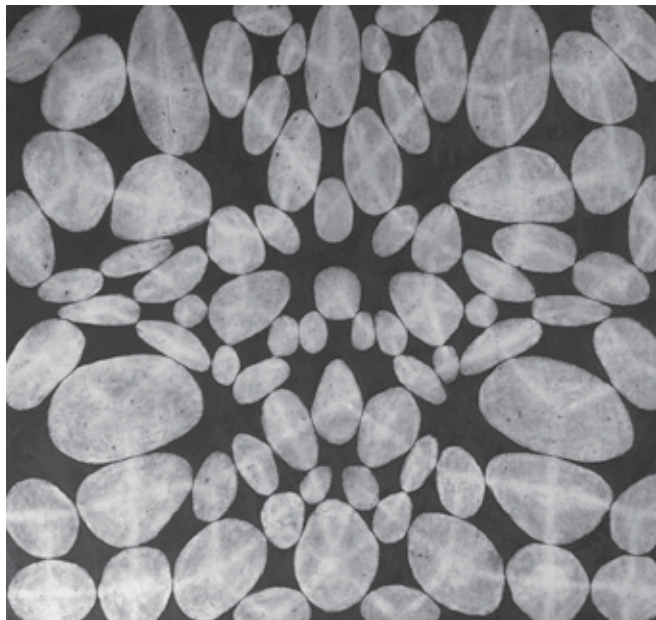
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From the exhibition:

William Holton

My work is driven by the accretion and accumulation of many simple parts to create complexity based upon the relationship between these parts. This complexity unfolds simply from proximity, overlap, or how edges meet, etc... I introduce contingency by setting simple, loose rules that come from the drawing itself as I work. This idea of having a conversation with the work, letting it tell me what needs to happen next, informed by what has already happened, is central to how I think with the drawing while drawing. "Annihilation" alludes to how the paper itself was prepared. I began with pentimenti left from the destruction of the old drawing that was already there. By peeling off that image bit by bit with tape, I rendered the paper as white as possible and began the new drawing from there, informed by these traces of marks. The title also reflects my fascination with particle physics and self-regulating systems in nature such as the human brain, the earth, or the universe itself.

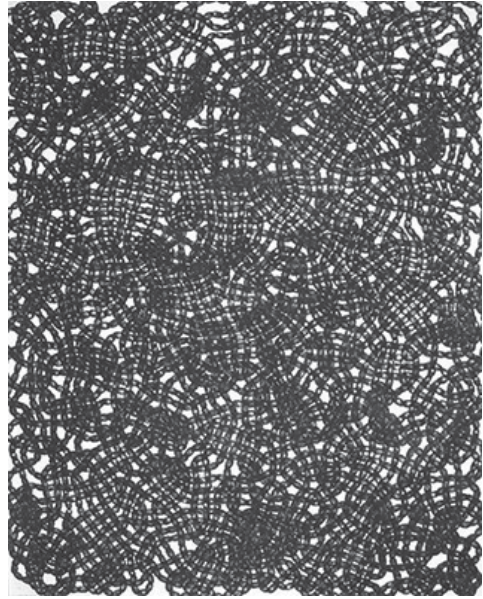


Top: Annihilation, 45" x 48"
China marker, charcoal, graphite, pigment on prepared paper, 2010

Bottom: Green Chimneys, 47" x 33"
China marker, graphite, pigment on prepared paper, 2010



Left: Local Feedback, 53" x 38",
Charcoal fingerprints on paper, 2006



Right: Pulse, 53" x 36",
Charcoal fingerprints on paper, 2006

From the exhibition:

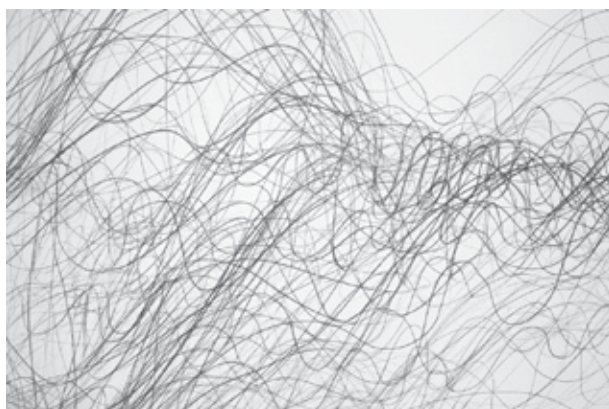
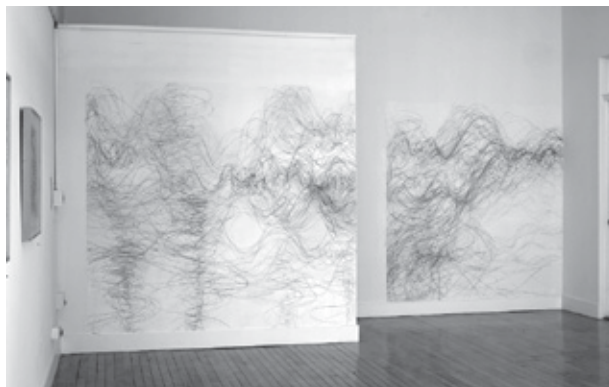
Margaret Neill

Drawing is central to my practice as an artist. I draw to investigate the properties of abstract curvilinear form found in the localized conditions of my surrounding environment. This experience is sublimated in a process both primal and analytical in developed drawings that are composed of deeply layered intersecting geometries and invite the viewer to contemplate presence in the fluidity of time.

I make drawings to forge a path to new territories of my perception. Using pencil on paper or directly on the wall, I explore a singular concept—a reaffirmation of place: a lived emotional and physical experience in sensation and memory. Linear or solid, dense or transparent, the drawings move from one to the next in ephemeral yet solid works that celebrate light and space. They record a portrait of their space by subliminal means. A wall drawing is the intense emotional presence of their location and the activities within. The pressure and buoyancy of the unfolding shape propels each work forward. They have a feeling of air, sound, and speed, an ineffable material that can be pushed or blown through time. An undercurrent of urgent necessity drives this work as each piece unravels the strands of line into shape. My drawings are a mechanism of idea, desire, and presence; these works seek a way of being that is quiet, continuous and alive.

Top: DRIVER, 80" x 196", in two panels
Pencil

Bottom: ESTUARY 3, 24" x 25"
Pencil on paper mounted on panel, 20011



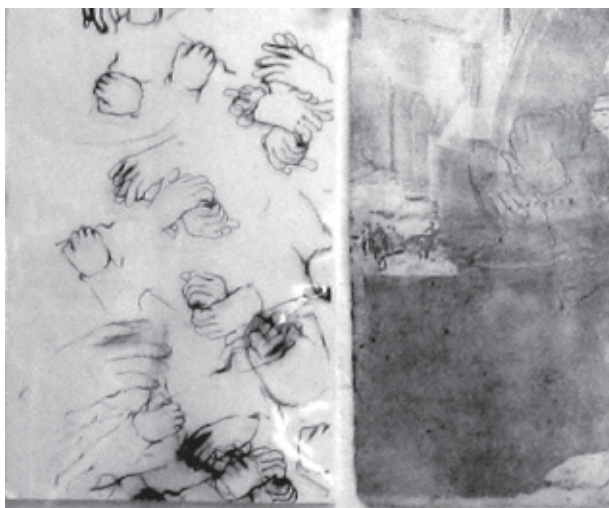
From the exhibition:

Sumru Tekin

The drawings in this installation suggest in their multiplicity, and repetition, a continuous re-imagining of the distance between invention and fact—between an original and its copy[ies], between an event and its representation. It is in that space of uncertainty where the attempts to represent what cannot be represented are made visible. The repeated gesture, mark, and image are activated as ceaseless, inadequate responses to the question: “what if it looked like this, or this, or this—instead of what it appears to be?”



translation/suspended gesture, 2011
Dimensions variable. Pencil, ink, black and white
photograph, photocopy, photo transfer, mono
print with carborundum and engraving on various
papers.



Interdisciplinary Collaborations



J. Fiber (Jane Fine and James Esber)

The Perceptual Foundations of Drawing Ability

Rebecca Chamberlain
University College London

Howard Riley
Swansea Metropolitan University

Chris McManus
University College London

Qona Rankin
Royal College of Art

Nicola Brunswick
Middlesex University



Abstract

Observational drawing is fundamental to artistic practice, by enhancing perceptual processing (Kozbelt, 2001; Seeley & Kozbelt, 2008) and creativity (Chan & Zhao, 2010; Pratt, 1985) regardless of an artist's specialist medium. However, the perceptual and memorial processes underlying drawing ability remain poorly characterized. The aim of this exploratory study was to measure the contribution of visual long-term memory, visual perception and attitudes and abilities in education, to drawing. Long term memory was found to be correlated with drawing ability, confirming previous findings (McManus et al., 2010). Specific visual perceptual faculties such as the identification and reproduction of geometric characteristics also accounted for a proportion of the variability in drawing ability. However, learning disabilities such as dyslexia were not predictive of inaccurate drawing. In light of these findings, pedagogical methods are proposed using an *Eight Step Strategy*, which focuses upon elements of the visual scene such as figure/ground and spatial relationships.

Introduction

This article is an extended version of a presentation made to the Thinking Through Drawing conference held at the Teachers College, Columbia University, New York City in October 2011. The authors would like to thank the organizers, Andrea Kantowitz, Angela Brew and Michelle Fava for the opportunity to share their research, which has been driven by the authors' common interest in the

various processes employed by art and design students. This common interest developed in the first instance from an initial aim to study a potential relationship between dyslexia and drawing ability, and to this end, studies were conducted between 2008 and 2011 in collaboration with students on the Foundation Diploma course (a diagnostic, pre-degree year) at Swansea Metropolitan University, Wales, and with Masters level students at the Royal College of Art, London.

There is much evidence to suggest that individual differences in visual perceptual processing underpin differences in drawing ability. One of the earliest studies of perceptual advantages in artists in general was conducted by Theron Cain (1943) who found that individuals who were able to copy simple geometric shapes were also more likely to gain higher grades at art school. Cohen and Bennett (1997) followed this line of inquiry in their seminal study on the effect of motor coordination, representational decisions and misperception on drawing accuracy. They concluded that misperception of the to-be-drawn object was likely to be the greatest source of drawing errors, but did not posit precisely which perceptual errors were most likely to yield inaccurate depictions. In a more recent study (Kozbelt, 2001) artists' perceptual expertise was investigated using visuo-spatial tasks including Gestalt completion, embedded figures, mental rotation and line drawing. Artists outperformed novices on perceptual and line drawing tasks, and a large proportion of the variance in perceptual and drawing scores was shared, suggesting the influence of visual

processing on drawing performance. Furthermore, a recent study by Cohen and Jones (2008) suggests that artists that are more impervious to phenomenal regression produce more accurate drawings. In line with these earlier findings, our initial studies aimed to assess the relationships between drawing ability and: dyslexia; visual memory ability; perception of geometric figures; and phenomenal regression.

Method

Participants

The sample consisted of 105 art students (84 female, mean age = 21.7 (+0.4) years) attending the Art and Design Foundation course at Swansea Metropolitan University (SMU).

Apparatus and Stimuli

Questionnaire and drawing/perceptual tasks were completed in one A4 size paper booklet. Participants were provided with HB pencils, erasers and sharpeners to complete the tasks. All visual stimuli were presented via a Microsoft Office PowerPoint presentation, presented on a 4x3 m projector screen.

Questionnaire

1. *Self-perceived artistic and design ability* – Rated artistic performance on a range of skills in relation to others studying art and design. Responses were indicated on a 5-point Likert-type scale ranging from “much above average” to “much below average”.
2. *Drawing and painting experience* – Amount of time spent drawing and painting currently and over the past two years on an 11-point scale ranging from “most days for 4+ hours” to “never”.
3. *Communication and numerical difficulties* – Family history or a personal diagnosis of dyslexia, dyspraxia, dyscalculia, stuttering or stammering.
4. *Spelling test* – Correct spelling of a word from 4 alternative spellings for 20 commonly misspelled words (Brunswick, McManus, Chamberlain, Riley, & Rankin, 2011)
5. *Mathematical ability* – Response to a range of statements on attitudes to mathematics on a 4-point scale ranging from “strongly agree” to “strongly disagree”.
6. *Educational background* – GCSE, AS and

A-Levels (subject-specific academic examinations generally taken in the UK at ages 15, 16 and 18) attained for all subjects including art and design

7. *Demographics* – Gender, date of birth, nationality, and parental practice and sympathy toward the arts.

Drawing and Perceptual Exercises

1. *The Rey Osterrieth Complex Figure* (Rey & Osterrieth, 1993; Meyers & Meyers, 1995) – Copy of the Rey Osterrieth Complex Figure (4 mins)
2. *Hand Photograph* – Copy a photograph of a hand holding a pencil (5 mins)
3. *Cain House Task* – Copy of five hexagonal shapes (Cain, 1943) described as representing the cross-sections of different types of houses (5 mins)
4. *Block Construction* – Copy of a construction made from children’s building blocks (5 mins)
5. *Rey Osterrieth Delayed Recall* – Reproduction of the Rey Osterrieth Complex Figure from memory (3 mins).
6. *Doors Task* – An adaptation of stimuli used in a previous study (Cohen & Jones, 2008; McManus, Loo, Chamberlain, Riley, & Brunswick, 2011). Matching of five consecutive computer rendered images of doors at different angles with one of a set of 23 door outlines (20s per image).
7. *Shapes Task* – Methodology as in previous task however visual stimuli were door outlines without computer rendered 3-D information (20s per image).

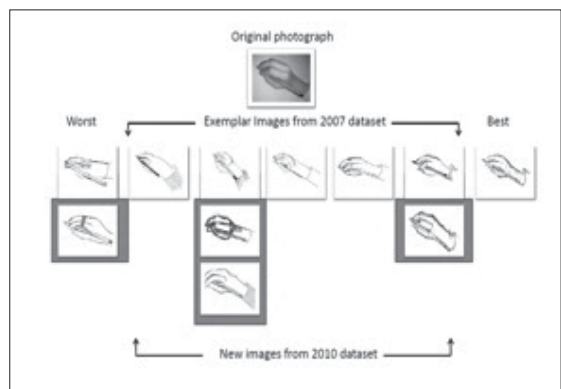


Figure 1. Diagram of drawing rating methodology.

Drawing Rating Procedure for Hand and Block Drawings

Participants’ drawings were rated by a convenience sample of ten non-expert judges consisting of postgraduate and undergraduate students at University College London (UCL). Each judge was required to rate the drawings from best to worst by sorting them into seven categories (Figure 1). Judges were informed that quality of drawing was to be determined solely on the basis of accuracy, and not on aesthetic appeal. Exemplars of the quality of drawing accuracy in each category were given to the judges in order to aid the rating process.

Results

Learning Disabilities and Mathematical Ability

No relationship between learning disabilities such as dyslexia, dyspraxia or dyscalculia and drawing ability was found (all $p > .1$). However, mathematical ability and an interest in mathematics were significant predictors of drawing ability as well as academic

attainment at age 16 but not age 18 (Table 1).

Artistic Practice

Painting and drawing time total values were calculated by adding scalar points pertaining to amount of drawing and painting practice from 2008-09 to 2009-10. Multiple regression showed that amount of drawing practice ($t_{76}=3.55, p < .01, \beta = .54$) and painting practice ($t_{76}=-2.52, p < .05, \beta = -.39$) both significantly predicted drawing rating. This model accounted for 14.5% of the variance in drawing rating scores.

Perception of Geometry and Phenomenal Regression

Phenomenal regression did not predict observational drawing ability but accuracy in the copying of angles and linear proportions were found to be predictors of high level observational drawing ability (Table 2).

Visual Memory

A significant correlation was found between drawing ability and performance on both the Rey Osterrieth copy and delayed recall (Table 3; Figure

	GCSE Mean Grade	A-Level Mean Grade	GCSE maths grade	Maths more enjoyable at school
Externally rated drawing ability	.353, $p < .01$.169, $p = .256$.240, $p < .05$.231, $p < .05$

Table 1. Correlations between GCSE scores, math ability and attitudes toward math and observational drawing ability (n range 47-102)

	Angular Error	Proportional Error
Externally rated drawing ability	-.296, $p < .01$	-.233, $p < .01$

Table 2. Correlations between drawing rating and angular and proportional errors on the Cain house task (n=102)

	Externally rated drawing ability	Cain House Task Angle Error	Cain House Task Proportion Error
Rey Osterrieth Copy	.299, $p < .01$.085, $p = .393$.014, $p = .890$
Rey Osterrieth Delayed Recall	.266, $p < .01$.015, $p = .880$	-.023, $p = .820$

Table 3. Relationship between Rey Osterrieth Performance, Performance on the Cain House Task, and Observational Drawing Ability (n range 98-104)

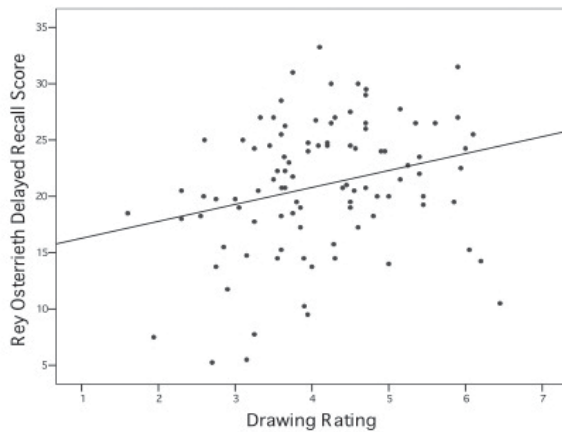


Figure 2. Relationship between Rey Osterrieth delayed recall score and drawing rating 2).

Discussion

Drawing practice significantly predicted self-perceived and externally rated drawing ability, and accounted for a moderate amount of the variance in drawing scores. This suggests that expertise in drawing is developed over time, in much the same way as other areas of expertise (Ericsson, Charness, Feltovich, & Hoffman, 2006). Chan & Zhao (2010) found that involvement in the arts correlated with drawing ability most greatly in young adults, suggesting that dedication to arts in general may be a good predictor of drawing ability. Similarly, academic achievement also seemed to underpin drawing ability at GCSE level, however this correlation disappeared by the time students reached A-Level. The foundation of the relationship between academic achievement and drawing ability could be due to intellectual functioning. Alternatively, the relationship could be sub-served by motivational factors. The manner in which academic achievement in general, and practice in the specific area of expertise, contribute to drawing ability has yet to be investigated.

Observational drawing ability appears to relate to the ability to process simple geometrical relationships between components of the subject-matter under observation. This suggests that subtle nuances in direction of line, which when violated give rise to the feeling of poor drawing, are reflected in the angular properties of the visual stimulus. Artists appear to break down more complex images into simple lines (Tchalenko, 2009) therefore identi-

fication and replication of subtle angular deviations within complex lines could be the basis of accurate observational drawing. Whether perceptual heightening as demonstrated in these drawing tasks transcends the rendering scenario is a matter of debate in the literature (Glazek, 2011; Glazek & Weisberg, 2010; Phillips, Inall, & Lauder, 1985; Seeley & Kozbelt, 2008).

Positive correlations were found between performance on the Rey Osterrieth Complex Figure task and drawing ability, suggesting that visual memory is implicated in the drawing process. This link is independent of any relationship between perception and drawing as scores on the Rey Osterrieth memory condition did not correlate with errors in the Cain house task. It is necessary to develop memory tasks that do not call upon drawing as previous research has found differences in visual recognition memory attributed to artistic competence only when graphic depiction is involved (O'Connor & Hermelin, 1987). Stimuli such as those used in the Cain house task in Study 1 would be ideal for this kind of analysis. They have similar geometric properties as the Rey Osterrieth complex figure and can be subtly manipulated to produce many variations on one original image for use in a delayed match to sample task as used in previous investigations (Bays, Gorgoraptis, Wee, Marshall, & Husain, 2011; Glazek & Weisberg, 2010; Sullivan & Winner, 1989)

Directions of future research

The current research suggests that accurate perception of the geometry of the stimulus gives rise to more accurate drawing. If accurate perception does in fact lead to accurate production, then strategies can be incorporated into drawing teaching that exploit these faculties.

A primary objective is to develop *inclusive* strategies for the teaching of drawing, which empower all students. An exploration of the *Eight-Step Strategy* first introduced by Sherrie Nist and Donna Mealy (Mortimore, 2011, p.113) is being conducted as a means of teaching dyslexic students, but is here adapted and developed from current findings:

1. *Focus attention upon a) the model and their surroundings (figure/field relationship), and b) the relationship between scale of drawing and size and format of paper. See Figures 3 & 4.*

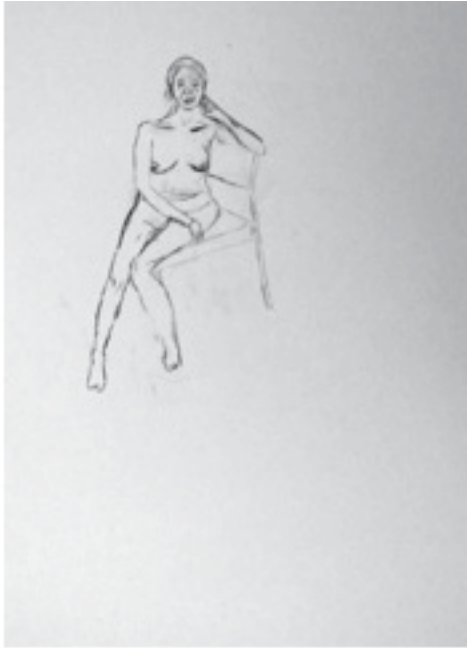


Figure 3.



Figure 4.



Figure 5.



Figure 6.

An example of a lack of awareness of the semi-otic potential implied in the relationship between the model and her surroundings is illustrated in Figure 3.

The scale of the drawn figure bears an uncomfortable relationship with the scale of the sheet of paper, and its positioning within the sheet allows no relationship with the key axes (central vertical, central horizontal and the two diagonals) to be perceived by the viewer. Moreover, the figure appears unrelated to its surroundings; not a single mark is deployed to explore the tonal contrasts between the figure and the surroundings, or the possibilities of geometric harmonies between the linear proportions and the angles within the figure-shape and those of the environmental context.

Once attention is focussed upon the figure/field relationships, we see in Figure 4 the possibilities for expressing the rhyming and the rhythms that exist between the two, the figure is seen to be integrated with its environment, and also with the format of the drawing sheet.

2. *Explain a general overview of the task: in terms of drawing from observation, this is the equivalent of mapping the spatial relationships between salient points on the subject-matter under observation, whilst at the same time keeping an awareness of the proportions between the figure and the drawing sheet (Wholist mixed with Analyst cognitive styles)*

The “N-Grid”, a network made up of those salient points on the figure; Nose, Nipples, Navel, kNees, kNuckles, is a useful concept to introduce the method of triangulation, a way of maintaining accuracy between the location of those salient points, and the proportions and angles which relate those points.

Figure 5 illustrates a lack of awareness of the N-Grid, with the result that proportional relationships within the figure are not under control, neither are the relationships between figure and surroundings.

Here in Figure 6, on the other hand, we see evidence of control of proportions, both within the figure itself and between the figure and surroundings.

3. *Introduce new terms, such as “contrast boundary” and “negative space”.*



Figure 7.

The term *contrast boundary* refers to the juxtapositioning of light and dark tones at each edge formed when one material surface is occluded by another. The term is preferred to the more common one, *outline*.

Negative space is a term familiar to most teachers of drawing. It refers to those spaces observed between objects, the spaces for which we have no word to describe. Thus, a way of looking without language acting as some kind of visual filter is encouraged. It appears that those spaces are drawn with more accuracy than those shapes/objects to which we have allocated words. Evidence of the student’s awareness of both these useful concepts is illustrated in Figure 7.

Steps 4 to 8 are laid out below, and mainly refer to the strategies of repetition and discussion with tutors:

4. *Repeat first three steps at the beginning of every session.*
5. *Discuss with tutor the process underway on the drawing board.*
6. *Repeat the tutor’s strategy with support from the tutor.*
7. *Draw independently at unsupervised sessions.*
8. *Re-demonstrate strategies at each session as reinforcement.*

Summary

Associations have been found between drawing ability and academic achievement, visual long-term memory and perception of angular relationships. It seems the *Eight Step Method* is adaptable and useful in the context of these findings: Students, both dyslexic and non-dyslexic, report improvements in their observational drawing.

The impact on perceptual functioning as a result of the Eight Step Method: Novices who have not had extensive training in drawing can be tested for visual memory and perceptual ability before and after drawing tuition in order to assess whether the act of drawing serves to improve perceptual functioning. This will extend current findings from correlation to causation, and will test the hypothesis that drawing leads to domain-general perceptual enhancement, further characterising the mechanisms by which perceptual and memorial functioning come to be associated with drawing ability.

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Paul the Robot as a Naive Drawer

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Paul, a cybernetic entity, is the expression of Tresset's artistic practice. This robotic installation utilizes some of the technology developed in the context of the Alkon-II project.

Drawing is the human activity investigated in the AlkonII project. The research uses computational and robotic technologies to explore drawing. In particular the research focuses on observational face sketching. The main goal is to shed some light on the (mind) processes that may characterize the emergence of style during a sketching creative act.

Our project follows three main research paths based on: (i) the study of sketches in archives, notes left by artists and specialists' research; (ii) contemporary scientific and technological knowledge; (iii) an artist's insights (in the present case, Patrick Tresset). Even if still partial, the knowledge of our perceptual and other cognitive systems has progressed, and advances in computational hardware, computer vision and artificial intelligence, now permit the computational simulation of some perceptual, and cognitive processes. It is thus nowadays possible, with some imagination and insights, to implement a coarse computational simulation of the processes active when an artist is sketching faces from life.

One important objective of our investigation is to implement an embodied computational system capable of simulating the various important processes involved in face sketching. The ensemble of processes to be simulated include: (i) the visual perception of (a) the subject/sitter and (2) the sketch itself, (ii) the drawing gestures, (iii) the cognitive

activity (including reasoning), (iv) the influence of the years of training (or experience), (v) the inter-processes information flow (or connectivity amongst processes). Note that due to our current knowledge and technological limitations the implementation of each process remains coarse and approximate. However, the implemented system is expected to draw in its own style.

Although Paul utilizes some of Alkon-II research output, Paul is more craft than precise science. Our goal for Paul is to have it draw interesting sketches of the public. Nevertheless the drawings produced are noteworthy of gallery exhibition quality. In the discussion we elaborate on why Paul may produce aesthetically pleasing drawings.

When we are exhibiting installations where Paul is a performer, we are exploring on one hand the performative nature of drawing and on the other the perception the audience has of the artistic practice and the artist. We remain safely away from the uncanny valley (MacDorman, 2005; Mori, 1970): Paul does not pretend to be human. It is only an obsessive drawing entity. It has only one eye (camera) and an ordinary laptop serves as its brain. The (crude robotic) arm's limited freedom makes it only able to imprint curvilinear traces or erase these. Yet, Paul is displaying some form of attention when focusing on a person and some form of intention as for tracing a line there is an implicit need for intention. The presence of intention is even more striking if the action slightly fails, such as when the arm is attempting to draw a straight line but not managing to do it perfectly.

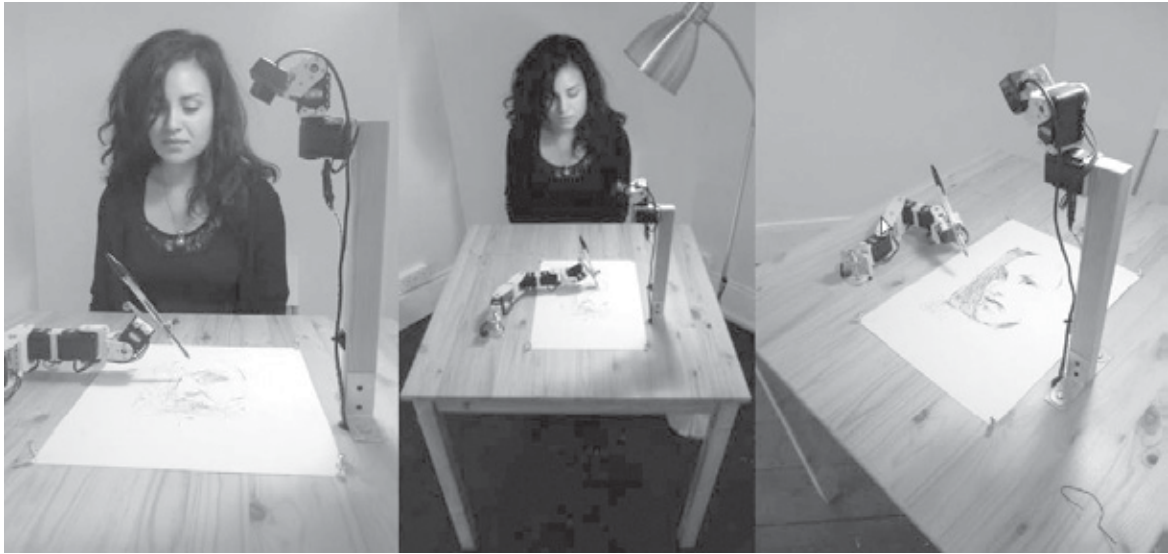


Figure 1. Paul the robot drawing Stella, Tenderpixel Gallery, London, U.K., June 2011.

Background

There are many examples of computerized systems attempting to draw from reality, e.g., in computer graphics, a subject referred to as Non-Photorealistic Rendering or NPR (Gooch & Gooch, 2001; Brennan, 1982; Chen et al., 2004); these systems produce approximate renderings extrapolated from reality, usually by taking as input digital images or photographs. NPR systems are meant to produce figurative paintings, while the scope of our research is focused on figurative drawings.¹ Recently, Colton explores another facet of NPR by using an approximate facial expression recognition AI system to influence the painting style.² To the best of our knowledge, the vast majority of NPR systems are designed to render drawings in a particular style by producing output images mimicking a final result with little attention paid to the creative steps and feedbacks involved in the artistic generation itself: i.e., how, as Zeki formulates it (Zeki, 1998), the artist laboriously extracts permanent, lasting and enduring features from a visual stimulus forming a novel presentation of the original subject.

The pioneering work of Harold Cohen with his AARON system (Cohen, 1988) is probably the most important exception to this (NPR) trend from Computer Graphics, in which a model of the artist's activity whilst drawing/painting from imagination has been studied, implemented and refined over the years and successive generations of the system itself. Since the early days of his work on the AARON

concept in the 1970's, Cohen has stressed that the crucial behavior common to any kind of art is the awareness of the work in progress: therefore some form of feedback—eventually consciousness—is essential to art genesis. A program with the ambition of generating art has to show this capacity of assessing the result of its past actions to influence future actions. In contradistinction to Cohen's work, which makes no real-time use of computer vision, we investigate the artistic drawing activity whilst drawing from reality and memory as well as from imagination.

There also has been a long tradition of drawing automata or systematic machines which we can trace back to at least the 18th century, e.g., with Maillardet's automaton which was able to draw seven sketches and write four poems. Closer in time to us are important links between the origin of computational art and drawing machines. The Algorithmists who were pioneers of the field made extensive use of early drawing machines, in particular pen-plotters. A notable member of this group is Roman Verostko, who was celebrated in 2009 by ACM Siggraph with the attribution of a prize honoring achievements in digital art, and who still uses pen-plotters. Although Harold Cohen has for some time now used large format ink printers as output for AARON, until the early nineties he too used custom drawing/painting machines. Interestingly the first versions of AARON were using a drawing robot, a type of mechanical turtle that allowed for

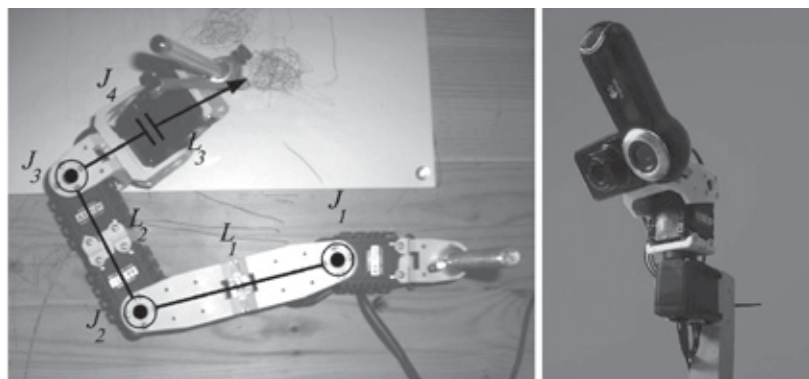


Figure 2. Arm and Eye

J1: Shoulder
J2: Elbow
J3: Wrist
J4: Hand

L1: Upper arm: 108mm.
L2: Lower arm: 88mm.
L2: Hand + pen: 110mm.

large scale drawings. This early robot was performing live notably at Documenta 6, 1977, Kassel in Germany. From Cohen's descriptions we can recognize that the performative quality of the installation had a strong impact on the audience; an effect that later Cohen would judge distracting. In contradistinction, we are interested in understanding what aspects of an artistic creative performance may elicit emotions of the audience or sitter, as this represents yet another aspect of the full understanding of the perception of art.

Paul's technical description

Paul's Hardware

Paul is a robotic hand-eye system dedicated to the drawing activity and conceived to be used as a performer in gallery installations (see fig.2).

Traditionally RC servos have been used as actuators in DIY robotics and low cost research projects, but they present numerous drawbacks, such as not providing any feedback, or the need to have one dedicated wire for each servo. An interesting alternative are smart servos such as the Dynamixel AX-12 Servos manufactured by Robotis.³ Each such servo includes an integrated 8 bit micro controller. The servos are addressed with an 8 bit ID that can be networked in a daisy chain. Commands are sent by writing some values in registers. Servos states (for feedback) are queried by reading values from registers. Commands include velocity, position, compliance, maximum load. Feedback includes position, velocity, load, voltage. Even if the specifications of these servos are rather impressive, they remain low cost actuators. As such they present some other drawbacks including a relatively low resolution and low feedback frequency. Furthermore the associated construction kits are very well

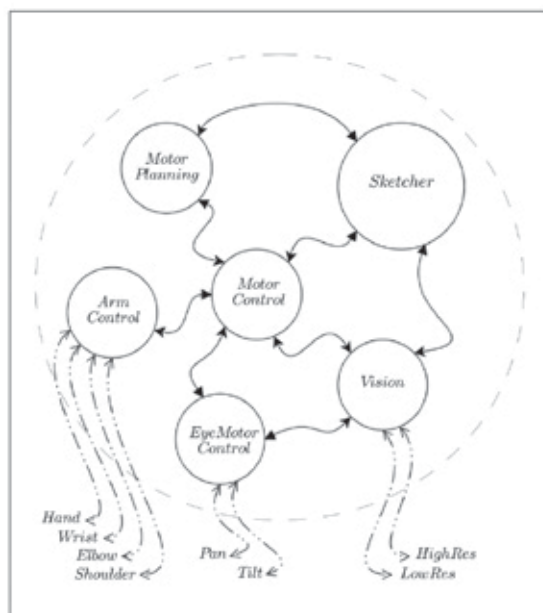


Figure 3. Paul's architecture overview

designed. For these reasons we have opted for these servos for Paul's construction.

Paul's Software

Contemporary robotic software architecture is based on communication between concurrent distributed processes. In recent years we have seen the development of open source robotic software frameworks such as ROS4 and YARP5 . These frameworks help organize communication between sensors, processors, and actuators. One of the advantages of these frameworks is that they facilitate the components' reuse and have a large ecosystem of research teams that use these and

continuously publish new components reusable for other projects. Paul is currently using YARP as a framework. The choice of YARP was following the participation in the BCBT20096 summer school, where YARP was introduced.

For Paul's successors the system is being ported to ROS as it is now a more complete system, seems to be becoming a standard in robotic research around the world and also provide a large range of reusable components. An overview of Paul's current framework is presented in Figure 3.

Paul's sketching cycle

Overview

1. Scan the environment by moving the eye until a face is detected. Use a line feature detector.
2. Focus the eye onto the sitter.
3. Limit the region of interest (ROI) to a close-up framing.
4. Convert the ROI to gray levels.
5. Make an image pyramid with n levels.
6. Draw salient lines with increasing precision.
7. Perform the shading behavior.
8. Execute the signing script.
9. Human operator mechanically and boringly detaches the paper, gives it to the sitter and puts a new sheet of paper while Paul cools down and waits for the next sitter.

Discussion

Since June 2011 Paul has sketched more than 450 individuals and has been exhibited in various locations (London (a few times), Istanbul, New York, Camden (Maine)). The response from the audience has been very positive, especially when considering the responses from artists and other art professionals. It is surprising that such a relatively simple entity can produce so constantly interesting and often unexpected drawings.

We can propose a range of hypotheses that could explain why Paul draws relatively well.

An artistic evaluation. Patrick Tresset, Paul's main developer, is an artist who practiced drawing extensively and as such has used his insights to craft the program. Patrick has also evaluated Paul's output as if it was his own, and has used this feedback to adapt the software until the output became satisfactory. As such we could assume that Patrick has taken charge of a part of the drawing process. The drawing should be seen as the result of a collabora-

tion between a human artist and a robot.

A naive drawer. Paul is a naive drawer. Paul has no memory, no concept of what a face is. As such his drawings are not negatively influenced by the knowledge of a subject, what Van Sommers calls the "conceptual bias" (Van Sommers, 1984).

The depiction of salient features. When Paul draws salient lines they are extracted from the response of Gabor filters which are accepted as good simulations of simple cells in the early visual cortex. In computational models of visual attention such as Itti's (Itti & Koch, 2001), Gabor filters are used to build one of the saliency maps. Areas that display high orientation disparities are the salient regions. In effect Paul puts an emphasis on regions that would be expected to be perceived as salient.

The influence of decisions based on visual feedback. Although there is very little use of feedback data to control the otherwise random shading process, it seems that this is sufficient to produce patterns that are perceived as not due to chance, and as such perhaps richer in emotive content for a human observer.

Paul's physicality. Like a drawing produced by a human, Paul's drawings are the results of movements: as such they are the record of a process. We can hypothesize that this adds to the richness of the experience when an observer is reading the sketch. Furthermore due to the configuration of Paul's arm the type of errors it makes might be perceived as rather natural by a human observer.

These factors are at this stage hypotheses that will be investigated in the near future. It is even possible that the combination of these characteristics facilitates the production of satisfactory drawings.

Beyond Paul

The successors to Paul will in the near future evolve in two directions. On the one hand some will evolve towards being more theatrical and be presented in an art context. Their the first evolution will be to shorten the time it takes to do a drawing from 20-30min to 10-15min and tell the sitter that they have to sit and remain still for the duration of the drawing session. This will require that Paul keeps the sitter interested, for example by pretending to look at the sitter more often, and perhaps by doing some entertaining actions or gestures. On the other hand we are continuing work on the research version that will provide a more accurate model of the sketching activity. As such the system will make

constant use of visual feedback during the drawing activity. It will also have a priori knowledge of what a face is, and how to represent it.

Footnotes

- 1 The production of computational abstract art works has been far more prolific (Whitelaw, 2004), but covers a too wide range to be as relevant to perception and our attempt to open the window on the artist's mind.
- 2 Refer to Simon Colton's research at Imperial College London on emotionally driven painterly renderings: www.thepaintingfool.com.
- 3 www.robotis.com
- 4 ROS, Robotic Operating System, <http://www.ros.org>
- 5 YARP, Yet Another Robotic Platform, <http://eris.liralab.it/yarp/>
- 6 <http://bcbt.upf.edu/bcbt09/>

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Figure 4. Sketch of Stella by Paul the robot, Tenderpixel Gallery, London, U.K., June 2011.



Figure 5. Sketches series by Paul, Tenderpixel Gallery, London, June 2011.

(in Japanese; see MacDorman 2005, Appendix B, for English translation).

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Evolving Dialogues between Surgeon and Drawing Practitioner

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Medical professionals regularly produce drawn images as a means of recording and explaining. In particular, surgeons produce drawings as a means of noting information on patients' records. Drawings are also regularly used to teach complex anatomical structures and surgical procedures. Drawings can also be seen on the patient's body prior to an operation. After working sometime in operating theatres at St Bartholemew's Hospital, London (Bart's), the haptic nature of the action and process of drawing and surgery appeared to be a fundamental concern to both surgeon and artist.¹

Collaborative work with surgeons and other medical practitioners using drawing included collecting and making images before, during and after operations. Images retained for research, included sketches made by surgeons for patients, medical students and of tissue samples for laboratory use. Drawings made to record the processes of particular operations, of anatomical structures and encoding haptic interventions, were made by drawing practitioner Jenny Wright.

Originally drawing research was undertaken at Bart's hospital, during complex maxillofacial procedures undertaken by consultant maxillofacial surgeon, Mr Neil Shah. Later work was made at Moorfields eye hospital under the supervision of Miss Narciss Okhravi and Mr Ananth Viswanathan consultant ophthalmic surgeons.

The initial premise was to discover the contemporary use of drawing in the field of medicine. It quickly became obvious that drawing was a common tool in the surgeon's repertoire of record

keeping and teaching. In the words of Karen Ellis Barzman (1991) drawing was a normal, convenient "graphic conduit—a passage between one body of knowledge to another".

Initial research found many different examples of drawing practice made by surgeons inside and outside theatre. A collection of these drawings continues to be made for research purposes. Some of these drawings are a codified system used to record and illustrate anatomy and physical structures. Others reflect some of the physical aspects of surgical procedures and on analysis revealed some of the gestural and performative nature of both surgery and drawing.

Surgeons used drawing as a convenient way to record and disseminate information. The variety of methods and uses of drawings has continued to surprise medical staff, who almost always denied using drawing in their work at all. These images were supplemented by gesture; this communicated part of the movement, and to a certain extent something of the haptic nature of the particular surgical process. The drawings are evidence of a detailed study of anatomy and surgical procedures; they are physical records of movement and time.

Mr Ananth Viswanathan's drawing showing the anatomy of part of an eye examined the disease process caused by raised inter ocular pressure. The simple operative process (trabeculectomy)² was rehearsed with a few marks on the paper surface, but gestural movements were performed above the surface indicating instrument position and motion prior to the actual performance of the operation.

A drawing given to medical students of the knee, made by Mr Pramod Achan, was similarly used to rehearse surgical movement. Pens were used by the students not only to further annotate and analyze the particular structure, but took on the role of syringes and scalpels as part of the preparation for the operation they were about to observe and assist at.

Miss Narciss Okhravi has produced many drawings in her medical retina clinic at Moorfields hospital. A key example did not use pen or pencil marks but demonstrated a crucial movement on paper during a debriefing session with a junior doctor. The essential action needed to perform a Capsulorhexis³ during an operation to remove a cataract from an eye was shown by the deft tearing of a circle on a scrap piece of paper. This drawn image showed simultaneously the movement of the hand and the flexibility of the creative surgeon in educating future ophthalmic practitioners.

Surgeons are not limited to drawing upon two dimensional paper surfaces but mark structures on the body. At the opening stages of an operation these marks are often using pen on the skin surface, indicating underlying anatomical structures. Some of the drawn codes were included in sketches made by Jenny as a record of the procedure as well as part of the investigation into the anatomy of the head and neck.

Whilst watching Neil using a Harmonic scalpel, an instrument that uses high frequency sound to cauterize tissue, connections between the actions of the surgeon and the action of the drawing practitioner began to be made. Neil at the time being unfamiliar with the tool, worked quite slowly moving over the surface of the tissue. It was at this time that there was a realisation that hand movements of surgeon and drawer appeared synchronous. Analysing the drawn marks in the sketchbook led to inferences of tactile sensations. (Figures 1 and 2)

Subsequent drawings produced in theatre reflected something of the range and pace of physical interventions in surgical procedures both in terms of the character of mark and the substance of the resultant image. The drawing work had to incorporate features of haptic, kinaesthetic, tactile and proprioceptive sensations as well as the visual.

Alison Dutoit (2008) in her essay *Looking as Inquiry: Drawing the Implied Urban Realm* explains some of the physical intensity of drawing.

“The meanings of the English word “draw” suggests the tactile nature of the act: to drag, to elicit,

to provoke, to eviscerate, to accumulate, to delineate. Only the last implies a purely visual activity, or more appropriately, an activity addressing visual interests.”

For her “drawing is an activity in which the whole body participates.”

Taking on board the physical links between the act of making a drawing and performing surgery, drawing activities were devised to analyze and make a mimetic action based on observed surgical procedures.

During surgery the surgeon moves a variety of instruments across and around different tissue structures. Tissue appeared to vary in terms density and substance. The challenge was to find some way of recording movement which changed speed and direction, and which also recorded movement of different surgical tools through different qualities of tissue onto a two dimensional support. Marks made to follow the movement and weight of hand and tool inevitably influenced the form of the resultant images produced.

Working in the busy operating theatre also meant adapting drawing techniques, whilst considering methods of collecting information that were applicable to the haptic nature of drawing and surgery. The continuous removal and restructuring of tissue meant that any images made were rapid and small. Drawings also had to be made whilst moving around the operating table as the position of the surgeon and medical staff changed as they worked on different parts of the patient’s body. Images were made in the hand, an echo of the dynamic tactile movement being observed.

Errol Barron in his work *Drawing in the Digital Age*, explains some of the tactile nature of drawing as related to pressure sensitivity and the way in which it can demonstrate thought processes.

Much of drawings value derives from what one thinks and what one feels ...the feeling which helps formulate ideas also supports the judgment...”

Simple linear drawings reflected some of the movement and weight of the tools. Surgical instruments have different and distinct purposes and functions, and these leave marks on the surface of the tissue. In the drawings one observes darker lines, which have been made to correspond with the depth and weight as well as the movement of the

tool. The qualities of tissue structure are more variable in maxillofacial operations, and this is reflected in the drawing. The tones reflect the steady, usually slower division of more dense flesh or bone. Lighter lines express the more fluid, smooth motion that the surgeon uses when dissecting more ductile tissue. This can be seen in the recordings of movements using the Monopolar cauterising tool or harmonic scalpel. The pencil strokes revealed the direction of the movement of the tool as it separated and uncovered structures. Small bleeds on the surface, sealed with the point of the cauterising scalpel, appeared as dark points, relating to the burnt tissue as well as the tiny focussed halting movement of the tool at a specific point. These marks appeared as dynamic full stops as they follow the course of venous or other tissue structures. The decisions of the surgeon's gesture and tool use are informed by visual and tactile sensation. The small sketches are a reflection of the surgeon's decision-making and attempt to mirror the surgical process.

While focussing on the quality of the incisions made by surgical tools, images were made that revealed some of the shapes of the tissues on which the surgeon was working. In the case of the maxillofacial surgery, a rich series of drawn marks follow-



Figure 1. Wright Jenny (artist) Tongue tumour. Image and detail from theatre sketchbook showing cauterized areas. 15 x 22 cms Pencil on paper Jan 2011

ing the movement of the scalpel excising a tumour, developed into an image revealing some of the form of the tumour being removed. (Figure 2) As the operations progressed, images were made that conveyed something of the mass and texture of the rather solid diseased tissue. Although the surgeon was making incisions around the structure of the tissue in order to remove it, mimetic drawn marks made began to resemble the compact, dense shape of the cancer being removed. To make the image more readable sometimes, contour lines were added to mark areas off the perimeter surface.

Understanding the haptic processes demonstrated in the movement of surgical tool across tissue became a key part of the dialogue. For Neil, this allowed him to step outside the immediate activity and consider the role of different kinds of percep-



Figure 2. Wright Jenny (artist), Image from theatre sketchbook; Neck tumour tissue 01 6 x 6cms Pencil drawing on paper, Jan 2011

tion as well as the acquisition and refinement of skilful tool use in surgical procedures. Discussions often centred on drawings that focussed on specific movements at particular stages of an operation.

It was from these images that recording schemas were devised, focussing on specific parts of an operation in order to analyze hand and tool use. This was subsequently abandoned as the evolving com-

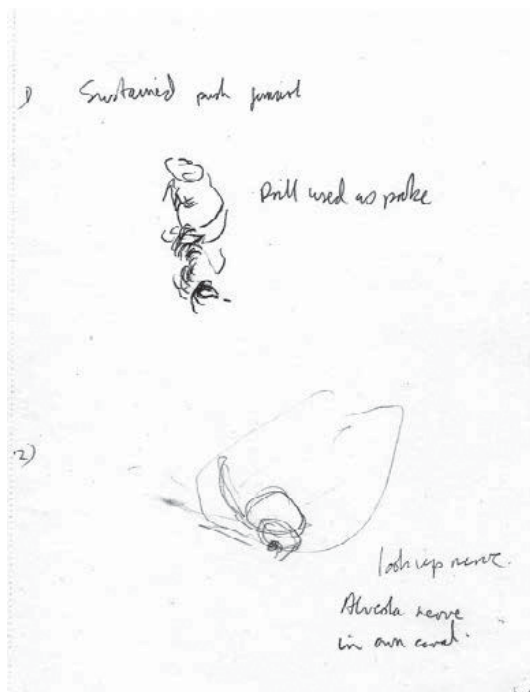


Figure 3. Wright Jenny (artist) Image from theatre sketchbook showing tool movement. Pencil on paper 15 x 22 cms Jan 2011

plexity of even the most simple surgical procedure could not be exactly replicated. Tissue texture and depth can vary greatly, cutting tools can become blunter, cauterising instruments falter; any combinations of these, as well as other interventions cause pauses and breaks in the flow of the surgeon’s activity. It was interesting that during these periods of close observation that Neil felt that the breaks were longer than they actually were. Following this small pilot study there was a growing awareness of the enormous variability of the process of surgery, even within what was essentially the same procedure.

Work continues with the development of drawing activities based on observations of surgical interventions with particular reference to Phacoemulsification (cataract removal) at Moorfields hospital. As the tissue structure of the eye is more uniform my images have focussed on fine finger movements and observations made by following the procedure through a microscope. Planned drawing activities will be used as part of microsurgical training with medical students at Moorfields hospital.

Although the ophthalmic operations observed have involved different tissue structures, there

appear to be comparable physical practices. All the observed surgery use of tactile and visual cues are used to produce accurate, economic movement with two hands simultaneously in three dimensions.

When considering drawing activities around the observation of phacoemulsification, different aspects of haptic perception are more to the fore. As all the surgical tools are used with the aid of a

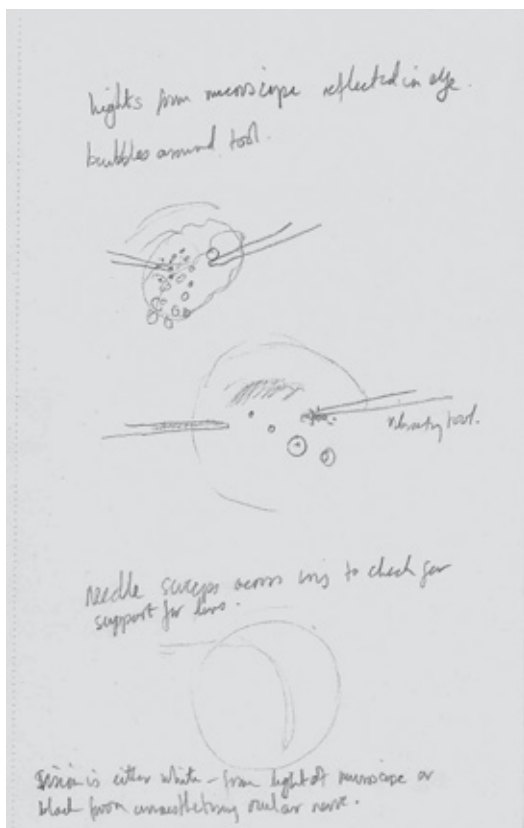


Figure 4. Wright Jenny Image from theatre sketchbook. Observation of cataract operation. Pencil on paper 16x21 cms April 2011

microscope, the surgeon has to be confident of the position of their body and limbs in space, as well as the fine movements they make in the confined area of the eye. They use their kinaesthetic and proprioceptive senses particularly to position and manipulate tools. This is particularly important at the beginning of an operation, where the conscious patient is positioned carefully in order that the microscope can be placed for the surgeon’s use. In maxillofacial surgery the surgeon moves around the

body for ease of access; in contrast, the ophthalmic surgeon is stationary.

Marks made during observations of ophthalmic procedures reflect the refined visual and motor skills necessary to manipulate tools in a confined space and have become a test-bed exploring substances that are analogous to the tissue being operated on. Different drawing materials and supports have been explored in order to find ways to develop tactile acuity and motor skills. These continue to be developed with medical students as part of their training in micro surgical techniques.

Marc Treib (2008) proposes in *Drawing/thinking confronting an electronic age*, that

We think and record thoughts using drawings; we propose and we test ideas and designs; we adjust and create. At some point—and this is one of the miracles of drawing—the image begins to tell us more than we have projected into it; new or unrecognised relations or ideas emerge... (p15)

Footnotes

1. For the purposes of this paper the definition of haptic when linked to drawing and surgery relates to the sense of touch in all its forms including:

Proprioception: That is the perception from the whole nervous system relating to the position, orientation and movement of the body in space.

Kinaesthesia: Relating to the sensation of movement of body and limbs, originating in muscles, tendons and joints. Sometimes called muscle sense.

Cutaneous sense: Sensation originating from skin surface with reference to senses of pressure, temperature and pain.

Tactile perception: Encompassing the cutaneous sense, but focusing more on sensation of pressure rather than temperature or pain

2. Trabeculectomy is a surgical procedure used in Glaucoma treatment where raised inter ocular pressure is not being satisfactorily treated by eye drops. A small incision is made in the sclera to remove part of the trabecular meshwork, allowing fluid to drain from within the eye into the structures under the conjunctiva where it is more easily absorbed.
- 3 Capsulorrhexis is a surgical technique in which a continuous circular tear is made in the crystalline lens to allow the break up and removal (phacoemulsification) of the lens nucleus during cataract surgery.

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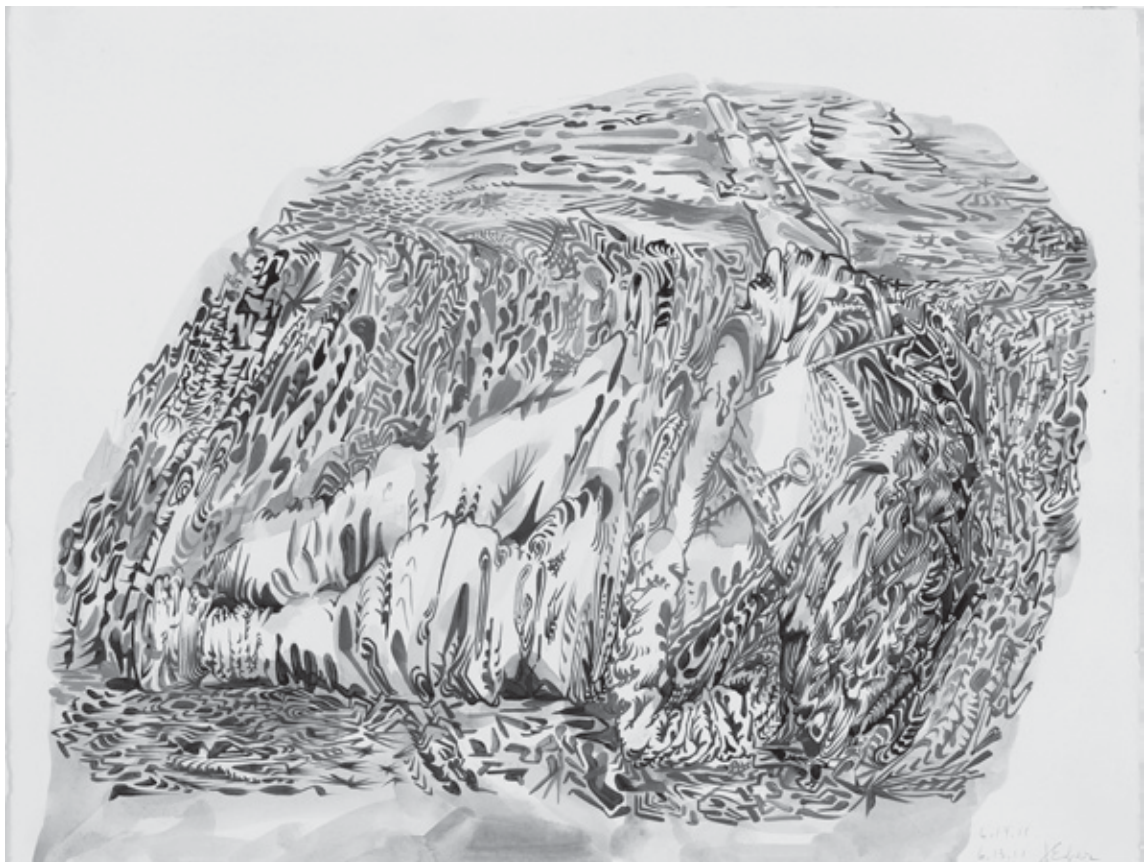
From the exhibition:

J. Fiber

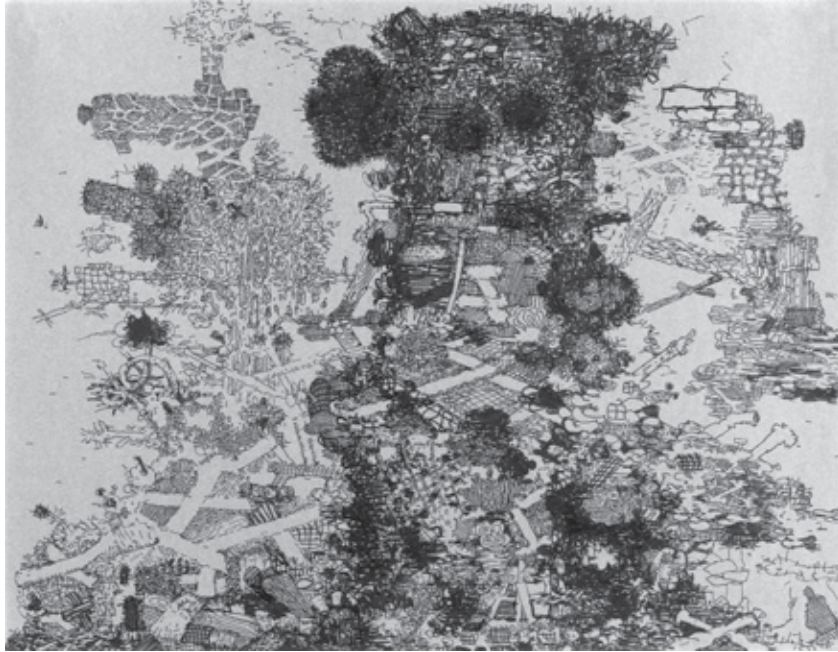
The drawings of J. Fiber, made with poured acrylic, colored pencil, graphite and ink are small worlds, rife with drama and conflict. Ruggedly masculine passages bump against petite strings of flowers; turgid forms push into bosomy mountains; and little boys with guns wear bows in their hair. Images of sex and violence are everywhere subverted by feminine decoration. Working section by section, the couple pass the drawings back and forth, challenging each other at each exchange, ultimately creating small worlds, full of paradox. J. Fiber describes the creative process as a curiously potent struggle between two sides of the self, where decision-making can be as fraught as an old married couple's argument over whose turn it is to do the dishes.



J. Fiber, *Wretched Refuse*, 30" x 22", Acrylic, ink, colored pencil on Paper, 2007



James Esber, *Figure on Ground*, 20" x 26", Acrylic on paper, 2011



Jane Fine, Untitled, 19.5" x 25.5", Ink on paper, 2011

Drawing is a way of working out ideas. It has an inherent quality of expedience and clarity. When I draw I try not to think too much. I almost always have talk or music on in order to occupy the conscious part of my brain. The idea of what to draw and the broad outline of how to do it are resolved before I begin. The most important decisions however are made in each moment of drawing and involve only the small movements of a pencil or brush. When things are going well, these decisions are equal parts the exercise of some mysterious muscle tick and the conscious avoidance of repeating myself or the facile clichés of other art.

James Esber

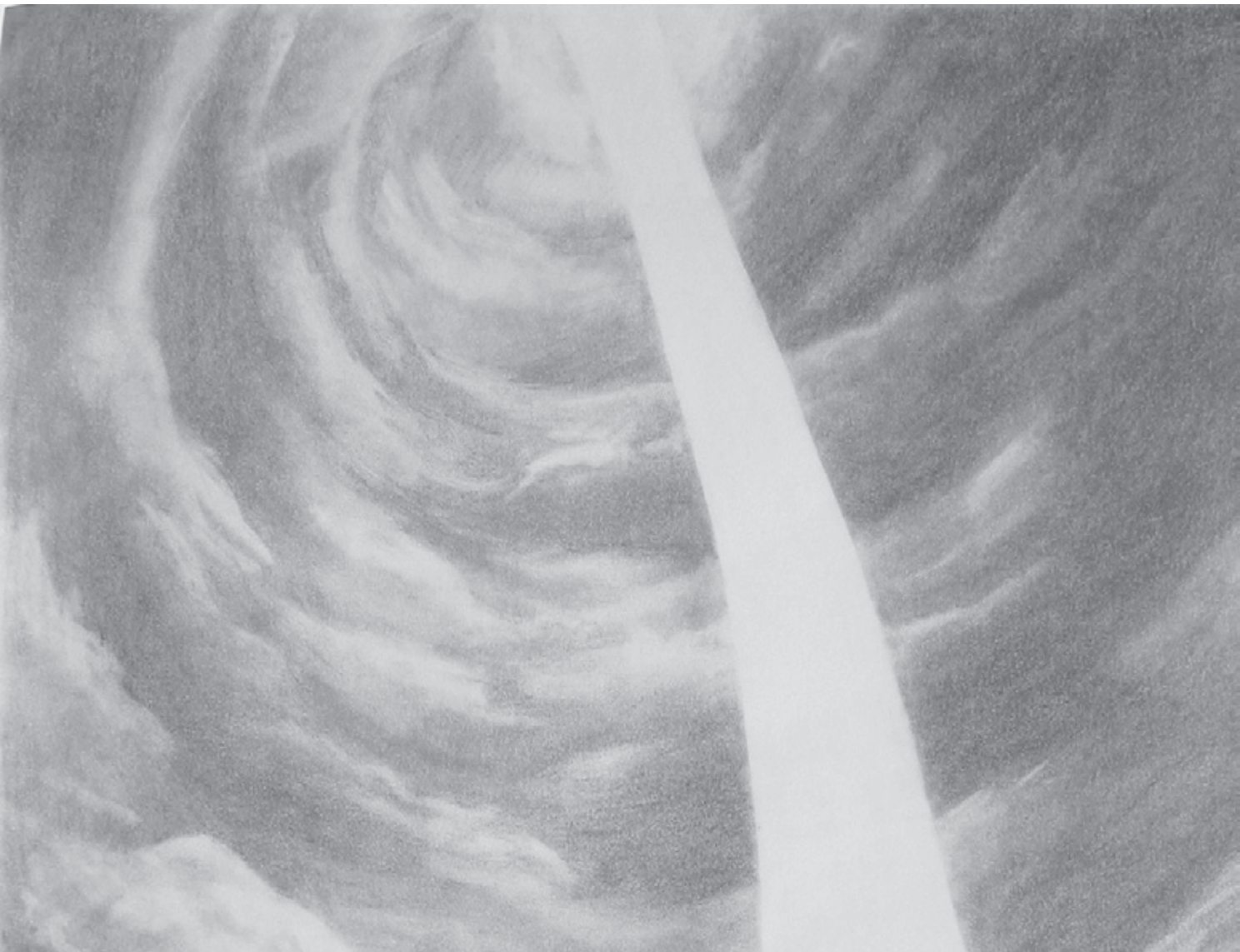
Located on the border between figuration and abstraction, my drawings resemble rotten landscapes. Anthropomorphic bits and pieces inhabit battlefields, sinking ships and abandoned construction sites. Collapse and decay are ever-present as a myriad of supports try to prevent the slide toward entropy: scaffolding, nails, bricks, tape, boards and patches.

In this new group of improvisational work on paper, the drawing materials are limited to black (and hints of silver) marker on dark-hued paper. The depicted conflicts function as a metaphor for the battles inherent in my own creative process: trying to make something from nothing, intention from accident, illusion from flatness and meaning from doubt.

Using invention as a sign for optimism, the work turns celebratory. It's a party room, even if all the guests are scarred and bandaged.

Jane Fine

Drawing Broadly / Thinking Broadly



Mia Pearlman

Drawing: A Matter of Life and Death?

Andrea Kantrowitz
Teachers College, Columbia University



Can drawing be a matter of life and death? Stephen Farthing gave us a powerful example of how drawings can kill, citing Churchill's drawing of the map of modern Iraq in Cairo in 1921. It's startling, but significant, to think about drawing in that way. Dr. Shah and Jen Wright have given us a vision of how drawings might help save lives within a medical context. Neil Shah showed us how surgery itself can be understood as a form of reductive drawing. I believe that drawings—and the teaching of drawing (and art-making in general) can help save lives, in a manner much less tangible, but perhaps just as vital.

I have been a teaching artist in New York City schools for 12 years, and have worked in a broad range of schools, from the outer limits of the Bronx to Harlem and Chinatown. I have taught in alternative transfer high schools, for students failed out of traditional programs, and in one of the highest performing public elementary schools in the city. These experiences have taught me how drawing in particular, and art-making in general, may empower children and adolescents to explore, invent, solve problems and understand concepts across disciplines. The children themselves report that they learn to manage their emotions and visualize their dreams through art-making. This is more difficult to measure, but not less important. One student, held back for two years not for any intellectual deficits, but simply because she was unable to control her anger, says, "When you are mad, it helps you get another mood... you do art, and you get happy again."

For the past two-and-a-half years, I have been part of a team of artists working on an art model

development and dissemination project (AEMDD), a collaborative effort initiated by the Studio in a School organization, in collaboration with Metis Associates and the New York City Department of Education (NYCDOE) and funded by the Federal Office of Innovation and Improvement in Education. This project, *Framing Student Success* is aimed at demonstrating measurable improvement in struggling students' math and literacy skills through targeted and rich art instruction. It is a longitudinal study, following the same students from third through fifth grade (8-10 years old.) Our mandate is to develop and disseminate a "groundbreaking and comprehensive model" of how art and core subject area instruction can function as equal partners.

We have worked very hard to design and provide rich, deep art instruction that naturally and intrinsically bridges the disciplines, rather than



Figure 1.

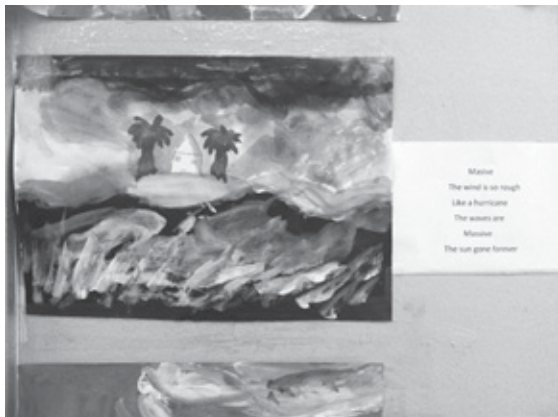


Figure 2.



Figure 3.



Figure 4.

simply using art to illustrate math and language arts concepts. This has been a complex and challenging task, full of unexpected twists, turns and opportunities. Students, when prompted, easily see the connections. They notice acute and obtuse angles, for example, or apply their knowledge of scalene, isosceles, equilateral or right triangles, to help them draw a butterfly's wings more accurately. (Figure 1) In this case, they are using math to help them draw better: the core subject is at the service of the arts. One student, Bazeed, said at the end of fourth grade, "I had art before, but Studio in a School is really different... I never realized before how art was not just making things, but about learning and understanding stuff. Not just about art, but science and social studies and math and ELA. How everything is connected."

Making visible the specific character and substance of those connections is at the heart of our work as artists and art educators. By literally "drawing" those connections for themselves, students take ownership of their education, assimilating core subject knowledge into a bigger, integrated understanding of the real world. Along the way, they learn to "draw" out their own internal ideas and feelings, giving them material form, and thereby seeing it more clearly, through what Barbara Tversky describes as a "tool for thought" (2011). For example, one of our units involved creating a mythological creature based on a self portrait drawn from observation. They then wrote a story about their super hero. One girl, (living in a shelter with her mother) drew a portrait of an invisible girl, with tears running down her face. Her story was about how it was now time for this girl "to shine her light, to let everyone know what she could do." (Figure 3)

Quantitative data is visible everywhere in this school. Attendance percentages decorate the hallways. Charts with test scores, broken down in seemingly infinite detail, line the resource room. We know our program is beginning to have an impact: with three treatment schools and three control schools involved we are starting to see the measurable results administrators and government officials look for. How do we measure the quality of attention, the deep, sustained engagement seen in the classroom as students have the opportunity to make the deep connections, not just across disciplines, but within their own personal sense of themselves? What is the value of a practice which integrates the work of their hearts, hands and

minds? As the 5th grader, Luis, put it:

“We all have a piece of art inside of us. It just needs a chance to come out.”

Using Sketching: To Think, To Recognize, To Learn

David Kirsh



I would like to talk about “thinking with the body” and several other things: there are three topics that I would like to cover.

First, a pragmatic epistemic thing about diagrams, using that as a way of introducing what I think is a fundamental interactive strategy, a strategy we use for interacting with the world. Then I will look at a separate and distinct thing, which is using sketches as a way to help us recognize things, and then finish with something about sketching using the body.

So here is a question. People will find that they typically reach for a pencil and ruler to solve this kind of question:

“All 3 medians of a triangle always intersect at a single point”. What does that mean?

The median is the line to the midpoint of the opposite side. So you reach for a pencil and paper to try to answer the question. Why do you do that? Because it is too hard to do all of that in your head. So I think that this reveals a key interactive strategy: you pose the problem, then if you can solve it in your head, you go ahead and do it. If you can't, you do something on paper. So you first create the figure. You think “OK...median.” and you can do one of those mentally. Now you have to create the other two. Would you be confident that you could imagine all these medians in your head, to test where they intersect? Some of you can, some of you can't. The next step is “I think I can do the second one in my mind, projecting onto this, but I can't do the third one”. At this point you are trying to project structure, so at some point you are going to reach

for the ruler again, and you are going to draw the medians in. You may or may not draw the third one in, because you can already see that it is going to intersect the others.

This is a process: create something, create structure in the world, project onto it, create structure again, project onto it....and that is how we work a lot of times: we do what we can in our heads and when we can't, we make structure.

Projection gets more faulty the further and further out you go. It becomes harder and harder to keep all that stuff reliably in your mind. By externalizing we convert some of that mental projection, mental stuff, into a form that is useful, outside, for these epistemic concerns. This cycle of thinking, of doing things in our heads, projecting onto the world, then creating structure, lets us go beyond what we can do in our heads, by creating things outside.

So projection is a way of compensating for the limits of our imagination. I wanted to explore this idea, of the difference between projection and imagination. I am going to draw the distinction in this way: projection is a kind of imagination but it is tied to a structure, so that you are projecting onto a structure. In order to do that you have to have some anchor for the projection. For instance the triangle has no specific size in your imagination, but when it is externalized it has a specific size. When you draw the median it is very specific to that structure, out there. The external structure supports the projected extension.

Let us draw some definitions:

We did a little experiment – but first, to intro-

duce the distinction: perception is “seeing what is where”, it is detecting, and you are you are supposed to get it right, if you can. Projection is “augmenting something”, so here, in a tic-tac-toe game, we are given just the grid, there is nothing else there. If I ask you to play the game in your imagination or with somebody you project onto this with your little imaginary x and you project their imaginary o and so on; that is projecting, it is augmenting. Imagination is like full virtual reality. So you blind-fold someone and have them play the game of tic-tac-toe in their head, they are imagining the whole game, so they are entertaining structure in their head and they are processing, and it doesn’t matter what is out there. That is pure imagination, unfettered.

We did a little experiment to see if people were better at projecting than at imagining—to see if they could do more and better at things if they were projecting.

So we trained them on tic-tac-toe, by first having them be able to call out the cells using numbers (i.e. identifying the cells by numbers 1 to 9) so if they wanted to put the x there, they could call out the cell number.

There were 3 conditions; one was a blank condition, with a blank piece of paper. That was the imagination condition. The second was called the projection condition where you were given the table (the grid) the third one; they had the table plus X and Os.

What we found was that in general in tic-tac-toe you didn’t get anything from the table / grid (the second condition). I had expected that the grid was going to facilitate and people would play better.

Anyway, we had had the foresight to do some pretests on people to find out who were good visualizers and who were less good. We found that the strong visualizers indeed performed better and they were a little bit better with the grid (second condition) but not significantly better, and the weak visualizers, they performed less quickly, but they basically performed the same.

So we had found out nothing significant yet. We said “oh well, I bet it will happen when we teach them the 4x4 game”. So now they had to play tic-tac-toe with 4 in a row. As we were hoping, everybody did get better with the external table / grid.

So the task has to be difficult enough that you cannot do it in your head, and then you can get something from the external structure, you can lean on it.

The weak visualizers really got a lot from the grid, the strong visualizers got something, but less.

When we went to a 5X5 grid, we expected the weak visualizers, if they can play the game at all, to get a lot from the grid and we expected that the strong visualizers will be able to play the game, and will also get a lot from support of the grid.

So the idea is that external structure can help. In fact it isn’t always the case for the 3x3 game: a lot of people preferred the blank page. In the easy case of the 3x3, they said of the grid “this is getting in my way”.

So it only helps when it is going to provide some structure that you need or that you can use. What we infer from this is that there is a cost to not playing in the imagination and actually putting things into a place in the world.

So this is all about projection. The implication is that imagination is good, sometimes it is better than projection, but sooner or later your imagination dries up and you can’t play the game any further, and you need external structure to facilitate you to go further.

Now I want to move on. That was all about projection. I think it is a juicy phenomenon.

The second phenomenon is this: If you were an anthropologist or archaeologist you have a question when you are confronted by stones. In this case one is a lithic axe, nature-made, and one is man-made. How do you decide which is which? That is the problem they have. The answer is by extensions; there are principles of lithic illustration, established as ways you should make figures of the stone i.e. how to sketch the stone. There are rules: you throw away a lot of the detail and you just accept certain things. You are looking for certain things, you define the chips in certain ways, and so when you look at the stone now the principles of how you sketch it make the eye attend to the right details. It teaches you what to throw away and what to include. The most effective way of making a decision is to know the principles of lithic illustration and to try sketching. So attention is directed to the right things by the principles of how to illustrate. The eye goes back and forth between the illustration and the physical object, identifying what is the correct cue. So now we can see elements in the stone that we could not see before, because we have built this scaffold outside, that is helping to direct. It is not a programme or a recipe. It does not say “Step 1, Step 2, Step 3” but it does say that you have to meet

these constraints, here is what to count, and here is what not to count.

Now I will take these two ideas and use them in the third:

I did a big study, and am continuing to do it, where we set up video cameras all around the studio in which the choreographer of the Royal Ballet every year makes a new piece with his very contemporary dance company Random Dance. It takes about 6-7 weeks to make a 1 hr piece. We set up cameras to record from the moment it starts to the moment they are ready to perform the piece. We have captured all of that.

In this particular case this video clip is of a random period of a dancer practising. What I would like you to look at is Hans. What is Hans doing? He is practising. This form of practice is called “marking”. They dance all day so they can’t be expected to practise with full energy and full intensity. They do a smaller version—this becomes an interesting phenomenon to study. You can see that most of the activity is going on in his head.

The question that stood forward was “do I get anything more from marking than from mental simulation?” Could marking possibly do more than the mental projection of thinking about the action? Why don’t I just mentally simulate it? Why bother to move the body?

Marking is a universal phenomenon: tennis players, cellists, Irish River Dancers use it, In acting it called an “Italian run through”, when they perform a very quick version. It is a kind of modeling.

We did a study where we asked a dancer Antoine to mark a phrase. The tempo was about right, the movement was quite large. Then he did a smaller version. He preserves some aspects but not others.

The question was what do you get from doing the small stuff? You certainly can’t perform it. So how could this possibly facilitate better performance?

To explore this we had dancers learn a phrase for 10 minutes. We graded them all on their initial performance. Then one group lay down and mentally simulated the full phrase they had just danced, one group marked it, and one performed the full phrase. We then graded them again and we measured the improvement.

We were hoping to find that marking did something better than lying on the floor. To our absolute surprise marking was better than full out performance!

The conclusions with respect to marking are it

helps to manage attention—how would it do that? Well, think about lithic illustrations, where you are not taking the whole thing, the photographic result, you are drawing just a fraction of it, so the marking is doing just a fraction of it. A lithic illustration says I know what to look at—it is helping me attend to certain things. The marking, like a lithic illustration, is helping me attend to what I want to be thinking about, an aspect of the full out thing. That’s one possibility of why it facilitates. Another possibility is that if I am doing this I can project to the outside better than I could in imagination alone, like the first case with tic-tac-toe. I can project more because there is an external structure to anchor it.

The third thing is when I mark I may think about the timing, the extension, so there are all these aspects. People study aspect by aspect and then they have to integrate the aspects later but they are studying aspect by aspect. If they practice full out they have to do everything at once, so it could be less good.

I am looking for people to tell me where there is a theory of studying aspect by aspect, because I think we do that in most everything. We pull things out and exaggerate things.

And the other thing that could be an explanation is that you get something for free—so if you are going to the full extent, and all you are concerned about the edges and the corners, some of it “comes for free”.

I want to start here I want to end there, I don’t think about the intervening stuff, I get it for free by thinking about the end piece. So that it can be something that reduces my cognitive load.

To summarize, there is only so far you can by imagining before you need to project onto the structure. Drawing can help us manage our attention i.e. it is a kind of coordinating structure that directs you as to how you are supposed to do it. Sketching lets us focus on aspects of things, aspect by aspect. The idea of embodiment suggests that the body itself could be used as a sketching instrument—in fact dancers sometimes call it sketching. Marking is a kind of 3-d sketching with the body index.

Material Thinking: Drawing to Record, Understand and Respond

Ian Mc Innes

School of Textiles and Design, Heriot Watt University, UK

Introduction

As an established knitted textile and knitwear designer and tutor, I have been engaged in a longitudinal practice-based research project into the iterative links between drawing and knitting. Through observations I have investigated the work of students and industry designers and my own practice, and whether drawing offers scope for design innovation in the industrial manufacture of knitted fabrics and goods. The range of drawing encompasses figurative, decorative and gestural compositions. The range of textile work utilizes the patterning possibilities of hand machine and digital machine technologies in the production of fabrics and the intervention of hand manipulation skills during and post fabric production. (Fig 1)

The symposium offered an opportunity to explore drawing through hand knitting, using presentations and discussions about “thinking through drawing” as the context and inspiration. I was confronting the main premise of my research through a slow process of hand knitting and within defined parameters of materials, location and time. I realized I placed myself in this situation to challenge my own thinking and methods of working.

Drawing and textile design

Established teaching approaches in design drawing for constructed textiles (knitting and weaving) have emerged from the pedagogies developed by the Bauhaus School of Design's, Weaving Workshop (Wortmann Weltge, 1993).

Drawing was seen as a means to make sense of



Figure 1. ‘Trench momento mori’

the textures and patterns in nature. By recording these qualities through the use of studio media, there developed a heightened sensibility of visual and tactile material properties of surface and pattern. Bauhaus Weave graduate comments:

If we try to have a rhythm of horizontals, of verticals and horizontals, or of staggered diagonals we will arrive at results that resemble actual textiles, for the dominant textile elements are present : the straight lines of the directions of the surface activity (Albers, 1965).

Drawing, for design at the Bauhaus, was something different from observed and expressive drawing. It was a method of analyzing certain visual and tactile properties of images, surfaces and objects. It was also a means of ordering information to explain the intended appearance of the final fabric, a “tactile blueprint” (Albers, 1965). In her analysis of drawing practice in graphic design Schenk (1991) describes the act of recording through drawing as developing a visual literacy, perception and visual memory and developing a visual description, or instructional diagram to inform production. We understand from this that designers draw in order to develop a heightened visual awareness and a manual dexterity in communicating ideas effectively.

My recent interviews and observations of industry knitwear designers identified drawing sketches to communicate initial ideas and the use of established schemas to explain the production of familiar fabric types and garment features in new yarns, colors, proportions and configurations. Presentation drawings are sometimes produced as a persuasive promotional device to in-house selection panels and sales teams. Eckert (1999, in her study of knitwear designer practices, identified a distinct lack of drawing in the design development and production of knitwear and the prevalence of the Mood board in leading and distilling familiar and routine design components and their interpretation for the projected season.

There is no evidence in the research to date of drawing being used as the catalyst for design innovation in knitted textiles and knitted goods.

Framing the task

The task was limited to one day’s activity of eight hours of hand knitting during the proceedings of the public symposium and approximately four hours of machine knitting by senior knitted textile design students and the knit production technician based in Scotland. It required a harnessing of materials and methods. This entailed selecting yarns, which were reliable in providing a sound structure when knitted in a simple loop formation such as Knit or Purl stitch. The range of yarns selected comprised wools of medium thickness normally associated with traditional argyle knitted garments to very fine sewing thread—like synthetic blends of yarn. Some of these yarns had regular textured effects along their length to contrast with the more

smooth yarns such as viscose. I chose a limited color range from white to cream, grey, brown and black in order to communicate a tonal mood. This focused attention on the texture of individual yarns and stitches. The knitting needles chosen were compatible in size to the thickness of yarns to produce stable structures.

I was not only gathering a stock of yarns in preparation for constructing linear structures, but more importantly building a framework of potential, stimulating my mind to speculate possibilities and in so doing forming a clearer picture of the task ahead of me and different scenarios for creative production and goal setting. I tested the combination of yarns and knitting needles and crochet hook and their compatibility and this included finger knitting with rope-like thicker yarns of smooth fibres. I was developing knowledge of yarns and their visual and physical characteristics in basic stitches and structures and also improving my manual dexterity. I was limbering up to be fit and ready for the task as I imagined it, and yet mindful of the unknown and the element of risk. In part I was not able to apply an operational goal condition to possible solutions (Kirsh, 2009).

I resisted the temptation to plan in order to predetermine outcomes. I was consciously placing myself in a position of uncertainty of how I would respond, what was expected of me and what was intended in terms of outcomes. I was clear I wanted to capture the essence and spirit of the symposium and embrace the values of freedom, empowerment and growth through discovery and to be as true as I could be to the words and thoughts of the participants. Goals, operators and, choice points, consequence and evaluation functions would have to be learned in part in the course of the activity.

Developing a system of annotation

By using combinations of knit and purl stitches along the same row of knitting or from row to row, a wide variety of textured effects can be formed and patterns built up. This combination of stitches formed the basis of my development of linear structures and was augmented by casting on additional loops and knitting multiples of two stitches together intermittently to widen and narrow the width of the fabric. I also selected loops and dropped them off the needle to create a textured effect. I also took all loops off the needle and picked up previously formed loops lower down the fabric and started

knitting with them to build up the fabric.

There is an intimate sensory, haptic, almost visceral connection with materials through a practical engagement in the hand making, discovering the physical and tactile properties of the yarn and its interlocking loops. There emerges an external and internal connection with materials, tools and process (Pallasma, 2009). Machine knitting can distance the maker from the sensory experience of holding, wrapping and forming the yarn loop in building up the structure. I began to see the needles as drawing tools working in different and complimentary patterns of repetitive motion and synchronized with the wrapping of the yarn as the drawing medium.

I started with the intention of responding to key words and themes for each speaker. I was clear that the choice of yarn, color, stitch and form would be symbolic and that I would not be knitting graphic letter shapes and words into the structure. I aimed to explore a textile vocabulary through the process of making which was workable in different configurations, combinations and their proportions and “readable”. I envisaged the knitted fabric as the paper on and through which was placed a drawn element such as another yarn color or yarn type or an alternative stitch.

To discuss every linear structure produced is beyond the scope of this paper. I have therefore selected key pieces to illuminate the context, thinking and decision-making for and through the making.

I choose a combination of contrasting yarn types at the beginning of the first structure, to narrate the opening remarks and the introduction of the keynote speaker (Fig 2.) The phrase and words that I responded to from Barbara Tversky’s keynote speech were:

“This (image) is an interesting aside, but you will see from my presentation that I will keep returning to the line as my main theme”.

I was inspired by this statement in alluding to the human need to wander, explore, ponder, in order to consolidate the discovered, the known, the valued, the constant. The yarn I introduced was cream colored wool and compatible with the size of needles chosen. The stocking stitch rectangular structure produced a stable “paper” on which I could add a textured linear row of purl stitches at regular intervals to represent the regular line and replace the wool yarn intermittently with black



Figure 2. ‘Tools of thought’ lines

viscose for selected groups of two stitches through the length of the structure to symbolize the “asides”. This yarn formed a contrasting vertical graphic line across the length of the fabric, enhancing this linear scaffold of connecting themes, which made the whole.

I was unsure how to respond to the presentation on “Surgery drawing” because of the sensitivity of the subject matter. I wanted to be true to the investigation of the use of drawing during surgical procedures and pre and post surgery communications and the different tools of pencil, pen, knife and stitches. As the presentation unfolded and a distinct audible response emanated from the audience, I was moved by what the lines represented in terms of action, body, tools, materiality, physiology and emotion, value and purpose. It had to be a different structure from those that had already been produced. I chose a more literal narration with a yarn of changing red and pink tone through its length, which when knitted was almost flesh-like and contrasted with solid color dark grey yarn and black viscose and a white synthetic yarn. (Fig 3.) This white yarn comprised a crotchet chain, which acted as a central vertical core from which one centimetre lengths of horizontal threads were trapped at regular intervals along its length. This created the effect of sutures when knitted into the structure.

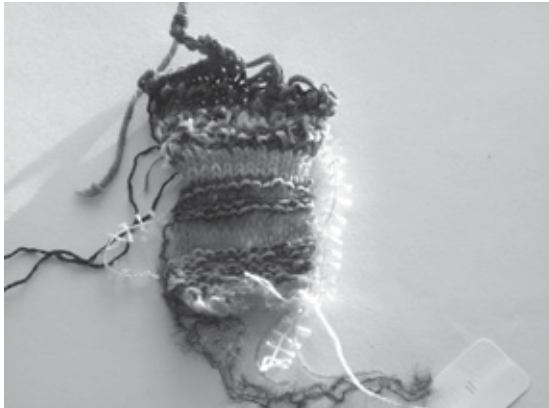


Figure 3. ‘Evolving dialogues between surgeon and drawing practitioner’



Figure 4. ‘Robotic drawing’

Initially a structure was produced for each speaker, then a time lapse developed, given the differential speeds of verbal communication from the speakers and the speed of hand-knitting. I had reached a level of confidence and understanding of the task, whereby I worked with these transitions to the point that the work started to take on its own pace and identity.

The time constraints and the intense activity required a high level of attention in listening, assimilating, reflecting and producing. Each presenter offered different presentation approaches. I became more focused on each verbal communication because it was the constant, the continuum. Phrases became triggers for informing the choice of stitch, yarn and needle size. It also allowed me to concurrently focus my eyes and hands on the co-ordination of materials and tools in the making. I was becoming increasingly aware of the distinct activities and my co-ordination of them and the need for their interdependence and synchronicity.

I was unable to annotate key words from each presentation or my reflections during the activity of making. I tested out the feasibility of this in the first piece of knitting but it disrupted the motivation to make. I realized very quickly that the task demanded that I engage with the content in a different way from usual. The intention to capture words or phrases and then use these to inform the making seemed a logical sequence. In reality it slowed down the process of decision making and creating. I was following the learnt behaviour of taking written notes during a presentation and then using this to plan and inform the making. Using written words to

record and distill the presentations and then mediate between them and the act of making was in effect avoiding a more immediate, spontaneous and pragmatic approach. It was essential to establish within minutes of each presentation a strategy for making and to start making. It was possible to concurrently adjust techniques and materials in response to the presentation as it unfolded. Each piece evolved during the making. Pauses in the proceedings allowed me short periods of time to write words to capture current thinking and reflections and this acted as a useful reference after the symposium.

I was mindful of one participant’s poignant remark of the developing work:

I understand your intention to create a 3D drawing as opposed to replicating the 2 dimensional construct.

The conversation that ensued was sufficiently searching to stimulate in me a more focused development. It was at this point that the work started to gather its own momentum and I started to capture, through the structures, the broader themes developed in the symposium. The work became more linear and less rectangular, more organic and sculptural rather than plains of low relief textures and tones. A deeper understanding of the task and an awareness of the internal dialogue between thinking and making was reached as I was monitoring the emerging progress of the structures. Fayena-Tawil et. al. (2011), in their protocol analysis of levels of cognition through drawing, provide a coding category for levels of cognition and meta-cognition.



Figure 5. ‘Drawing bodies’

Albeit based on verbal protocol analysis, this was a helpful reference after the symposium to measure my own level of thinking during the task, as I remembered it.

When narrating the presentation of the Drawing Robot I returned to a similar structure and the same yarn types as the keynote presentation. I aimed to capture the drawing motion of the robot with complete rows of black lines of fine viscose yarn crossing the cream wool in stocking stitch as the ground (Fig 4.) At intervals I knitted triangles of contrasting texture and tone, to represent the interventions and asides of the speakers. By knitting into only part of the row at ever decreasing stitches, the effect developed a distortion to the overall form of the structure and at the same time created a different rhythm in the knitting motion. My intention was to replicate the broad movement of the robotic arm and contrasting this with its shorter movements in building up tone in the drawing being created by the robot.

In response to the presentation about cities and people and the every day drawings they subconsciously make in the environment through movement and actions, I was reminded of Paul Klee’s idea of “taking a line for a walk”. I decided to make a linear structure that was stripped down to the essential components of an interlocking structure with contrasting yarns to emphasize length, direction and purpose. (Fig 5.) This was the point at which my work transformed. The knitting began to emerge as a mark in itself when placed on a paper-covered surface and latterly when suspended in space. It became the gesture, the mark, a three-dimensional drawing



Figure 6. ‘Suspended loop structure’

within the physical space. The drawing took on a tactile and physical quality which evolved depending on whether it was suspended from a single or multiple points or held in tension. I felt a strength emerging in the work where I was exploring line as a structure in itself, gesturing with the constructed line through a physical space (Fig 6.)

I recognized that each presentation stimulated different responses. Although a framework for the task had been established, there was sufficient diversity of materials, tools and processes to provide alternative and complimentary approaches. It was not possible to summarize the presentations in a very literal way. Each structure was triggered by a word or phrase and aimed to capture the essence or snapshot of the presentation. The scope of the activity led to pieces that were to some extent ambiguous in their communication of the presentation, but were nonetheless interesting linear structures in themselves by using the presentations as the stimulus for their origination.

Scottish contribution

I relayed key words from the pre-symposium presentations (Farthing’s *The Bigger picture of drawing* and Betts’ *A New Curriculum, a New Pedagogy*) by email to senior students and the knit production technician in knitted textiles in the School of Textiles and Design, Heriot Watt University, Scotland. They made selections and responded to them through hand machine and production machine knitting. Being remote from the symposium proposed different, but complimentary responses. The working environment is very well resourced, secure and

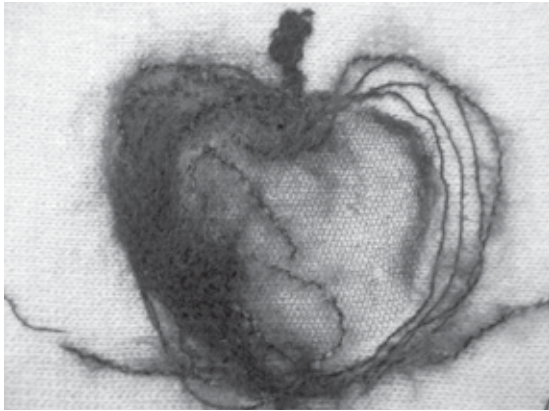


Figure 7. ‘If you can’t write you draw it’ detail Cath Hodgkinson



Figure 8. ‘Open-minded’ detail by Stephanie Laird



Figure 9. Knitted structures in progress and displayed during the symposium

familiar and provided flexibility to analyze, select and modify and refine fabric ideas. A community of practice was established for the task with reciprocal mentoring and a sharing of knowledge, expertise and opinion. This helped with decision-making and the refinement of individual design ideas. The images were sent as email attachments for printing and display at the final day of the symposium.

After the event the designers completed e-questionnaires, which aimed to obtain their observations and experiences of the task and whether it challenged traditional approaches and behaviours. Some participants identified a change in approach to designing and others followed very familiar and predictable methods. In the early stages students selected words describing objects or processes or visual images, which were immediately translatable into knitting (Fig 7). As the task progressed, participants started to explore more abstract references (Fig 8). Some participants commented that access to a comprehensive yarn and machine resource made it difficult to make choices and maintain a focus in production in order to make an effective response in the time-scale. The possibilities for interpretation were vast and participants had to limit the choice available to them and define individual parameters of materials, equipment and technique. The remoteness seemed to offer a more objective analysis of the words and phrases and less conditioned thinking, which may have biased their approaches to the task. It was recognized by the technician that the task was sufficiently framed to affect a more fluid interaction with the manufacturing process. He commented on a willingness to intervene with the production knitting process and change one yarn midway through the knitting sequence to modify the visual and tactile properties of the fabric. This is contrary to normal production practice where time is invested in extensive preparation and planning for an effective and efficient production of the fabric and free of manual adjustment.

Conclusion

I recognize that the activity of hand knitting for some is synonymous with hobby craft and social circles and considered a form of relaxation and therapy, in its repetition of production and knitting to instructions to produce garments or gifts for family and friends. I presented the linear structures to the delegates at the close of the symposium. The pieces were presented as products that encapsu-

lated thought and action, a physical manifestation of an individual synthesis and interpretation and response to the symposium. The knitting made direct connections with delegates because of its familiarity as a textile and process. This provided a powerful tool for communication. I found it challenging to verbalize the process and product, it demanded an external communication of what had become increasingly a deep internal immersion and non-verbal activity. Explaining the relevance of the activity and the pieces provided a more acute reflection. I saw the knitting process as a useful set of tools with which to explore thinking through making and making through thinking.

The success of the outcomes was not reliant solely on the materials and process of manufacture. It was also due, in part, to the environment and the language. The way of thinking was not familiar to me as a starting point for the origination of ideas in drawing through knitting. There was also the challenge of time, tasking the narration in response to an intense and fast paced symposium with what is fundamentally a slow process in shaping thoughts and commentary into linear structures. I found it intimidating, inspiring and motivating and sufficiently supportive to take risks and discover new ways of thinking and making through the act of doing.

I felt a tension emerged between the activity and the context in which it was initiated. The process of making and the qualities being developed took on their own momentum and context. There was a point at which the activity took over and started to reveal interesting qualities in their own right, which in turn informed further work.

To produce a single piece would be the equivalent of writing an essay, which would be demanding whilst at the same time assimilating the content of individual presentations. I therefore aimed to produce knitted “notes”, a series of linear structures, each one individual and yet relating to one another and contributing to a whole that aimed to capture the mood and themes presented at the symposium. The linear structures communicated graphic and tactile qualities and a physical dimension in the performance properties of yarns in different forms of varied sizes (Fig 9).

Suspending myself in another intellectual, conceptual domain stimulated and stretched my existing knowledge, skills, and understanding. It challenged my routine behaviours of drawing through knitting. The time constraints and the

intense activity required a high level of attention in listening, assimilating, reflecting and producing. I viewed the outcomes in a new context, valuing the thinking and origination from an alternative perspective.

Acknowledgements

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Drawing Bodies: A Kinaesthetics of Attention

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What I would like to bring our attention to is the action of drawing bodies. Of bodies drawing bodies. And particularly of bodies in motion. What happens when we attend to the sensations of being in motion with other bodies?

But what if attending itself is a way of moving? A way even of drawing? When we attend to something, we don't do so in the abstract. To draw our attention to something is not in the least figurative. Or rather, it is the figure itself that we must begin to set in motion differently. What are we doing with ourselves as we gather to think through drawing, as this gathering is itself collected and redistributed? A symposium is, of course, traditionally organized around drinking and talking, for which the image and text traditionally serve as a kind of supplement. Plato's *Symposium*—to evoke, with this one example, a long history and context—is an account of a spoken “dialogue,” a dramatic scene handed down to us on paper, which our eyes drink in by moving in a kind of collective repetition, taking their turn in an intoxicating rhythm, drawn out and shared across time.

This task of thinking through drawing, with all of the ways we can pass through, inflect, and read it, thus asks us to attend to what we're doing when we attempt to think through drawing. What do we do to pose and work with the question? What are the ways in which our histories of doing this both allow and disallow, suggest or dissuade movements? How would we go about *learning* about thinking through drawing? I want to call our attention to both the multiplicity of modes that happen, often more or

less together, but also to the specificity of them, the ways in which we take on certain gestures of learning. If only to see what new gestures we might learn.

Elusive gestures

Can we speak of *a usual gesture of learning*? This is even more difficult to think if we refuse to imagine gesture (like education) as a kind of supplement, an artifice, something sketchy to be looked past. But is that not how we begin?

Drawing is nowhere, after all. A thing for kids, and for those who would prefer to remain kids even if it means taking on a profession and mastering a formal tradition. Even then, drawing as a discipline, we often lament, falls between the cracks. The making of marks has a hard time leaving its mark. If drawing is the fundamental activity we turn ourselves to immediately upon our learning to stop eating the crayons, it is likewise a bare step from such fumblings.

But let us put this childish impression in a larger cultural context: As Jacques Derrida (1976) lays out in *Of Grammatology*, the spoken word, in its immediacy, has become the vision of a kind of pure presence, of unmediated thinking itself, of which writing is a poor, if necessary, supplement. Extending this, we could say that drawing falls even further behind, a kind of crude mark making, not even proper writing. And if we were to extend this line of thinking even further, gesture—rather than bringing us back closer to the ephemeral immediacy of speech—becomes a particularly cursory form of drawing.



ARE working with the embodied experience of drawing planes, with Gerhard Richter's Six Grey Mirrors No. 884/1-6, 2003. Dia Art Foundation. Photo © Martyna Nieszczęsna, 2011.

We can agree, then, with the assessment Stephen Farthing shared with us—in tracing the limits of the elusive terrain of drawing, as a way of knowing something about it—that the slipping shadow a plane casts on the ground is not a drawing. Since Plato's allegory of the cave, at least, the casting of shadows has been linked with illusory nothingness. It is thus a telling example: if drawing is not passing shadows, it is nevertheless what borders on and follows them all too closely.

But what if, rather than arguing the proximity, we simply re-draw it? As Derrida points out, contrary to our common sense narratives, writing, and mark-making as a whole, comes prior to—has priority in relation to—speaking. Speaking is, we might say, a particular form of leaving traces, of drawing. Seen from this perspective, the very suppression of the gestural mark is itself a particular form of gesturing: in this case, the gesture of outlining an acceptable terrain, creating the impression of it being distinct from some negative space. When we first learn to count, for example, we are quickly

discouraged from using our hands. To learn is to learn the *idea* of numbers. But rather than escaping the movements of our bodies have we not simply displaced them to a gestural locus our culture prefers, the tongue? We learn our multiplication tables by the gestures of speaking them, until we can do so subtly that we hardly notice. Sublingual: learning is recognizable to us as the gesture of forgetting gesture.

But this is just to say, switching figure for ground, that it is only in the movements and gestures we make in the world, no matter how subtle, that our thoughts take shape. Indeed, we might say that is only through drawing—the thing that is nowhere—that a sense of *where* is expressed. It is not that we are first in a world in which we might then choose, for example, to dawdle by drawing. But rather it is only in the child drawing out uncertain movements, gestures, and traces in the world that the where of the world begins to shape up in the first place. We draw out, and are drawn out, by our worlds.

Figuring

What if drawing is understood, then, not as the fixing of traces, but of their expression? In other words, what happens if we understand drawing as primarily a form of moving? And what if moving were the mode proper to thought itself: the way we find our way? The pilot ignores his own shadow, to be sure, but navigates instead a critical, emergent line mediating the transition between density and buoyancy. This life and death tension, this livelihood, is drawn out as a gesture expressing the lived dimensions of space. In that sense, that last bastion of stuffy frivolity, figure or life drawing, is actually what we are doing all of the time. We are continually working with what is somewhat condescendingly, narrowly, and misleadingly called our “body image,” sorting out how we move in relationship to others and the world. And while we often feel like we know how that goes, on some level we are always making it up as we go along, *figuring* things out. Threading earth and sky.

Contrast that to our usual notion of figure drawing as a specialized and tradition-laden domain demarcated by collections of techniques and pedagogies held loosely together by the special peculiarity of the object being visualized. Treated as a visual-tactile exercise, figure drawing lends us to thinking of the body as a kind of empty pose, *mere* gesture. And yet, if we would prefer to think of the figure as a kind of elaborate and specialized aesthetic object, what is it that draws us to it or pushes us away? One possibility is that we somehow recognize there the modern challenge of embodiment itself: the need for, or resistance to, figuring something out about our figure. Buried under our desire for the skill of rendering dynamism and life in the drawing itself, we find a deeper challenge pulling on us: that we have yet to truly understand the figure as a moving process.

We tend to stand the figure on its head, even priding ourselves on the optic/pedagogic trick of such a move. At best, we might suggest that if we could feel a pose for ourselves that might lend itself to an improvement in rendering it. And yet, in this time that is witness to the demise of the centrality of the figure even in drawing, which is itself beleaguered, there is perhaps room for another gesture. Engaging with the sensations of figuring, of being either drawer or drawn, can allow us to access a more accurate and functional facility with the movements and structures that underlie our expe-

riences in general. What happens when we take the time to feel the sensations of movement that are often dismissed in our visually dominated and oddly disembodied culture? What if we treat the body not as a visual object but as a locus of kinaesthetic experience? Figuring, as a process of working out the felt relationships between things in motion, is a kind of fundamental inter-disciplinary learning.

If we think of figure drawing in this more robust way, as the thing we are doing all of the time, (even when we pretend not to be doing it), then figure drawing starts to be defined less by a subject, by a history of technique, or by a medium, and more by the feedback that it provides us about our continued “figurings.” In the process of discovering the movements that allow us, for example, to follow lines around the surface of ourselves or another, we are not just doing contour drawing, but finding new ways to draw out, organize, and move ourselves than we might otherwise be used to. In this light, the question is not whether we are doing figure drawing or not, but how is it going?

A kinaesthetics of planes

Take the problem of planes, for example. We don't get far in drawing without having to wrestle with planes, not the least of which is the plane of the paper. Unfortunately, how we are asked to think about our embodied relationship to planes leaves much to be desired. As a glance at any anatomy textbook will demonstrate, our Cartesian sense of space does something rather violent to the body, leaving it both bisected by planes, and hanging, oddly nowhere. It is as if we are saying: Planes determine space, and space in turn is the framework in which movement happens. In the process, space becomes interchangeable, the body ungrounded, movement an abstract equation. In fact, our language and references for human anatomy and movement have their roots in the study of the cadaver, the dead body spread out and still on the surface of the table, or moved by an observer studying the movement of joints isolated along “planes of action,” rather than a felt, organizing intention.

But what about living bodies? The very fact that the anatomist can construct a reference for thinking about the movements of the body should highlight another dimension of planes: that planes—even the most abstract of them—are something that we must draw out. Anatomy books are invariably illustrated, and any child can rudimentally follow suit, literally

drawing out a plane on a flat piece of paper. But we also do so in countless implicit ways all of the time, drawing out subtle or forceful planes into our world. We construct our sense of space.

Even the notion of a stable, enduring space is something that we must work to draw together. Anyone who has tried to memorize the movements of classic anatomy, described as they are in relationship to abstract planes, will recall the remarkable effort it takes to first locate a sense of those reference planes. You wind up having to hold yourself in odd configurations and perspectives, playing at being dead and then moving yourself, in order to make sense of the terminology. So even in this limit case—this game of imagining space to be fixed, immutable, and indifferent to the movements expressed within it—we find ourselves constantly making and unmaking planes. We establish and re-establish variations on them with subtle or overt movements of our bodies, our balance, our eyes, our hands. A plane, in short, is something we draw out.

Indeed, we can only really experience a plane in relationship to other possible planes. To bring a plane into being one has to move off of it, draw it out. Planes are always partial, turning into view, “a good start.” The idea of drawing out an entire plane is in some quite tangible sense inconceivable. Which is to say, the idea is itself a kind of shorthand gesture: “take this to go on forever...” It’s a move we make. Oddly, it is a mathematician, Henri Poincaré (1905), who articulates the active, kinaesthetic generation of geometric space most forcefully:

...Sight and touch could not have given us the idea of space without the help of the “muscular sense.” Not only could this concept not be derived from a single sensation, or even from a series of sensations; but a motionless being could never have acquired it, because, not being able to correct by his movements the effects of the change of position of external objects, he would have had no reason to distinguish them from changes of state. Nor would he have been able to acquire it if his movements had not been voluntary, or if they were unaccompanied by any sensations whatever. (p. 59)

Far from simply being gridded up by the Car-

tesian planes of universal space, we are constantly moving and sketching out new planes, making forays of space.

Line quality

What would be gained by having an experiential taxonomy of the line? (What conversely, would a taxonomy be without its lines?) Much seems to be at stake in doing this well. On the one hand, the drawing of lines is a way of crossing disciplines, of establishing connections across divisions. Drawing, in this sense, is naturally exploratory and interdisciplinary. We navigate the corridors of the disciplined space of the school by wending a particular and idiosyncratic line through it all. We draw out the trajectory of our education. On the other hand, it is the drawing out of lines in the sand, separating out this area from another, that allows for the disciplinary structure in the first place. What keeps the lines we weave across disciplines from simply establishing new fixed structure for us to rail against? Can we imagine a dynamic and interdisciplinary taxonomy of the line?

Perhaps we would have to find a new way of thinking about the relationship between lines and planes—one that didn’t establish domains within an abstract space, but instead expressed the essentially dynamic and moving quality of space itself. Deleuze and Guattari, in their book, *A Thousand Plateaus*, (1987) talk about a “plane of immanence,” which, unlike a traditional plane, cannot be moved in relation to or “transcended.” But this doesn’t mean that movement is precluded. Rather movement becomes an expression of the plane itself. We move not from one plane to another, but instead find ourselves in constant relationship to a mobile, immanent field of coherence.

One could say that just as Derrida challenged the classic hierarchy of speech and mark-making, Deleuze and Guattari have flipped the usual assumption that movement is expressed within, and defined by the coordinates of a prior stable space. Rather, space itself is an expression of movement. The plane of immanence adjusts to maintain consistency with the varied movements of life.

Perhaps one way of imagining this plane of immanence is to evoke the notion of *hyperbolic space*, organized around a non-Euclidean geometry that, unlike uniform Cartesian space, actually increases in relationship to itself. A kind of excess of space, long thought a mere abstraction, a theory

impossible to model. But it turns out that crochet—the craft formed by the continued articulations of a line in relationship to itself—is an elegant way to express hyperbolic space. (Wertheim 2007) A hyperbolic plane begins to take up more room as it is drawn out, until it begins to fold back on itself. A line, expressed on this plane is not simply a line in space, but becomes a line of coherence around which the whole plane can flexibly reorganize itself.

The plane of immanence, in contrast to the Cartesian grid, creates multiplicity by moving in relationship to itself, rather than *holding and replicating* movement. The sea slug ripples its baroque topology to express a line of movement within the eddying sea.

Might we be able to imagine a dynamic and organic mode of moving and making lines that doesn't simply demarcate new fixed structures, but suggests a way of moving from one dynamic organization to another? Taxonomy of line wouldn't just involve a curiosity cabinet of line types, but might be conceived as hyperbolic: a growing and always partial articulating of the myriad ways in which we can move and express lines.

Drawing motion

Following this line of thought, the movements of the world in relationship to itself express a kind of ongoing figuring. The movements *of* the world express a kind of interdisciplinary attention, and always leave a trace. (Which is in turn a movement.) The distinctions that we usually draw between a thing and its representation, an abstract idea and its concrete model, or between things that endure and things that are ephemeral, begin to break down. It is not that there is movement and then a charcoal trace of the movement. But instead, movements are always traces of other movements. A gesture leads to a mark, which can only be understood and transformed by another gesture. The action of looking at a drawing is not a kind of abstract empathy or decoding but is itself a way of moving, of drawing.

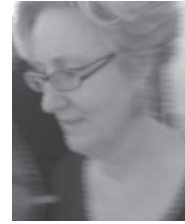
We move in relation to other movements. If we dare to think that drawing might be a kind of fundamental gesture or movement through which we figure our world, what could we gain from this? What would we have to learn? And how would drawing move differently?

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Locating Empathy with Double-Blind Drawing and Bimanual Palpation

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Introduction

The aim of the work was to explore the nature of empathy between participants in a drawing performance, within a gallery setting during the *Thinking Through Drawing* conference. Participants lay flat on a large roll of brown paper in the centre of the gallery while I lay head to head or toe to toe with them. I requested that they draw on the paper with both hands at once whilst I recited a passage from Shakespeare's *Midsummer Night's Dream*. I then asked permission to palpate my participant's spleen whilst they continued to draw.

The performance used blind drawing, a practice previously explored by Claude Heath, accompanied by a poetic text. I added bimanual splenic palpation to this practice; it is not only a medical technique¹ to find an organ that sequesters blood and pathogens, but also my own playful way of exploring anger and melancholy.

Participants took a colored pencil in each hand and lay down on the roll of brown paper, which stretched down the length of Macy's gallery. They were asked to draw with both hands whilst I recited the following passage from *Midsummer Night's Dream*, in which Lysander, one of the main characters, speaks about sympathy, heaven, earth and the moment.

Lysander:
Or, if there were a sympathy in choice,
War, death, or sickness did lay siege to it,
Making it momentary as a sound,
Swift as a shadow, short as any dream,

Brief as the lightning in the collied night,
That, in a **spleen**, unfolds both **heaven and earth**;
And ere a man hath power to say "Behold!"
The jaws of darkness do devour it up:
So quick bright things come to confusion.

A Midsummer Night's Dream
Act I, Scene I, 141-149

I then drew, lying head to head or toe to toe, together with each participant, both of us lying along the line of the paper which bisected the gallery floor. Following that I palpated the spleen of my participant. I also had brief discussions with each participant afterwards.

Using the above complex mixture of words and actions I wished to examine the "hovering attention"² aspect of the practice of empathy, or "putting yourself in the shoes of the other"³. The experience could be summarized as an "entrance into a trance like state where one had the feeling that two souls had been briefly knitted together", which reflects the words used by Hermia, when replying to Lysander.⁴

Definitions of terms and concepts

Empathy: The word empathy was not coined until the early 1900s. It is likely that when Shakespeare used the term sympathy he included the phenomenon we would call empathy.

My description of empathy⁵ can be summed up as "putting oneself in someone else's shoes". It includes movement (hovering attention) and yet



Figure 1. Ian McInnes double-blind drawing at Thinking Through Drawing.



Figure 2. Artist Jane Fine and James Esber double-blind drawing at Thinking Through Drawing.

is also quiet and still (allowing the other person freedom to move or hover intellectually). By using this approach I hoped to enable the subjects of my experiments to think and feel on different levels at the same time.

In Suzanne Keen’s book *Empathy and the Novel* (2007) she takes her perspective from both psychology and philosophy and describes the contemporary use of the word empathy as follows:

Empathy	Sympathy
I feel what you feel	I feel a supportive emotion about your feelings
<i>I feel your pain</i>	<i>I feel pity for your pain</i>

Drawing: I use the term drawing⁶ to mean “the act of telling a story or making an impression with a simple tool or material that fits in the palm of one’s hand”.

Double-Blind Drawing⁷: Drawing using both hands at once, eyes closed. I like the way the words double-blind drawing represent an affectionate parody of the double-blind controlled trial⁸, which is so fundamental to medical practice. For me there was a mischievous pleasure in making an experiment that both contained the idea of two arms of

a test, but also represented a single, united process. I like the notion that one side of the brain might “tip off” the other, more logical side that something mysterious and magical might be going on.

Bimanual Palpation of the Abdomen.⁹ Palpation of the spleen is focused on the haptic elucidation of one of the most difficult organs to detect from the outside of the body (without the aid of complex machinery). It requires the senses to be highly attuned and practiced. Experienced practitioners may close their eyes to perform the task. This is not written down in a text-book, but is learned by individual observation and experimentation. Double-handed technique ensures that several fingertips catch the sensation of gently rising mass (the spleen moving with the breath) beneath the surface of the abdomen. I incorporated this technique into my New York performance, enhancing the impression of the subject becoming a patient in a hospital, undergoing an intimate examination, whilst also being part of a spectacle in a gallery.

Critical reflections underpinning this gallery event

A triad of personal observations, collected over a twenty year period, informed the design of this performance. Firstly the freedom and excitement discovered when making sculpture from clay at my very first sculpture evening class, in 1978, shortly after registering as a doctor. I had a sensation of

part of my brain “opening up” for the first time. Secondly, I drew with my left, non-dominant hand for the first time, at the suggestion of a tutor, when I returned to college¹⁰ in 1990 and found new exploratory potential in my drawing and a strong sense of being attuned to life. Thirdly I noted that when typing my MA thesis on drawing, in 2001, there was a difference in the freedom and flow of thought during bi-manual typing, using all fingers, compared with writing with a pen.

What was striking about these three observations was that each was located at the dawning of a very intense and daunting experience; becoming a doctor, becoming a mother and writing my MA drawing thesis, having just introduced collaborative drawing practice to my long-standing medical colleagues at a hospital in South-East London, which felt quite a risky undertaking. During my research degree I decided to take drawing with both hands at the same time, eyes closed, to my participants in the Big Draw¹¹ experiments, in order to understand more about practices in both medicine and drawing. Claude Heath asserts that drawing from touch carries a quite different body of knowledge from drawing by eye. (Kovats, 2006)

Avis Newman suggests drawing offers the most direct access to the intimate workings of the artist's mind:

I have always understood drawing to be, in essence, the materialisation of a continually mutable process, the movements, rhythms, and partially comprehended ruminations of the mind: the operations of thought. (Kovats, 2006)

Here Newman describes the act of drawing as a way of casting our thoughts into the visual domain, with the opportunity to recast as understanding deepens. By asking my participants to draw with both hands at the same time I receive a dual reflection, an impression from both hemispheres of the brain making this a rich and real-life-like experience for my participants, whether in a hospital or gallery. Medicine is an activity that requires constant use of both hands, whether taking blood or examining a patient. In New York my participants were artists. By reciting the passage about the spleen, heaven and earth and then palpating their spleens whilst they lay on the ground drawing with both hands I took them into a territory of “war,



Figure 3. Sara Stuart-Smith at Elixir Gallery, Queen Elizabeth Hospital

death or sickness”, a field in which medical practice also takes place.

I thought that this activity might help elucidate important aspects of empathy, which requires a complex balance of thinking and feeling. Participants have confirmed that having the opportunity to work resting on the ground allowed more thoughts and feelings to emerge, something I also observed in my research in the hospital¹². I was looking for an engagement with the physical, searching for internal images and symbols that might allow transformation, via the process of drawing and the sense of touch to a space that is both internally located and attached to the external world and the socially engaged space. The double-blind drawing approach, lying on the floor in an art gallery¹³, with eyes closed, allows that opportunity.

Comments from a couple of my participants are recorded below:

For me it felt like being transported to a different space. I wasn't aware of this till afterwards, but when I finished drawing and opened my eyes I suddenly realized that the room was actually quite crowded, and not the quiet, intimate space I had been experiencing with my eyes closed, in which I was aware of the words and the paper, and communicating just with you. It also felt therapeutic somehow, although I couldn't describe in what way. There was a sort of trust involved in which I just did what you said without needing an explanation, like in a medical situation, but without feeling vulnerable, just receiving something. (participant, artist & teacher)

I felt conscious of rhythm in the movement and sound through the drawing act, which was hypnotic and triggered the same sensory experiences as building a drawing through knitting with hand pins. Because I was lying on top of the paper I felt I was immersed in the drawing both physically and sensually and was creating the drawing from the central core of the paper with pencils as conduits for my own physical presence. (participant, textile designer & knitter)

I hoped to simulate processes that occur during empathic understanding giving participants, who included artists and teachers, a different way of thinking about empathy. The physical action of mirroring and the psychological process of imagining the situation of the other are both important. I believed that this activity would anchor my participants in an activity that had a physically comfortable (albeit psychologically challenging) feeling that would allow them to explore the activity of drawing in a way that mimicked the experience of being a patient in a hospital, that of lying down and being examined.

In order to explore empathy I also needed a technique that would lead me to encounter, in Lysander's words "war, death, or sickness". The delicate manoeuvre of bimanual palpation of the spleen (a blood sequestering organ located in the upper left quarter of the abdomen) seemed to fit the bill as, in his words, "in a spleen, unfolds both heaven and earth".

Conclusion

The performance in Macys Gallery, helped me to reconsider the relationships between drawing and empathy. The act of restoration and reparation is as important in teaching and gallery settings as in healthcare.

The notion that both hands are moving, sensing devices, working in unison unites the two practices of art and medicine. I made a "field" for drawing that was grounded on the floor of the gallery. My intimate drawing space was constructed by a roll of paper, two pencils and a quotation about heaven and earth, spleen and a sense of the moment. The event or collaborative art practice drew participants into the territory of relational aesthetics (Bourriaud, 1998) and the "gift" economy (Morgan, 2003) functioning as a "therapeutic intervention".

The interaction allowed a space to come about, in which engagement occurred in a tactile and physical way with, for example, the enjoyment of the activity, the contact between the pencil and paper, the texture of the paper, the spontaneous movement of arms. In New York the rhythmical sounds of cello notes, used in previous performances, were replaced with the rhythm of nine lines of Shakespearean poetry, which broadened the engagement to include notions of war, death and sickness. The intervention appeared to facilitate an altered experience of the act of drawing and communicating. Each participant responded differently, and articulated different aspects of the experience. The question remains whether my performance enticed knitting together of souls. It was a "knitting" in the sense that the presence of the palpator was not only felt as in a *touch*, but was also perceived in a way that might be experienced as mysterious. To help answer some of the questions about the nature of the drawn encounter the performance will be repeated in Cornwall at the private view of the show *Brief Encounters*.

Footnotes

- 1 My PhD is an investigation of my drawing practice as an artist, investigating empathy, in the hospital where I also work as a doctor. I entice others, mainly staff, to collaborate with me in the making of performances & drawings, which, at their heart are concerned with relationships between people.

- 2 The phrase hovering attention was used by Paula Heinman (1949), a student of Melanie Klein, to describe the positive clinical use of empathy in a psychoanalytic setting.
- 3 A term first used by Melanie Klein (1959)
- 4 My good Lysander/I swear to thee by Cupid's strongest bow/By his best arrow with the golden head/By the simplicity of Venus' doves/By that which *knitteth* souls and prospers lovers/And by that fire which burned the Carthage queen.....
- 5 For more information about empathy the following is very useful: Decety, J., Ickes, W Eds *The Social Neuroscience of Empathy*, MIT Press, Cambridge, Massachusetts. My personal take on it uses a more psychoanalytic framework and is rooted in the description of the first clinical use of counter-transference by Paula Heinman at the 1949 *Psycho-Analytic conference*, Zurich
- 6 My research degree definition is in tune with Gerlinde Gabriel who talks about the hand and the tool (Gabriel's introduction to 'The Body of Drawing' at the South Bank Centre 1993). "For the hand holding the pencil which makes the line of drawing is also a form which cups itself into a container, suggesting a structure, a "body" which begins to be the inside and outside of what is the material condition of sculpture".
- 7 For my very first event in autumn 2008 in the hospital where I work I asked participants to select an animal that captured their interest, their own pet or an animal that fascinated them for some reason, one that they could identify with and would feel "at home with" in some way. I provided a selection of color photographs pictures of animals, varying from Aardvark to Zebra, to help them visualize. I played notes to them, on a cello, as some of them drew.
- 8 The best and most reliable form of research in medical circles is considered to be the double-blind, placebo-controlled study. A treatment is said to be proven effective if it has been examined in properly designed and sufficiently large studies. In these experiments, one group of sub-

jects receives the "real thing"—the substance or activity being tested. The other half receives a placebo, designed to appear, as much as possible, like the real thing. Individuals in both groups do not know whether they are getting the real treatment or placebo (they are "blind"). Furthermore, the researchers administering placebo and real treatment are also kept in the dark about which group is receiving which treatment (making it a "double-blind" experiment). This is important as it prevents the researchers from unintentionally tipping off the study participants, or unconsciously biasing their evaluation of the results. (Health Library 2011)

- 9 http://www.med.ualberta.ca/education/ume/clinicaled12/clinskills_gastroenterology/cfm?yr=2

Carefully gaze at the abdomen from a slight distance, checking movement with respiration, flank distension, the presence of abnormal pulsations, visible peristalsis, and visible masses. Warm your hands by rubbing together (if it's a cold day) and ask permission to examine the patient's abdomen. Tap gently to check for a fluid wave or shifting dullness. Take out your stethoscope, warm the end and listen for bowel sounds, presence or absence, type and pitch. Listen again for bruits & venous hums. Palpate lightly to elicit local tenderness use one-handed technique. Deeper palpation may be better with two-hand technique (one hand on top of the other). Perform orderly palpation of four quadrants. Relaxation techniques to relax abdominal muscles may be needed. Start in a non-tender quadrant and check for guarding, rebound tenderness.

To palpate the spleen begin in the right lower quadrant and follow the path of splenic enlargement. Begin with superficial one-handed palpation for an edge or splenic fullness. Move to bimanual palpation technique (patient supine) with left hand attempting to move the area below the left rib forwards and push the spleen outward. The spleen will be felt during inspiration; the fingers should move forward during inspiration to feel the tip of spleen as it comes down. If you still cannot feel it but suspect that it may be enlarged ask the patient to turn onto the right side, rolling slightly for-

ward with the right knee flexed to relax the abdominal muscles and repeat the examination.

Precise from the University of Alberta website, accessed 20/1/11

- 10 three months after the birth of a baby
- 11 Structured drawing activities (2007-2011) with staff of a mixed ethnicity hospital community in south-east London, based on the concept that drawing is a useful tool in the practice of empathy, which is thought to be essential to the practice of medicine. Empathy, “putting oneself in the shoes of another” is examined critically through drawing as practice, conducted within the hospital environment. This research coincides with a period of immense change for the hospital Trust where I work as both an artist in residence and a consultant microbiologist, looping between one practice and the other on a daily basis.
- 12 In my first experiment in 2008 I asked confident participants to repeat the drawing process, still with eyes closed but with greater contact with the ground, either lying down to draw or gently resting the head on the ground to draw with both hands. I provided a yoga mat, head cushion and a screen of clean washing, on a white clothes horse, to shield them from the gaze of people wandering along the corridor next to the hospital gallery where the event was taking place. In 2010 events benefits were noted by participants who welcomed the opportunity to lie down for a few moments during a hectic clinical day.
- 13 or public hospital corridor
- 14 In my original experiments in 2008 & 2010, participants included doctors, nurses, and porters, catering staff and occasionally patients and relatives
- 15 The use of this technique in hospital events did not take place until spring 2011 when my collaborative art practice in the hospital was very well established
- 16 *Brief Encounters*, Morvah Schoolhouse, Penzance, Cornwall, Spring 2012

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Drawing from Drawing

Doug Fitch



For me, drawing is a way of seeing things that don't exist yet. I draw to discover what I am thinking—to see how it looks—to flesh it out.

One day, when I was teaching a class about drawing, when a student whined that she couldn't draw. I wondered why she was in the class, but I asked her, "well, you have just *drawn* a conclusion very well! So what is it you *can't* draw? I bet you could *draw* water from a well....or we could *draw* this class to a close—what does it mean—'*draw*'?" And suddenly I realized that this little word has a lot of meanings. How does one become a good "draw-er" anyway? Why is a draw-er different from a drawer and why do we put drawers in a chest while many people who draw have something to get off theirs? People can draw a bath or a cart without a pencil. We draw back the shades or the covers each morning and instantly our attention is drawn to something. Perhaps we look withdrawn or speak with a drawl? We take a draw from a pipe near the fire and watch as the smoke is drawn up the flue. From what do we draw inspiration and why - when the game draws to a close at the end of the day, and no one wins—why is it called a draw?

And what can we draw from this exercise in semantics?

Drawing happens when I match my thinking process to the speed of my hand—i.e. when I merge mind and body. It places me in the present. Drawing is a meditation from which I can access inner vision. I put down something on paper and then react to it. Once I make a line, it becomes a condition: does it look like what I thought? Does it



Pete in Hand

make me want to draw another or shall I erase it? It encourages me to make decisions only I can make. It has instantly become something that already exists and it draws me into the world of its own need to be drawn. More marks on the paper let me see further what was only a moment before a desire, a conundrum, an enigma, a problem to solve.

Drawing is a way to manifest what we alone can imagine and to be able to share that image with other humans. We draw drawings from within us the way we draw water from a well. And we drink water as we drink in images—we absorb them and are in some sense made from them (you are what you eat, and by extension, drink). As water replenishes our body, drawing nourishes our soul.

When I want to figure something out, I sit down to draw it into being. Sometimes, when it is a dimensional thing, I try to find a material to draw it in those actual dimensions, like cardboard. When I design interiors I like to walk into the room and start cutting out cardboard shapes to see how they affect the room and how the context of the room



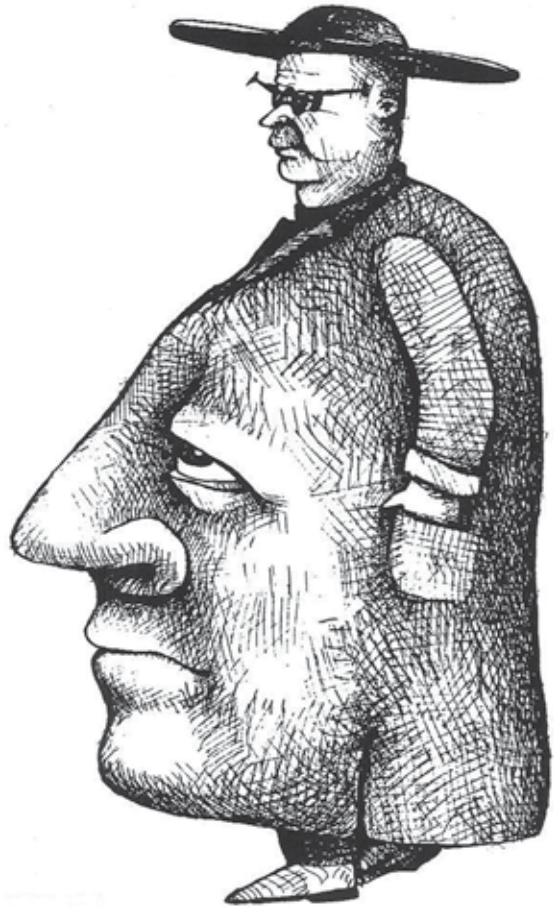
Waiting Room



Drawing Forest

affects their size and shape. It is as if the room is a piece of paper and the cardboard objects emerge as a solid drawing you can walk around inside of. I think you can draw with anything as long as it serves to help draw out of you what you are trying to see more clearly.

When I make something, I start out with a kind of vague notion of something very specific—maybe more of a feeling about something—and the act of drawing focuses my attention on defining what that feeling is and isn't. I draw lines around it as if they are boundaries. I draw lines within it to help establish its particular it-ness—to delineate it from the void of vagueness. Once I know what it is, I can make a drawing of it and that is a different kind of drawing. It becomes more like illustrating where



The Sandman

I focus on the craft of drawing more than actively seeking the inner vision. I shift into a mode where I start making the drawing into an object—making it into a better bridge between what helped me see what I knew it could be and what other people can now look at understand.

I often try to preserve the sketch-like quality of the act of seeking in my finished work whether it is a costume design, a piece of theater or a drawing or sculpture. I believe this quality keeps the object feeling fresh—as if it has just been made—and in this way, it invites its audience to seek something in it too, as if they too have a hand in its creation. Sometimes (but not always) when a work of art is too “finished” there is no room for a viewer to enter it and reinvent it for his or her own purpose. What



La Grande Macabre, Lincoln Center's Avery Fisher Hall in 2010, with the New York Philharmonic.

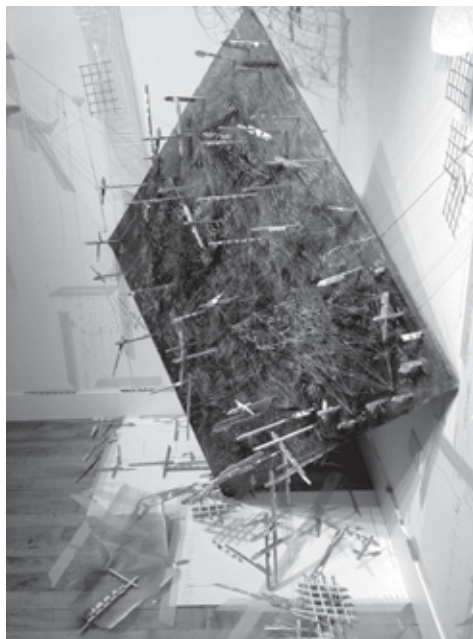
is the purpose of an audience if there is nothing for them to do but look? Art has to resonate with an audience—to encourage them to intuit and to be conscious of their own intuition. If it is “too finished” it can become more like a magic trick where the effort of the viewer is to wonder how it was made rather than what is it doing to me. I like it when a work of art leaves parts for a viewer to complete, or, I suppose you could say, leaves room for one to draw his or her own conclusions from it.

I think drawing therefore is a way to manifest an act of curiosity. There are many ways to get from Point A to Point B and drawing can be that very personal journey.

From the exhibition:

Jeesoo Lee

This piece is a study where uncorrelated images from my memories and present mind are materialized to obtain a meaningful aesthetic. Fanciful and unrecognizable shapes are mapped with threads, nails, and other materials on a board to create an unexpected form of inner-scape that evokes my cognitive and perceptive abilities. It is abstract, informal and subjective; the process is based on a free form style, which enables me to make decisions about where to locate elements and how to orchestrate the images together with efficiency and ease. And though the process has ended, the visually constructed physicality opens a new geographical imagery which is left open to interpretation. Lines of flexible materials are drawn from point to point, layers are built above and beneath, and the nature of complexity is explored in abstraction.

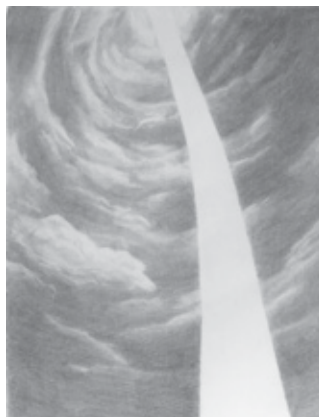
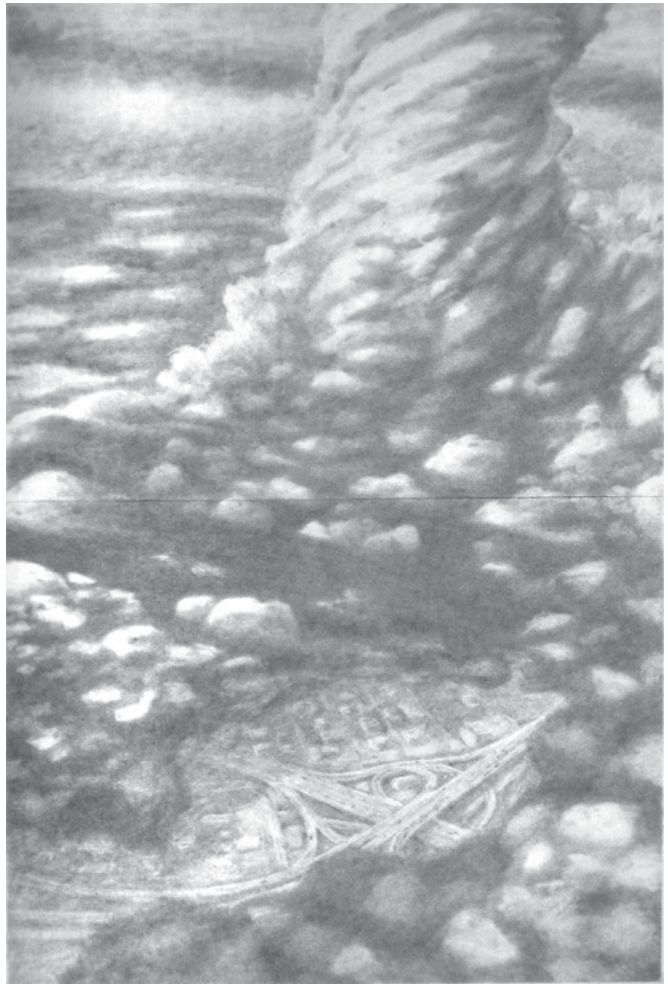


Obscura model 1, approximately 4' x 6' x 1"
Mixed media, 2011

From the exhibition:

Mia Pearlman

These drawings are a meditation on chance, control and the ephemeral nature of reality. They are a reaction to the overwhelming knowledge that is now available of every aspect of our world, from the smallest nanoparticles to the incomprehensible vastness of the universe, and the way in which this hyper-awareness has the potential to be simultaneously awe-inspiring and soul-crushing. As such, they evoke environmental chaos, physical instability, and infinite destructive forces that exist beyond human control.



Above: Cloudscape XI, 22" x 14"
Graphite on paper, 2005

Left: Light Tunnel, 14" x 11"
Graphite on paper, 2007



Cloudscape VIII, 22" x 14", Graphite on paper, 2005

Biographies

Simon Betts is currently Dean of College Wimbledon College of Art. He studied painting at Sheffield Polytechnic and later completed his MA in painting at Chelsea College of Art & Design. He worked in further education for a number of years as course director foundation at Kensington & Chelsea College London, before becoming course leader foundation at Wimbledon in 2003. His drawing research interest is centered on drawing pedagogy and developing courses that promote new approaches to teaching and learning for drawing across disciplines. He co-authored with Professor Stephen Farthing and Kelly Chorpening the Drawing qualifications for the University of the Arts London. He recently led a team to develop the newly validated cross disciplinary MA Drawing course which, based at Wimbledon College of Art, begins this academic year. He has been an external examiner at a number of Colleges in the UK, and in 2005 was a foundation course consultant at the Shanghai Institute of Visual Art, Fu Dan University, China. He has recently been offered an International Visiting Fellowship by RMIT Melbourne, Australia, to work with their Pharmaceutical and Chemistry Faculty to develop on-line drawing modules to support learning in the sciences. As a painter he has exhibited widely in the UK and Europe. Group shows include: *perpetuum mobile* The Gallery at APT London,(2008), *The John Moores Liverpool 19* (1995), Kunstbrücke 2, galerie Parterre, Berlin Germany. Solo shows included *Radical surface*, De Ploeghis Gallery Gronningen, The Netherlands. Betts also selected and Curated

OUTBOUND 1 & 2, two residencies and exhibitions of 6 students from 5 London art colleges at Richter Werkatelier, Den Helder, The Netherlands in 2008. The working title for Simon's presentation is: *The Purpose of Drawing: New approaches for teaching across disciplines.*

Angela Brew is a research student and a member of The Centre for Drawing UAL, 123 Draw, and the Drawing Research Network. After studying sculpture and drawing at Edinburgh Art College she created and ran Skylark Galleries <http://www.skylarkgalleries.com/> and worked as an artist and drawing teacher. In 2006 she completed her Drawing Masters at Camberwell, and began her doctorate research on the impact of drawing practice on perception. Her research interest is in cognitive, perceptual and motor processes involved in drawing and learning to draw. She is studying the development and changes of rhythm in eye and hand movements, and the role of the pause in drawing. Her research method combines scientific study of changes in eye-hand interactions with practical experimentation in the drawing studio and classes, attempting to develop new drawing instructions, based on recent findings from cognitive science. Her PhD thesis presents a quantitative longitudinal study of students' behaviour as they learn to draw.

Rebecca Chamberlain is a PhD student in the Clinical, Educational and Health Psychology department at University College London working under the supervision of Professor Chris McMa-

nus. Her educational background lies within art, psychology, neuroscience and philosophy and as such she takes an interdisciplinary approach to her research. The broad aim of her PhD research is to explore the psychological foundations of drawing ability with a particular emphasis on the role of visual perception and visual memory. She is currently working in conjunction with Swansea Metropolitan University and the Royal College of Art studying the visual processes of foundation year and post-graduate art and design students. She is also interested in the neuroscientific basis of artistic skills and intends to pursue this using structural and functional studies of artistic processing in expert and novice artists.

Born in 1979, in Napoli, Italy, **Ruben Coen-Cagli** holds a PhD in Physics and is currently a Research Associate in the Laboratory of Computational Neuroscience at Albert Einstein College of Medicine in NYC. His current research aims to link the statistical properties of the sensory environment (natural images), the response properties of (visual) cortical neurons, and perception. His approach relies mainly on probabilistic (Bayesian) computational modeling, and, to a smaller extent, neurophysiology. After graduating in Quantum Physics in 2004, he completed the PhD in Physics in 2007 at University of Napoli, Federico II. Based on the idea that creative processes are linked to specific sensorimotor skills, his doctoral research exploited eye tracking experiments and Bayesian modeling to understand visuomotor coordination in the activity of drawing, and to develop an artificial agent with such capabilities. From 2004 to 2007 he has been a visiting scholar at the Academy of Fine Arts of Napoli. As a visual artist, his interdisciplinary projects have been presented at PixelACHE (Kiasma Museum, Helsinki), Institute Jean Nicod (Paris), CMCA 2006 (Goldsmiths College, London), DMS'2006 (Grand Canyon, USA), Generative Art Conference (Milano), and in several solo and collectives in Napoli.

James Esber has lived and worked in Brooklyn, NY since 1986. In January, 2011 James had a solo exhibition at the Aldrich Contemporary Art Museum in Ridgefield, CT. In 2007 he had a ten year survey exhibition at the Southeast Center for Contemporary Art in Winston-Salem, NC. He has had one-person shows at Pierogi Brooklyn (2010,

2006 and 1997), Pierogi Leipzig in Germany (2008) and at PPOW in New York City (2003, 2000 and 1998). He has also shown widely in group exhibitions, including *Wall Rockets: Contemporary Artists and Ed Ruscha*, Albright-Knox Art Gallery, Buffalo, NY (2009), *The Land of Earthly Delights* at The Laguna Art Museum (2008), *Material Pursuits* at the Fleming Museum (2007), *Twice Drawn* at the Tang Museum (2006), *SITE Santa Fe's Fifth International Biennial: Disparities and Deformations: Our Grotesque* (2004) and *Open House* at the Brooklyn Museum of Art (2004). In recent years James has been invited to lecture as a visiting artist at several colleges and other institutions. These include The Aldrich Museum (2011), Middlebury College, VT (2009), the Center for Art and Design, College of Saint Rose, Albany NY (2007), the Tang Museum at Skidmore College (2006), the Rhode Island School of Design (2004), the Brooklyn Museum of Art (2001), the Fine Arts Work Center in Provincetown, MA (2001), Princeton University (2000) and Bennington College (2000). James was a recipient of an individual fellowship in painting from the New York Foundation for the Arts in both 2008 and 2002. In 2005 he received a grant from the Pollock-Krasner Foundation. He has also been a resident at the MacDowell Colony in 2001 and 1992 and at Yaddo in 1997 and 1990.

Stephen Farthing is a painter and research professor at the University of the Arts London. He currently divides his time between painting, writing a book on Color with David Kastan at Yale, and the development of a taxonomy of drawing.

Michelle Fava is a research student and member of Loughborough University Drawing Research Group and the Drawing Research Network. Previously she taught drawing, sculpture and contextual studies in Further and Higher Education. Her PhD research engages with drawing and psychology of attention, considering the educational relevance of contemporary theories of visual attention, and cognitive studies of drawing. This research uses empirical observation of artists' drawing behaviour to bridge these disciplines, by considering the attentional strategies artists employ in order to draw from observation.

Jane Fine has lived and worked in Williamsburg, Brooklyn since 1986. She received a B.A. from

Harvard University and an M.A. from Tufts University and the School of the Museum of Fine Arts. She is also an alumna of the Skowhegan School of Painting and Sculpture. Jane is a recipient of grants from The New York Foundation for the Arts, The Pollock-Krasner Foundation and The National Endowment for the Arts. She has been a resident at the Cité Internationale des Artes in Paris, the Fine Arts Work Center in Provincetown, and a four-time guest at Yaddo. Jane had her first solo show in New York City at White Columns in 1994. Since then she has had solo shows at Casey Kaplan Gallery and at Pierogi in New York as well as Michael Rosenthal Gallery in San Francisco and Barbara Davis Gallery in Houston. Her work has been exhibited in group shows at The Tang Museum, The Brooklyn Museum, The Neuberger Museum, Jack Tilton, P.P.O.W., The Drawing Center and White Columns all in New York, as well as at Völcker & Freunde in Berlin, g-module in Paris, Vilma Gold in London, Post Gallery in Los Angeles, and The Weatherspoon Museum in North Carolina.

Doug Fitch is a multivalent thingmaker who uses drawing as a way to manifest the thinking process. He has worked in media ranging from architecture and opera to puppetry and food. He has created a number of performance installation feasts involving whole villages in France and designed and constructed the interior and furniture for a home for violinist Joshua Bell. In a traveling exhibition of drawings and painted sculptures entitled *Organs of Emotion*, he proposed a new design for the human anatomy aimed at better serving the life of emotions. An exhibition of tactile pictures, called *Mit Haut und Haaren*, is currently traveling around Germany. As director/designer, he created a production of Elliot Carter's opera, *What Next?*, conducted by James Levine, that was filmed and premiered at MOMA. He has also created opera productions for the Santa Fe Opera, the Los Angeles Opera, the Royal Stockholm Philharmonic, the National Symphony Orchestra. Recently, his productions of *Le Grand Macabre* and the *Cunning Little Vixen* with the New York Philharmonic were met with great acclaim. He is currently creating a touring production of *Peter and the Wolf*, to happen in a tent, with his company, *Giants are Small*.

Tara Geer got her BA from Columbia University with a double major in Art and Art History, she

graduated Magna Cum Laude & Phi Beta Kappa. She went back to Columbia with a Teaching Fellowship to get a MFA. She has been drawing and teaching drawing for the nearly 2 decades since. She has also worked at WNYC, the NY public radio station, writing and producing culture pieces for *Morning Edition*, *Studio 360*, Leonard Lopate and other national radio shows. She taught art in every borough of NYC, every age, in public and private school, frequently using Visual Teaching Strategies. Recently she has been drawing and teaching private classes out of her studio in Harlem and teaching drawing classes at Columbia. The private students range from advanced drawers working on specific projects, professionals in the arts having blocks, to kids with delays working on perceptual challenges. She has been to several residencies at MacDowell and Denniston Hill and shows her work in galleries, including Tibor de Nagy, The Drawing Center registry and the Four Seasons Hotel in Wyoming. She will have a solo show at the Outpost this winter. She received the Loius Sudler Prize for excellence in the Arts and the Joan Sovern prize.

Andrea Kantrowitz is an artist, teacher and doctoral candidate at Teachers College, Columbia University and a member of the Drawing Research Network. She holds a B.A in Art and Cognition from Harvard University and a MFA in Painting from Yale, and teaches graduate students in art education at the College of New Rochelle. She has also worked for many years as a teaching artist in the New York City public schools. Her research examines the cognitive interactions underlying contemporary artists' drawing practices. Her art work is represented by Kenise Barnes Fine Art.

David Kirsh is Professor and past chair of the Department of Cognitive Science at UCSD. He was educated at Oxford University (D.Phil), did post doctoral research at MIT in the Artificial Intelligence Lab, and has held research or visiting professor positions at MIT and Stanford University. He has written extensively on situated cognition and especially on how the environment can be shaped to simplify and extend cognition. He runs the Interactive Cognition Lab at UCSD where the focus is on the way humans are closely coupled to the outside world, and how human environments have been adapted to enable us to cope with the complexity of everyday life. He has written extensively on the use

of external representations as an interactive tool for thought.

Aaron Kozbelt (PhD, University of Chicago, 2002) is Professor of Psychology at Brooklyn College and The Graduate Center of the City University of New York. His research foci lie mainly at the intersection of creativity and cognition in the arts, particularly on the nature of the creative process, the psychological basis of skilled artistic drawing, and explaining variability in the lifespan creativity trajectories of eminent creators. He is the author of approximately 50 journal articles or book chapters on these and other topics and serves on several editorial boards. He has been the recipient of the American Psychological Association Division 10 Daniel Berlyne Award for Creativity Research and the International Association of Empirical Aesthetics Alexander Gottlieb Baumgarten Award for Creativity Research; some of his current research is funded by the National Science Foundation. His research on drawing and visual art aims to identify perceptual and cognitive differences between artists and non-artists, to empirically disentangle competing psychological explanations for drawing skill, and to develop a descriptive and predictive model of the creative process in visual art. He has also been a practicing visual artist for more than 20 years, exhibiting work in the United States and Europe.

Jeesoo Lee, a New York-based artist, bases her work on psychological states of being (including fear of water, suffocation, emptiness and liberation) and redefines them through the physicality of her material. The deconstruction/construction of her imagery investigates the search for enlightenment and reason. Her use of contrasting mediums (thread, color, line) continues this investigation while exploring the tensions of abstract painting with her current contemporary practices. Ms. Lee received a BFA from Sungshin Women's University, Seoul, Korea and a MFA from State University of New York, New Paltz, NY. Solo exhibitions include Oregon State University gallery, OR, 2010, C3 Gallery, New York, NY and Purchase College, NY in addition to two-person show at Amy Simon Fine Art, CT 2010. Her work has been written about in *The Chronogram* and *The New York Times*. Selected exhibitions include: Invitational Exhibition of Visual Arts at the American Academy of Arts and Letters, New York, N, Michael Steinberg

Fine Arts, New York, NY, Dieu Donne, New York, NY, Garrison Arts Center, Garrison, NY, Tiberino Museum of Contemporary Art, Philadelphia, PA and the Museum of the National Library of Spain, Madrid, Spain. She is an awardee for the prestigious award such as Thayer Fellowship/Patricia Kerr Ross Award and nominee for the American Academy of Arts and Letters Award and the Louis Comfort Tiffany Award. She is also going to Umbria, Italy in next summer 2012 as a fellow of Civitella Ranieri Foundation.

Ian Murray Mc Innes is Senior Lecturer in Design at Heriot Watt University, Edinburgh and has worked successfully as knitwear and knitted textile designer in Milan, London and Scotland. His research interest is in drawing origination for and through the weft knitted fabric and the creative application of digital technologies in their manufacture. He has designed a portfolio of successful degree and postgraduate courses across Fashion and Textile design disciplines and is sought by prestigious academic institutions as academic advisor and as external examiner in the UK, India, Dubai, Finland, Iceland and Mauritius. Appointed to the Scottish Academy of Fashion project team, he is responsible for developing product innovation through knowledge transfer and exchange projects, matching research expertise within the consortium with leading textile companies. Current development projects are focused on working with the Scottish Cashmere Knitwear Industry in the establishment of a Knit Research Centre and building a portfolio of collaborative knit research projects for existing and new emerging markets.

Chris Moffett is a philosopher of education, at Teachers College, researching the aesthetic practices of education—the ways in which we imagine and perform “education.” (From narratives and architectures of urban descent and emergence, to myriad forms of mark-making.) He is also a Feldenkrais Practitioner of movement education, and is part of a collaboration exploring embodied, kinesthetic practices of drawing. This work, at the interstices of education, movement, and drawing has recently been presented at a number of museums and institutions.

Michael Moore earned a BFA degree in Printmaking from Syracuse University in 1963 and an

MFA degree in Drawing from the University of Washington in 1967. He taught at the University of Southern Maine from 1967 through 1992. He has taught at the Pennsylvania Academy of the Fine Arts in Philadelphia since 1992, where he teaches a studio seminar, Graduate Drawing, and a discussion seminar, Subject, Form, and Content, in the Post-Baccalaureate Program which he founded in 1994. Michael taught in Scotland, 1972/73, has traveled to China and Japan, and has exhibited his work in two solo, two duo, three group, and 10 faculty exhibitions during the past 10 years.

Born in Ohio, **Margaret Neill** has lived and worked in Brooklyn, NY for over 20 years. She earned an MFA degree at Brooklyn College and have exhibited work in a variety of settings including the Cleveland Center for Contemporary Art, the Monastery Plazy in the Czech Republic and the Central Library of Brooklyn. In the Spring of this year she exhibited a 9 ft. x 9 ft. wall drawing at Masters & Pelavin Gallery in NYC in the group show, *A Field Guide to Getting Lost*. At Middlebury College in Vermont she taught an intensive month long course on drawing and was an artist in residence at Hiram College, where she created a 40 foot wall drawing. At Kentler International Drawing Space in Brooklyn, "Fixed in Time", a gallerywide wall drawing was exhibited where people were invited to view the drawing in process. She has shown paintings, drawings, and prints in a variety of venues across the United States including Lancaster Museum of Art in PA, Hofstra University Museum, Kent State University, Metaphor Contemporary Art in Brooklyn, and the Simon Gallery in NJ. Recent projects include permanent installations at The Boston Medical Center, NY Intercontinental Hotel as well as Deloitte University in Texas. She also has work in public and private collections including Colby College Museum of Art, The New York Public Library, The New School University, and Pfizer.

Since receiving her BFA from Cornell University in 1996, **Mia Pearlman** has exhibited internationally in numerous galleries, non-profit spaces and museums, including the Museum of Arts and Design (NY), the Montgomery Museum of Art (AL), the Centre for Recent Drawing (London), and Mixed Greens (NY). Upcoming shows include the Indianapolis Museum of Art, Morgan Lehman Gal-

lery (NY) and the Renwick Gallery at the Smithsonian. Her work is featured in several books on the use of paper in contemporary art. Pearlman has participated in many residency programs, including Proyecto'Ace in Buenos Aires, the Lower East Side Printshop in NYC, and the Vermont Studio Center. She is a recipient of a 2008 Pollock-Krasner Foundation Grant and a 2009 Established Artist Fellowship from UrbanGlass. Pearlman lives and works in Brooklyn, NY.

Justin Ostrofsky (B.A., The Richard Stockton College of New Jersey, 2008) is a 4th year Doctoral Student at The Graduate Center and Brooklyn College of the City University of New York. His major research aim is to understand the cognitive mechanisms that influence observational drawing accuracy. This research has involved conducting individual difference studies that have measured perceptual abilities of trained artists and non-artists in order to determine whether expertise in this domain of the arts is associated with changes in basic perceptual processing. Additionally, he is interested in determining whether the human visual system processes information in qualitatively similar or distinct ways when guiding perceptual judgment and observational drawing behaviors.

Patrick Tresset is co-principal Investigator of the Aikon project, together with Frederic Fol Leymarie, at Goldsmiths College, University of London. His main interest is to create autonomous robotic systems capable of imagining our reality. Patrick is currently based at Goldsmiths's Digital Studios preparing for a PhD. in Computer Sciences: *Face Sketching, a Multidisciplinary investigation*. Patrick studied computer sciences twenty years ago in France. He then came to London to become a painter. During the past 15 years he has participated in solo and group exhibitions in London and Paris. Since 2003 his interest in computing was revived when the research leading to Aikon begun. Joining forces with Frederic Fol Leymarie in 2004, he has been developing the AIKON project.

Professor of Computing **Frederic Fol Leymarie** is co-director of the Post-Graduate program MSc Computer Games and Entertainment (www.games-goldsmiths.com) at Goldsmiths College, which he founded with William Latham in 2008. He previously created and lead the MSc Arts Computing

(2004-7). He is also co-principal investigator of Aikon, together with Patrick Tresset. "Patrick and I met in late 2004 and started collaborating on Aikon in 2005. In 2009 we received a grant from the Leverhulme Trust which has helped fuel our research project and explore more in depth in particular embodiments of Aikon within robotics." Frederic received his B.Eng. in Electrical Engineering, with honors in aeronautics, from the University of Montreal, his M.Eng. from McGill University in Computer Vision and Biomedical imagery, and his PhD from Brown University (in 3D shape representation and computational geometry). His current research interests incorporate ideas from computer vision, together with the physics of waves and shocks and their modelling in modern mathematics via singularity theory. Frederic is also working on perceptual models grounded in geometry, based in part on Gestalt theory. Frederic has initiated several "shape-based" projects mixing the Arts, Humanities, Social Sciences, and Computing, including CyberCity and CyberMonument (late 1990's), Digital sculpting (with the Mid-Ocean Studio, 2002-5), and Digital archaeology (co-founder of the SHAPE lab. at Brown University, established in 1999).

Howard Riley studied at the Hammersmith College of Art, Coventry College of Art, and the Royal College of Art. He holds a doctorate of the University of Wales in the practice and pedagogy of drawing. He taught at various art schools in London before taking up a post in the School of Art and Design, Curtin University, Perth, Western Australia, where he studied with Professor Michael O'Toole, a pioneer of visual semiotics at Murdoch University in Perth. He has published in the areas of visual semiotics, generative art and multi-modality. His drawings have been exhibited in Australia, Malaysia, Finland and the UK. Currently, Riley is Professor of Visual Communication and Head of the School of Research & Postgraduate Studies at the Dynevor Centre for Arts, Design & Media, Swansea Metropolitan University, Wales, UK.

Neil Shah is a Senior Fellow of Head and Neck Optical Diagnostics Society. He is a Consultant Oral & Maxillofacial Surgeon, St Bartholomew's Hospital, London. Current Research Interests:

- The relationship between art, anatomy & surgery

- Oncology: tumour behaviour
- Reconstructive surgery: stem cells
- Comparative anatomy & human evolutionary anatomy
- Mineralised Tissue biology

Seymour Simmons is an Associate Professor in the Department of Fine Art at Winthrop University, Rock Hill, South Carolina, where he coordinates the Undergraduate Art Education program and teaches courses in both art education and studio art, e.g., drawing and figure drawing. He has a B.F.A. in Printmaking from Colorado State University, as well as Masters and Doctorate degrees in Education from Harvard University where his degree was in Philosophy of Education. Prior to coming to Winthrop, he taught at Massachusetts College of Art and worked as a researcher at Harvard ProjectZero with Dr. Howard Gardner. <http://www.seymoursimmons.com/>

Angela Hodgson Teall is a research student at Wimbledon College of Arts. She has worked as an artist in the field of arts and science for health, negotiating the expanding territory of medical humanities, since the 1990s. Through diverse drawing practices and empathic interactions she entices others to produce artworks with her. Angela studied medicine many years ago at University College, followed by arts degrees at Goldsmiths and University of the Arts, London. She works as a consultant medical microbiologist in South London Healthcare Trust, a series of hospitals where her collaborative drawing events are located, as part of her PhD in Visual Art, *Drawing on the Nature of Empathy*. Her research is interdisciplinary and her practice needs the collaboration of staff and students in both fields.

Sumru Tekin was born in Erzurum, Turkey and emigrated as a child to the US with her family. Educated at Massachusetts College of Art, and Parsons School of Design, she has a MFA in Visual Art from the Vermont College of Fine Arts and a BA in Art History from the University of Vermont. Her multidisciplinary approach to exploring the effects of language and image through translation and representation includes drawing, photography, text, and installation. Mining a historical rupture in recognition of a past that appears to be lost, she questions the adequacy of representation, notions of redemption, and the efficacy of apology. How can one rep-

resent a deferred encounter with an irretrievable moment?

Barbara Tversky studied cognitive psychology at University of Michigan and has held positions at Hebrew University, Stanford University, and now Columbia Teachers College. One focus of her research has been on visuospatial thinking, memory, and language, with broad applications including visual communication, diagrammatic reasoning, gesture, sketching, embodied and situated cognition, interface design, creativity, and education. She has enjoyed collaborations across diverse disciplines and diverse countries.

Jennifer Wright is currently a PhD student at the University of the Arts London, where she is researching into drawing and medical practice. Her director of studies is Professor Stephen Scrivener and her second supervisor Professor Deanna Petherbridge. Her research examines the haptic nature of drawing and surgery and is being developed as a tool to support medical students motor skill performance. The research work involves collaborative practise with surgeons, to this end Jenny has worked closely with Mr Neil Shah consultant maxillofacial surgeon at Barts Hospital London, who acts as one of her supervisors, and also with Miss Narciss Okhravi and Mr Ananth Viswanathan consultant ophthalmologists at Moorfields Hospital London. She is also working with students and researchers at Kings College London with the hapTEL virtual learning system. She is currently the honorary artist at Moorfields Hospital London and has been a visiting examiner on the Anatomy for Artists course at University College London.

The Practices of Investigation

The Program in Art and Art Education at Teachers College Columbia University is pleased to sponsor a series of publications under the general heading: "The Practices of Investigation," in which the idea of practice is defined in terms of pedagogy, art and research, and investigation as an openness to discovery, systematic inquiry, and unveiling the hidden and unsuspected order of things. The series aims to make a contribution to the domain of art education in which knowledge and practice are in transition, open to question and subject to considerable contemporary debate.

Faculty and students, working separately and in collaboration, have contributed to each volume. Taken together, the series features a wide spectrum of practical investigative work with children and adolescents in studios, museum settings and out of school. Leaning more towards theory, the series also encompasses short synopses of the variety of dissertation topics undertaken by doctoral students in the Program. Other volumes advance thinking about classroom art practices at all levels of schooling, while others question the dominant aesthetic-artistic foundations underlying the various practices of art education itself.

The series has been originated and edited by Dr. Judith M. Burton, Director of the Program in Art and Art Education. She gratefully acknowledges the participation and support of the art education faculty and students, and the Myers Foundations which has made publication and dissemination of this series possible.

Titles in Publication

Dissertation Monographs: Volume 1
Dissertation Monographs: Volume 2
Dissertation Monographs: Volume 3
Adventures in Art History
Museum Interactions: Personal Responses & Educational Perspectives
We 'Heart' Art
Adolescent Adventures in Technology
Mokarrameh Ghanbari and Darikandeh Village of Art
You Have to Look at Art Sometimes
Challenging Thinking: Possibilities and Potential for Teaching and Learning in the Visual Arts
Different Discourses: Investigations Through Surfaces
TC/MICA Research Colloquium, 2011
I Could Look At It Forever, An Exhibition of Work from the Rita Gold Early Childhood Center
Thinking Through Drawing: Practice Into Knowledge, 2011



Judith M. Burton, Director