Designing and Evaluation of Combining Movement and Drawing via Motion Sensing for Art Therapy

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Abstract
We describe a design and evaluation process using iterative design cycles and a design matrix to best understand how combining body movement with interactive drawing via an adaptive drawing system and motion tracking tools can serve as an effective new system in therapy. Increasing the range of physical movement to full body can allow patients to reveal information about their mental and psychological state, which helps achieve therapeutic goals. With corroboration from research findings, validated data were collected from art therapy practitioners and further analyzed. The results indicate a tool of this type can aid therapists' achieving goals by facilitating clients to express emotions and creatively, including clients prone to impaired verbal communication and people with physical disabilities or emotional problems.

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Art therapy; Movement; Human Computer Interaction; Expression; Observation; Gestural Systems;

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): *User-centered design*.

Introduction

Human beings resort to various ways to express their notion of 'self'. When inhibited from speaking freely or directly what they think or feel, they may choose a creative form to reveal their inner reality, depending on what medium they feel comfortable with. Music, drama, painting and many other art forms could be one of the choices.

Drawing is often singled out by art therapists as a common intervention for it is a less threatening way for people to express themselves (C. A. Malchiodi, 2006). Especially for clients with inner trauma, it could be difficult for them to use words to recount their experience. For this reason, drawing plays a mediation role between art therapists and clients in a triangulate relation. By drawing, people can enhance self-expression and self-esteem (Rees, 1998). In the process of drawing, clients are able to explore their experience-related feelings and further liberate the repressed emotion (C. A. Malchiodi, 2012). In addition, drawing has great potential to maintain a stable mental state in art therapy session because through therapeutic art-making can facilitate integrating left and right hemispheres (Hass-cohen, 2008). The symbolic representation of drawing can contain messages of emotions, cognition, expression of hidden traumas and ambiguous or contradictory feelings. Thus, drawing reflects people's inner reality with visual elements, such as lines, colours and composition.

Apart from using art media to express the unspeakable feelings or thoughts, body movement can also serve an outlet for one's inner feelings, as remarked dance movement therapist Stanton-Jones, we "use movement experimentation to explore new ways of being and feeling and to gain access to the feelings that can't be verbalized" (Stanton-Jones, 1992, p. 3). The fundamental principle underpinning the movement therapy is that human body and mind are primordially connected (Halprin, 2008a). Therefore, there is an inseparable interplay between physique, emotion and cognition. For instance, a simple gesture can contain meaning, emotion, behaviour and memory. Hence, movement can be a metaphor for therapists to access clients' psychological state.

Among all media to channel emotions or deliver messages, drawing may be the most illuminating one, not only because a person's state of mind could be translated into visual image, but also for the fact that drawing itself IS a trajectory of body movement (Matthews, 1984). Whether the act of drawing is conscious, unconscious, or even involuntary, it involves an action of executing an artwork and hand-and-arm movement to manipulate a medium, which, like any corporal movement, also contributes to the drawer's self-expression. Nevertheless, normal art therapy sessions only involve movement from fingertips to arm in the sitting posture due to the convention of art or convention of art materials. As a result, clients are hardly ever required to engage whole body movement in the drawing process. To compensate for the neglected physical movement in drawing, this study suggests that both the product of drawing (the accomplished piece of artwork) and the process (the act of drawing) are essential to art therapists' interpretation of their clients' physical, mental and psychological state.

However, common contemporary digital drawing input devices, such as mouse and tablet, only allow users to

draw with limited body movement, mainly just finger or rest movement in a sitting posture. Most digital drawing designs seem to neglect the fact that body movement can help reveal or articulate one's inner feelings. Even though there are digital Motion-Sensing drawing tools, they are designed primarily for art and design purposes (Hamilton, Lin, & Kerne, 2011; Scheible & Ojala, 2009) such as 3D paintings, 3D sculpture, installation and performance.

The second goal is to build a design framework for other researchers to design kinaesthetic drawing tool in the future. The author intends to explore the possible design features and establish a design vocabulary bank for researchers and art therapists. With adequate connected knowledge and vocabulary, researchers can further evaluate and develop the system in the future.

A matrix proposes a vocabulary bank regarding design features used for whole body-based art therapy to both art therapists and digital interaction researchers. The vocabulary and grammar given in this matrix have been developed and iterated and further validated by art therapy specialists and practitioners. It is expected through acquisition of this design language, both art therapists and interaction design specialists can establish a common knowledge framework. Furthermore, with the shared common grounds, both parties can predict the potential applications, discover new design features and create new treatments for clients.

The third is goal to investigate the use of a kinaesthetic drawing tool in art therapy practice. Investigating how whole body movement can help achieve therapeutic goals. Who can benefit from this tool? And which design features can be used for specific populations?

A qualitative study was conducted to evaluate the effectiveness of the tool for future art therapy procedures, and proposed user scenarios developed by art therapists. To gather reliable research findings, the author presented the artefacts and matrix framework of design features to art therapy experts. The study includes two demonstrations and seven expert interviews in a qualitative approach.

Research Framework

In order to understand how interactive design can function in the art therapy context, the author maps art therapy process with digital interactive process. Consequently, other researchers can understand how to and evaluate the drawing system or innovate a tool catering to the needs of art therapy.

Normally digital interaction process involves input, system and output. In the context of art therapy session, the input could involve therapist's instruction, client's physical or mental condition and client's treatment. In the process of drawing, clients use motion-sensing digital drawing tool to draw with free body movement. It is also a transformation process for clients to explore emotion and inner word in the therapy session. The output of this drawing tool is aimed to facilitate art therapists' observation and foster relationship between clients and art therapists. For the purpose to create a design framework, the author categorizes this drawing system into four aspects, body movement, visual effect, user interface and interaction. The research goal is to further explore all the possible

features and establish a word bank between designers and therapists.

Motion-Sensing Drawing Tool

The hardware of this markless motion sensing system consists of a laptop, a Kinect and a display device. The display device can be a TV or a projector. The software includes an open source graphic coding program called Processing and a middleware program OpenNI. When a user stands in front of a Kinect in a surrender pose, the Kinect can automatically detect the user's body shape and position through its infrared camera.

The size of our physical environment setting is 350 cm (Width) X 270 cm (Length). Kinect's motion-sensing range is from 120 cm to 350 cm. Within this range, a user's movement can be captured. In order to help the user be to aware of the space available in which movement can be captured, the researcher uses masking tape to create borders. The physical setting is shown in figure 18. and figure 19.

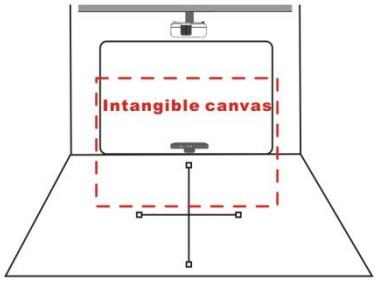

Figure 1. Insert a caption below each figure.

With the goal of providing users with an easy-to-understand drawing method, the researcher has explored the concept of an intangible canvas (figure 20.) based on the concept of a touchless surface. This original contribution allows the system user to easily and neatly shift from drawing with hands to an easy hands-free, backing up move, thereby crossing the plane from the drawing mode to the tracking mode. This differs from typical virtual painting systems that require the user to make a physical move, to stop the drawing mode, The moves required for typical virtual painting systems including clapping, moving to the side or bottom menu, often lead to confusion and overlapping strokes that were not meant to be laid on the virtual canvas. This intangible canvas was developed on the basis of the user standing 2 meters away from the Kinect. This intangible canvas is achieved by setting up a 2D canvas based on the virtual space projected on a screen. When a user moves into the drawing zone (figure 21.), the tracking point will turn yellow and start to draw. When a user moves out of the tracking zone, the point will turn green and stop drawing. In the tracking zone (figure 22.), a user can use the tracking point as if it were a normal cursor on computer screen. The reason for changing the colour of the point is to remind users which zone they are in on the screen.

In addition, this system encourages users to explore various degrees of body movement while drawing. The movement range in the system includes tight, medium and large. The movement range is independent of the canvas size, and it is the body movement needed to draw a stroke from one side of the canvas edge to the other. Within the tight setting, the user is able to draw across the screen with simple arm length hand gestures. The width of the tight movement range is 3 feet (either metric or imperial measurements). Under

the medium setting, the user can draw a cross on the screen with whole body movement. The width of the medium range is 6 feet. Under the large setting users have to move their feet with extensive body movement to draw a cross on the screen. The width of large movement range is 9 feet. This feature is designed for users to experience various levels of movement. Further, with the function to control the movement range, the system is able to adapt to various office sizes. These parameters are described in the first row of the Matrix Chart.

Figure 1. Small and Large movement under adaptive control.

In order to tap the full repertoire of body movement, the system is equipped with the feature to allow users to draw with various body parts. This feature is achieved by assigning strokes to different parts of human frame. So far the system provides users the ability to draw with one hand (figure 26.), two hands (figure 27.) and the head (figure 28.). These parameters are described in the second row of the Matrix Chart (Appendix C). Based on these 3D body movements, a user's artwork is presented as a 2D drawing on screen. It is expected that users will be able to create artwork with little effort.

Figure 2. One hand , Two Hands and head control.

With a view to the art creating process rather than the finished artwork, the researcher analyses how computer-generated strokes can aid therapists. The researcher integrates Memo Akten's Msafluid(Akten, 2008) and James Alliban's 2D-ribbon(Alliban, 2008) into the kinaesthetic system. So far the drawing system includes five stroke types, no stroke, ribbon, fluid, smoke and normal stroke with spray effect. Under the

normal stroke, when the velocity of a user's hand movement is increased, the strokes grow thicker. These parameters are described in the third row of the Matrix Chart (Appendix C). By coupling a user's body movement with the visual effect of a stroke, a user is able to see the quality of a movement visually. The normal stroke is also the one inherited resistive property.

As resistive and fluid are basic components in Media Dimension Variables, the researcher adds fluid strokes to the normal resistive stroke in the system. Fluid strokes consist of a particle system that creates a similar effect to traditional water colours. Normally the colour of fluid stroke changes automatically in a random colour cycle. The shape of the fluid stroke can vary from solid to liquid-like form depending on a user's drawing motions. With fast movements, a user can create an abstract form with intense particle motion on the canvas. These intense particles can also affect previously drawn images. These parameters are described in the fourth and fifth rows of the Matrix Chart (Appendix C).

The system also offers various parameters under fluid strokes such as the level of fluidity formed with the particles and duration of strokes. The duration of stroke is the time before strokes fade from the canvas. Users have to draw quickly to form an image before it fades away. The researcher believes this time restraint has the benefit of requiring users to draw following their instincts.

In addition, in order to aid users in loosening up their physique, the researcher provides a ribbon stroke that encourages users to perform warm up calisthenics. When the interface is not in the drawing model, the ribbon will automatically follow a user's body movement. The current design allows users to control the number of ribbons, the thickness of the ribbon and the behaviour of the ribbon. The behaviour includes calmness and wildness. The reason for adapting the behaviour feature is to engage a user's emotions during the warm up period. The author has also created smoke stroke and spray stroke with a quick rapid prototype approach.

Design Matrix

Based on the exploration design process and nature of a kinaesthetic drawing tool, the author has created a matrix framework chart defining all the major features and components into understandable categories for art therapy purpose. The four major categories are movement, visual effect, interface and interaction. These categories concern how users use their body and senses in the process of creating visual artwork and how art therapists can use this tool to observe a user's psychological state. The matrix involves the scope of a user's body movement, the characteristics of visual stimulation and the intensity of engagement. The main goal of the matrix framework is to define the parameters in a more rigorous language that accurately and academically describe all possible axes of the research scope. This matrix or agreed upon formal language can help art therapists and researchers better define the tool set, user scenarios and best practices for the emerging field integrating digital interaction with art therapy.

In order to verify this matrix the author presented and discussed it with art therapist, movement experts and psychologists and faculties of Vancouver Art Therapy

Institute. The main goal of this study is to discover how this kinaesthetic tool can aid art therapists. Other subtasks in the study include finding out the answers to the questions as follows: who can benefit from this new drawing medium? How can whole body movement aid art therapists to achieve therapeutic goals? What design parameters can aid contemporary art therapists in art therapy sessions? What combination of design features can aid art therapists to deal with specific user scenarios?

The main approaches to this study include the researcher's demonstrations to a keynote group of art therapy experts, one-on-one interviews and questionnaires. A link on the video featuring the drawing device was e-mailed to the experts involved in the research during the recruiting process. During the demonstration the researcher introduced the prototype in an informal way with an actual demonstration. The author and experts then had a free-flowing conversation.

The next step was conducting semi-constrictive 45-minute interviews with the same experts to collect relevant data. In the meanwhile, the researchers also presented a matrix of design features which listed all the possible design features and categorized them into movement, visual effect, interface and interaction. In order to help establish common ground, and better meet the need of art therapists, the researcher explained each possible design features in the matrix chart

The expert interviews include seven experts in a small but varied group. Among this group, five experts have practiced art therapy for over fifteen years. One expert has practiced seven years. The final expert has practiced between 11-15 years. They are also specialists with various types of clients including those suffering from depression, grief and loss, attention deficit hyperactivity disorder (ADHD) and autism, cancer clients, and clients with suicidal inclination.

Study Results

Based According to the questionnaires, all therapists agree that people with physical disabilities are the biggest client group who can benefit most from the tool. For example, people in wheelchairs would be empowered in the way they use their body to draw on this large screen. Another example is the seniors with arthritis who have difficulty holding a pen or picking up art materials. Using hand movements or voice recognition to command could help overcome the clients with similar disabilities.

The second major population is people with emotional problems and learning disabilities. The emotional problems could involve anger, anxiety, fear and depression. In general, the therapists agree this tool could be applied to all of the people above because body movement stimulates motivation. For instance, when dealing with people prone to anxiety, providing a safe and comfortable environment becomes art therapists' top priority. Therefore, therapists might set this tool on the small movement range for the anxiety-prone clients and work side by side with them. For the clients with anger management issues the therapists suggest that clients use their torsos or two hands to draw with large body movements to release anger.

The third major population identified by art therapists is people with behavioural problems, including children

with ADHD, children with autism or eating disorders. People with ADHD usually have difficulty controlling their impulse and maintaining attention. The therapists suggested that guiding the clients with ADHD to control their body movement would help them to learn how to control their impulse and behaviour. The large movement range setting is suggested to help them release energy in a positive way.

The people who might resist this tool could include perfectionists. Instead of exploring the process of drawing, perfectionists might end up focusing on how to draw realistically or worrying how therapists would judge them from their body movement. Traditional artists are also likely to lose interest because the tool will not allow them to work on details or draw precise line work. Moreover, some seniors could resist using this tool because they are not being open to the technology. Finally, depression clients with low self-esteem might resist using this tool because they are afraid to draw with large movements.

How Can Whole Body Movement Aid Art Therapist in Achieving Therapeutic Goals? In response to the question on the questionnaire, "What therapeutic goals is this drawing tool likely to achieve better than the drawing tools currently in use?" all interviewees choose "facilitate client's ability to express through movement. Six of seven interviewees choose "increase creativity in therapy sessions". The reason for the only interviewee's not choosing the option is because she doubts if this kinaesthetic tool can increase creativity. The interviewee further clarifies it should be the creative expression to be increased rather than the creativity. Such consensus confirms the author's hypothesis that whole body movement can help enhance a client's ability to express creatively. When drawing in a sitting posture, clients tend to focus on their mind activities. While drawing with whole body movement, clients are able to fully experience 3D body movement and express thoughts through the rhythm of movement. Other therapeutic goals the interviewees consider relevant are to reduce clients' anxiety, increase their ability to reveal inner feelings and facilitate therapists' categorizing clients' emotions.

What Design Parameters Can Aid Contemporary Art Therapists? The researcher has summarized the main key points from the interviews as to why the therapists are certain this is an effective tool to meet their needs. Primarily, this drawing device provides a playful entry to encourage clients to connect to their creativity. Often adults' body movements are more constrained than children's because they are more self-conscious and care about people's judgement. When using this kinaesthetic tool, the whole body movement is essential and inescapable if users are to create a final product. With motion-sensing stimulation and low skill operation, clients naturally loosen their body and let down their guard in the drawing process. The generative strokes provide clients with options to experience the poetic nature of drawing. The fun nature also shifts a client's focus from making a final product to creating body movement. Given the setting is a virtual environment, clients do not need to worry about exhausting art materials. In addition, client can make as much of a mess as he/she likes because the projected image is impermanent.

The second key point is that this tool can aid art therapy practitioners in observing a user's creative process and initiating meaningful communication for

further diagnosis. The recorded drawing process allows a therapist and his/her client to review previous drawings and ask questions. Thus they can communicate verbally about the process of drawing and body's actions.

The third key point is that the characteristics of this motion-sensing drawing system are highly controllable and flexible at the same time. By adding or removing design features, therapists can target specific therapeutic goals. For example, a therapist can set constraints on the clients to experience body movement within a specific setting. He can ask his clients to draw a straight horizontal line with thin stroke across the screen with slow steady hand movement under the setting of large movement range.

The final key point is that this drawing tool provides a safe environment for the people with touch issues. Not required to touch any substance, they can draw in a comfortable way. In addition, because it is touchless, this tool can be adapted for use in an isolated area in a hospital where clients are kept out of contact with contaminants such as germs and certain substances.

After the author presented the matrix of design features to the interviewees, all of the experts agreed on the way the author categorizes design features and believed that the matrix covers most of the features. Additional features suggested by the experts include the ability to share the same canvas over Internet. This feature would provide users the ability to draw together over a long distance. The second design features requested by the therapists is additional methods for both clients and therapists to control the interface and make commands. A few therapists also mentioned the need to use this drawing tool by couples, families and groups. Last but not least, some therapists request creating a tangible product for clients because displaying the physical artwork can lead the clients to reflect on the meaning of the whole experience and evoke the memory by reviewing the visual image.

The major difference between traditional art materials and this kinaesthetic tool is that this tool lacks tactile feedback and physical contact, for body movements in lieu of hands serve as drawing tools. As a result, clients can not physically hold or move the tool in the drawing process. However, physical contact is an essential element for most therapists to achieve therapeutic goals. For example, punching the clay allows clients to releasing anger. The second issue is that the motion-tracking function could delay due to the kinaesthetic capacity of various computer models. Therapists also pointed out the intellectually challenged clients might have difficulty learning to use the tool. In addition, therapists find it hard to compare the device with other tools because there is no similar drawing tool in the market. They also indicate users' first-hand experience is required to validate the effectiveness of the tool.

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Figure 3. Design matrix.

Movement		Visual effect			Interface		**Interaction**		
Movement range type	Body interaction*	Stroke types*	Stroke life period	Stroke effects*	Colour palette	Recording Saving modes*	Therapist interaction modes	Methods for commands* (menu, clear)	Embodiment
Large (Width 9 feet)	One hand	Traditional stroke tip	Forever	Transparency	Full colour picker	Process of drawing	Paint alone	Voice	Fully-Embodied
Medium (Width 6 feet)	Two hand	Normal Stroke, Ribbon, fluid and smoke.	Fade out long	Thicker/ Thinner over time	Fixed palette of colours (Primaries)	Client's participation /body In scene	Conversing while painting	Hand	Semi-Embodied
Tight (Width 3 feet)	Head	Body paint	Fade out short	Particle system	Auto colour (colour cycles on the fly)	Save in steps	Paint with therapist	Clapping	Not-Embodied
	One leg	Paint ball		Behaviours (Wildness, calmness …)		Save and label		Standing distance (touchless canvas)	
	Two legs			Effects past strokes/ canvas		Guided steps (background then foreground, layer…)		Z movement	