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Young Children Drawing Together on the iPad Versus Paper: How Collaborative Creativity is Shaped by Different Semiotic Resources

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Abstract

Facilitating collaborative creativity among children involves offering material resources that support collaborative and creative interactions. Popular views of tablets, such as the iPad, suggest that they are better suited to solitary game-playing or video-watching than to collaborative open-ended tasks. I explore this further through a social semiotic lens, applying the concepts of ‘semiotic resources’ and ‘affordances’ to develop a more nuanced understanding of what tablets have to offer in relation to children’s collaborative creativity. Through this lens, I compare observations of six pairs of 5-6-year-old children engaged in a collaborative drawing task completed either on paper or on the iPad. I apply a thematic analysis to the children’s dialogue across 25 episodes (15 iPad, 10 paper) and the visual dimensions of their 41 drawings (23 iPad, 18 paper), and develop three interwoven themes: 1) attitudes to space, 2) momentum of the line and 3) pathways to representation. For

each of these themes, I explore how the affordances of the iPad and/or the particular application feed into these aspects of the drawing process and the implications of this for children's collaborative creativity. The analysis suggests that drawing on the iPad can be more responsive and less subject to personal planning than drawing on paper. I suggest that this difference is shaped by physical properties such as the touch-screen interface, but also emerges as a result of the cultural investment in drawing on paper as a form of 'self-expression', a notion that works to limit exploratory and collaborative engagement with the resources. Since participants were noticeably open to exploring new ideas together while drawing on the iPad, I argue that we need to reassess the potentials of touch-screen tablets to support tasks of collaborative creativity in educational contexts.

Introduction

Facilitating collaborative creativity is a key part of learning and teaching in early childhood education. Early years teachers play a vital role in supporting children to work together in the creative zone of possibility thinking, in which we shift from thinking about 'what is' to 'what might be' (Craft, McConnon & Matthews, 2012; Craft, Cremin, Burnard, Dragovic & Chappell, 2013; Craft & Chappell, 2016). While some of the features of possibility thinking – such as self-determination – seem to relate to more individual creative pursuits, several others – including playfulness, risk-taking and question-posing – seem to foreground the social context and collaborative nature of creativity in action. As theorists of possibility thinking have found through observations of learning environments and child-adult interactions, making choices about the physical environment in which activity unfolds, including the resources that are given to children, is a fundamental part of successfully facilitating collaborative creativity (Cremin, Burnard & Craft, 2006; Kucirkova & Sakr, 2015).

Digital tablets, such as the iPad, have been the subject of much popular concern in relation to both collaboration and creativity. It has been suggested that digital technologies such as iPads are best suited to solitary use because of their size and portability (Steiner-Adair & Barker, 2013; Turkle, 2017; Wooldridge & Shapka, 2012). Others claim that portable digital technologies do not promote creative engagement since they are strongly associated with video-watching and game-playing and are not typically used in educational contexts for open-ended tasks (Palmer, 2015; Gray, 2011). With these concerns often voiced in popular media, there is understandably some reluctance among teachers in early childhood education to integrate digital technologies into children's collaborative creative activities (Edwards, Henderson, Gronn, Scott & Mirkhil, 2017., 2017; Palaiologou, 2016; Author, 2016). However, close observations are needed to examine and problematize our assumptions about

what kinds of activity digital tablets are best suited to. Looking at these observations through a social semiotic lens, in which the tablet and particular apps available are conceptualised as sets of semiotic resources with particular affordances that shape interactions, enables us to unpick the specific ways in which the resources are impacting on the process of collaborative creativity as it unfolds.

In the first part of this paper, I offer an introduction to social semiotic theory and the key concepts of ‘semiotic resources’ and ‘affordances’ (van Leeuwen, 2005; Bezemer & Kress, 2015; Kress, 2009; Jewitt & Kress, 2003). This is followed by a consideration of what previous research has suggested about particular affordances associated with digital tablets and what these might mean in relation to creativity and collaboration. I then offer an overview of the study, outlining the data collection process and explaining my approach to analysing the dialogue between children and the drawings they created. The findings are organised according to three themes, which are illustrated with reference to the dialogue, drawings and relevant previous research. The themes are: 1) attitudes to space 2) momentum of the line and 3) pathways to representation. In the discussion, I suggest that taken together, these themes show that interactions involving the iPad were highly responsive and involved less personal investment and planning in relation to each individual’s contribution when compared with the drawings on paper. As a result, the children were most often happy to engage in open-ended possibility thinking (‘what if?’) together when drawing on the iPad rather than working to a individualistic predetermined plan. In the final part of this paper, the implications of the findings are discussed, along with the limitations of the study and suggestions for future research in this field.

iPad and paper: Distinct semiotic resources with different affordances

In the theoretical framing of social semiotics, we can think about the iPad, along with particular apps on the iPad, and paper and felt-tip pens as distinct sets of semiotic resources that will afford different types of collaborative drawing experience. According to social semiotic theory, meaning-making is shaped by the social and material environment in which it occurs (Hodge & Kress, 1988; van Leeuwen, 2005; Kress, 2009; Bezemer & Kress, 2015). Social semiotic theory differs from traditional semiotic theory by suggesting that the relationship between the signifier (e.g. a drawing of a ‘tree’) and the signified (the idea of the ‘tree’) is complicated by social and material factors. Thus, what I mean when I draw a tree will differ depending on my immediate audience and the social discourses that surround the drawing process and the subject matter of the drawing. The meaning will also differ depending on the material resources I use to create the drawing of the tree and the actions through which I manipulate these material resources. So whether I use pencils, crayons or felt-tip pens to create the drawing (and the types of touch and manipulation used in order to

engage with these tools) will shape how meaning is made. Together the ‘actions and artefacts with which we communicate’ (van Leeuwen, 2005, p. 2) are known as ‘semiotic resources’.

Different semiotic resources have distinct affordances, that is, they invite different types of behaviour and experience. The concept of affordances was introduced by the ecological psychologist Gibson (1961) who argued that we perceive the world in terms of our potential actions in it rather than perceiving objects as at all separate from our physical engagement with them. In social semiotic theory, the concept has been taken up to explain how different modes and media shape meaning-making (Jewitt & Kress, 2003). Different semiotic resources afford different types of meaning-making because of their distinct affordances. The affordances in turn come about through the physical properties and social associations of the semiotic resources. For example, when we make a drawing with block crayons versus pencils, crayons make it physically harder to create a definite line drawing while pencils afford this much more readily. As a result of these distinct affordances, the drawing of the tree will emerge differently and will have different connotations as a result. Beyond the physical implications, the crayons and the pencils also have different social associations which will shape use. For example, block crayons are typically associated with children’s drawings, while pencils are seen as tools used by both adults and children; these associations will shape how the drawing unfolds.

In the study presented in this paper, the children engage in collaborative drawing through two sets of semiotic resources: the app Kids Doodle for the iPad and multi-colour felt-tip pens on paper. In the following sections, I explore what we know already about the affordances of digital technologies, including digital tablets, in relation to children’s drawing, creativity and collaboration.

Digital affordances of relevance to drawing

Digital technologies are often thought to foster quick-paced activity rather than careful and slow explorations. This is a common thread in concerns about children’s engagement with digital technologies, which suggest that when children use digital devices they are constantly bombarded with new information and struggle to slow down and concentrate on one thing at a time (Palmer, 2015 Greenfield, 2014). If this concern is applied to the activity of drawing, it would suggest that children might struggle to engage with a single digital drawing over a prolonged time, and would instead use the digital technology to flit between drawings or drawing and other activities. This is echoed in Denmead and Hickman’s (2012) study of adult artists. They found scepticism about the use of digital technologies in art-making among the adult artists they interviewed because the artists were concerned that digital technologies did not afford ‘slowness’, that is, a kind of slowed-down and mindful engagement and experimentation with the material resources essential in the art-making process.

In my own research on how narrative features in children's digital art-making on the laptop computer, I have suggested that children's digital art-making foregrounds a different type of idea formation as a result of the faster pace associated with digital art-making (Sakr, Connelly & Wild, 2016). While adults typically associate art-making on paper with the notion of 'self-expression' (Hawkins, 2002), which posits that pre-existing ideas are simply expressed through material resources, digital art-making is not subject to this same assumption and as a result it can open up the potential for ideas to arise directly through the interaction between the child and the material environment. In the study of narrative in children's digital art-making (Sakr et al., 2016), I observed that children's talk about what they were representing in their digital drawings often seemed to respond to the unplanned appearance of visual material on the screen. Following on from this, we concluded that children were less likely to develop narratives associated with their art-making while engaging with digital technologies, since the representations that arose through the art-making were more spontaneous, rhizomatic and fragmentary and tended not to be developed into linear stories with a clear beginning, middle and end in that order.

Another dimension of difference between paper and digital drawings explored in previous research is the potential in digital art-making for what researchers in this field term 'remix' (Lankshear & Knobel, 2010; Knobel & Lankshear, 2008) or 'mash-up' (Lamb, 2007). Remix refers to the prevalence in digital technologies of ready-made materials and the creative organisation of the ready-made material in unique ways. In the context of visual art-making digital software and applications, this might be the ready-made imagery that is often available, such as the image 'stamps' that can be applied to the screen in the popular art-making software Tuxpaint. While some would argue that the presence of adult-created, ready-made imagery acts to dampen children's creativity (McLennan, 2010; Szyba, 1999), many observational studies of children's digital creativity suggest that engagement with ready-made imagery is original, creative and exciting (Sakr, 2017; Ivashkevich & Shoppell, 2013; Ivashkevich & Wolfgang, 2015). The term 'mash-up' (Lamb, 2007) highlights how children creatively transgress the expectations of digital designers in how they engage with different ready-made materials available in the digital environment (see also Marsh et al., 2016). Although the app used in this study – Kids Doodle – does not contain ready-made imagery, there are other ways in which the app relies on ready-made effects for digital art-making. For example, in Kids Doodle, the colour of a drawn line changes spontaneously as the drawing takes shape. The changing colour of the line can be interpreted as a 'ready-made' effect that the drawer is responding to rather than creating. Similarly to the discussion about ready-made images, the response to this effect can either be conceptualised as dampening the child's creativity, or seen as an opportunity for creativity to emerge through an active, potentially transgressive, dialogue between the child and the creative resources involved in their drawing.

Digital affordances of relevance to collaboration. Different digital technologies afford different levels and types of collaboration depending on their physical accessibility. For example, Rogers and Lindley (2004) suggest that large digital interactive displays are characterised by ‘accessibility, visibility and “shareability”’ (p. 1134) and that this is particularly the case for horizontal displays. On the other hand, digital tablets such as the iPad are small in size and do not allow simultaneous input from multiple users. These physical properties might make collaboration more difficult. Wohlwend (2017) described children engaged in collaboration on the iPad using a digital puppetry app as ‘vying for physical space on the glossy surface of a 9.5 inch screen’ (p. 57), though she did not suggest that this necessarily inhibited – so much as simply shaped - the creative collaboration.

Collaboration on the iPad may also be made less likely because of the perception that the devices are best suited to solitary use and are not associated with meaningful social interactions (Steiner-Adair & Barker, 2013; Turkle, 2017; Wooldridge & Shapka, 2012). As a result of this perception, and also because digital tablets are a relatively novel type of technology (in comparison to paper for example), how to collaborate when using the iPad is less conventionalised than for more established resources. As Jewitt and Kress (2003) explain, the affordances associated with novel resources are ‘less fully and finely articulated’ (p. 2) and as a result, users may be less sure of the ‘etiquette’ that surrounds collaboration via these resources. This uncertainty was demonstrated by Russell, Drews & Sue (2002) in observations of adult users engaged with a public digital interface. In Labbo’s (1996) early research on children’s computer text-making in a kindergarten classroom, she suggested that how children engaged with the computer was more diverse in comparison with their text-making practices on paper. They were more likely to construct the screen, theatre, playground or canvas, while paper was much more likely to be used by the children as only a canvas for drawing and writing. Though the study presented here was conducted more than 20 years after Labbo’s research, it is possible that the sense of openness and possibility surrounding digital art-making will persist, particularly in a learning environment where the integration of digital technologies has been slow and reluctant (Palaiologou, 2016; Plowman & Stephen, 2005).

Study design. The study involved observations of six pairs of 5-6 year olds as they engaged with collaborative drawing via the app Kids Doodle on the iPad and via felt-tip pens on paper. The children were recruited through a state comprehensive primary school local to my university. The study was explained in writing to the parents/carers of all children in a single class, and 12 parents/carers returned consent on behalf of their children’s participation in the research, for the use of video observations and for the dissemination of findings through video segments and stills showing their children. The research was explained verbally to the children and it was explained that it was their decision to participate and that they could withdraw at any point. As suggested by Flewitt (2005), careful attention was paid to the

children's multimodal interaction throughout the process of data collection in order to observe any physical signs of discomfort that indicated that the children no longer wanted to participate. Ethical approval was obtained from the university research ethics committee before the research began.

Each pair of children was brought out of the classroom to a quiet group-work area in order to participate in the study. They were given instructions about how to play the game Squiggle, which was used in this study as a way to structure the drawing experience. The game Squiggle was originally introduced by the psychotherapist Winnicott for use with children in the therapeutic process (see Berger, 1980). In Squiggle, one participant makes a 'squiggle' on the page and the other participant turns the squiggle into a representation. The instructions given to the participants in this study were: 'one of you will start the drawing with a squiggle and the other will turn the squiggle into something else'. Winnicott suggested that this game would help to build rapport in therapeutic situations involving a child, and it has since been used in multiple scenarios to support relationship-building between individuals. It draws on Winnicott's (1971) idea of 'potential space' in which the individual's personal representational space overlaps with the shared representational space between individuals, and as a result, the process fosters closeness and affective alignment between those involved.

Following the instructions for Squiggle, there was a practice turn between the researcher and one of the children to make sure that the children understood the instructions. Three of the pairs used the iPad first to play Squiggle three times, and then used the paper and felt-tip pens; for the other three pairs, this order was reversed. On the iPad, the children used the free app Kids Doodle. This app enables users to make a line drawing, in which they can change the colour and effect of the line manually but also have to respond to spontaneous shifts in colour and brush size as the drawing unfolds. On paper, each pair generally used one felt-tip pen between them, though in some episodes, the children wanted to use other colours in the drawing and this was negotiated on a case-by-case basis between the participants and myself. During the episodes of collaborative drawing, I interacted with the participants to comment on what they were doing, ask them questions or remind them of the rules of the game. My participation was not controlled between episodes; sometimes my active participation appears very little, while in other episodes, my involvement is heightened. The fluctuation in my participation depended on my observations of how the interaction was unfolding and my own assumptions about what this indicated with regards to collaborative creativity. In another publication reporting on the same research study, but focusing more on the nonverbal embodied modes of interaction between the children, I have commented on how my participation increased when I perceived the collaboration to be 'coming loose', and I tried, through speech, gesture and touch, to bring the participants' attention back to a joint focus (Sakr, 2018). My own assumptions and associations are therefore a factor in how the episodes

unfolded and this is an important caveat when interpreting the findings as they are presented later in this paper.

I recorded the episodes of collaborative drawing through a video recorder placed on a tripod. The camera unfortunately malfunctioned for some of the episodes. At the end of the data collection, I had a total of 25 videos each showing one game of Squiggle – 15 of these on the iPad and 10 of these on paper. These videos ranged in length from 39 to 190 seconds. I stored the finished drawings for each game of Squiggle and collected in total 23 iPad drawings and 18 paper drawings.

Data analysis. As a first step in the analysis, I transcribed all of the video observations, producing separate written accounts of what was visible and what was audible. Transcription was a fundamental part of the analysis because it enabled me to ‘remember’ the sensory and affective experience of data collection (Pink, 2015), as well as begin to identify links between the research question and the data. While in another paper (Sakr, 2018) I have focused on the multimodal participation frameworks through which the collaborative drawing occurred (gaze, facial expression, gesture, touch, movement and body orientation), in this paper, I focus on the transcripts of the audio recording – the children’s speech, but also their non-linguistic utterances. I also focus on the drawings created via either set of semiotic resources. In the first round of annotating both the transcripts and the drawings, I was responding to the question: ‘how did the collaborative drawing process unfold?’, thus, I was interested in examining the features of the interaction and process as these were made visible and audible, rather than beginning to unpick the role of the resources in the activity.

The initial annotation of the audio transcripts built on previous studies of collaborative creativity among children, which have tended to focus on talk as the primary element in the construction of ‘shared meaning’ (Crook, 2000, p. 166; Mercer & Littleton, 2007; Littleton, Rojas-Drummond & Miell, 2008; Dobson & Littleton, 2016). In the context of children’s drawing, talk can tell us how children are negotiating visual representations that manifest in drawing (Cox, 2005). Talk can help us to decipher the underlying purposes of a drawing activity, from experimentation to storytelling (Malin, 2013), and can help us theorize how children use drawing as a means for actively making sense of the culture that surrounds them (McClure, 2011). I also aimed to look beyond comprehensible talk and consider non-linguistic utterances, since previous research has demonstrated that spontaneous vocalisations and nonverbal discourse markers have an important role to play in shaping the affective dimension of the interaction and rapport between individuals (Knudsen, 2008; Rojas-Drummond, Albarran & Littleton, 2008; Vass 2007).

The initial annotation of the drawings was similarly informed by previous research. In particular, it was based on the understanding that representation was likely to be important in making sense of drawings but that there are many possible pathways involved in representation, as well as a range of non-representational possibilities (Duncum, 1999, 2010). In drawing, we can arrive at representation in different ways, for example, we can start with an idea that we then express through a single representation or we can come to representation in a more fluid, rhizomic way, so that ideas emerge and disappear in the process of visual activity (Knight, 2013; MacRae, 2011). As well as considering representation in the drawings that were produced, I aimed to maintain a close interest in the non-representational elements of the drawing including pattern and colour (Kolbe, 2005) and the importance of experimentation with materials as a facet in children's art-making (Malin, 2013). In addition, I sought to engage with the lines comprising the drawing as the products of movement – as such, I saw the line as having its own momentum which related to the momentum of the wider physical activity of which its creation is a part (Wright, 2010; Matthews, 2003). These non-representational elements of the drawing process are important facets of creativity – colour, pattern, pace, experimentation and so on all contribute to the originality and elaboration of what is created through drawing (Kim, 2011). Following the initial transcription which focused on the nature of the drawing process itself, the second round of annotation involved comparing between the iPad and paper conditions, and examining how the affordances of the resources appeared to feed into the drawing process as it occurred. These annotations allowed me to move towards the overarching research question 'How do different semiotic resources shape the collaborative drawing experience?'. This process drew on multimodal mediated discourse analysis (Wohlwend, 2013; Scollon, 2004), in which sociocultural activity is observed and broken down into actions, which are then related to social and material conditions of the environment, including the affordances of the semiotic resources involved in the activity.

Through the two layers of annotations, I developed three interwoven themes of comparison between the drawing process on paper and on the iPad; each of these themes highlights affordances of drawing via the app Kids Doodle on the iPad and what this means for collaborative creativity more broadly. The three themes are:

- 1) Attitudes to space
- 2) Momentum of the line
- 3) Pathways to representation

In the following section, these themes are each introduced with illustrative examples offered through segments of the audio transcripts or selected drawings. Previous research is related where appropriate to explicit discussions of how these themes relate to the affordances of the resources and the implications for collaborative creativity more broadly.

Attitudes to space. Participants were sometimes careful to respect the space around the lines drawn by the other participant and to not draw on top of these lines. Examples of this were apparent in both the paper and iPad drawing, but it was less likely in the context of the iPad where drawings were more likely to be layered on top of each other.

In Figure 1, we see the layering of a representation of a face placed directly on top of an expansive ‘squiggle’ that fills the entire screen of the iPad. In examples like this, the initial squiggle of the first participant acts as a background for the second participant’s drawing. On the other hand, when drawing on paper, the children tended to be much more careful about leaving space for the other participant to draw. For example, one participant who was second to draw created a representation of a car drawn into the middle of the original squiggle, so that the original squiggle plays the role of just a frame for the second participant’s drawing (Figure 2). Or between another pair, the first participant created a large spiky squiggle filling the bottom two thirds of the page, and the second participant added their drawing along the space at the top so that the drawings of the first and second participant were essentially unintegrated (Figure 3). This type of disconnect between the first and second participants’ drawing was not possible in most iPad episodes because too much of the screen had been filled through the original squiggle.



Figure 1. Layering of representation in the iPad drawing.

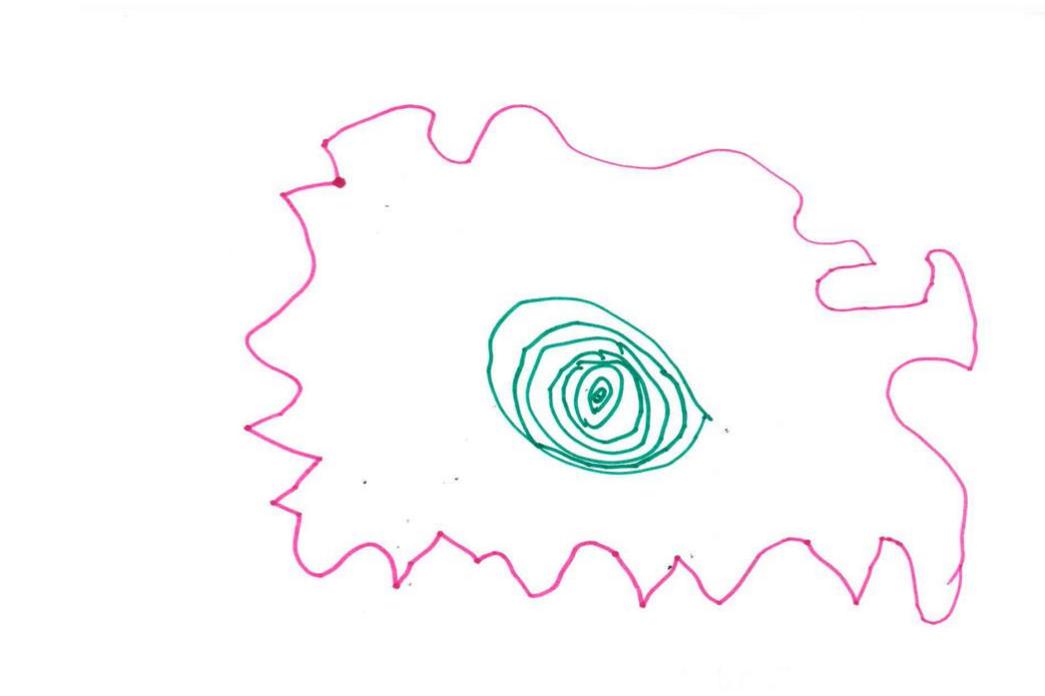


Figure 2. A drawing where the squiggle is used to frame a separate representation

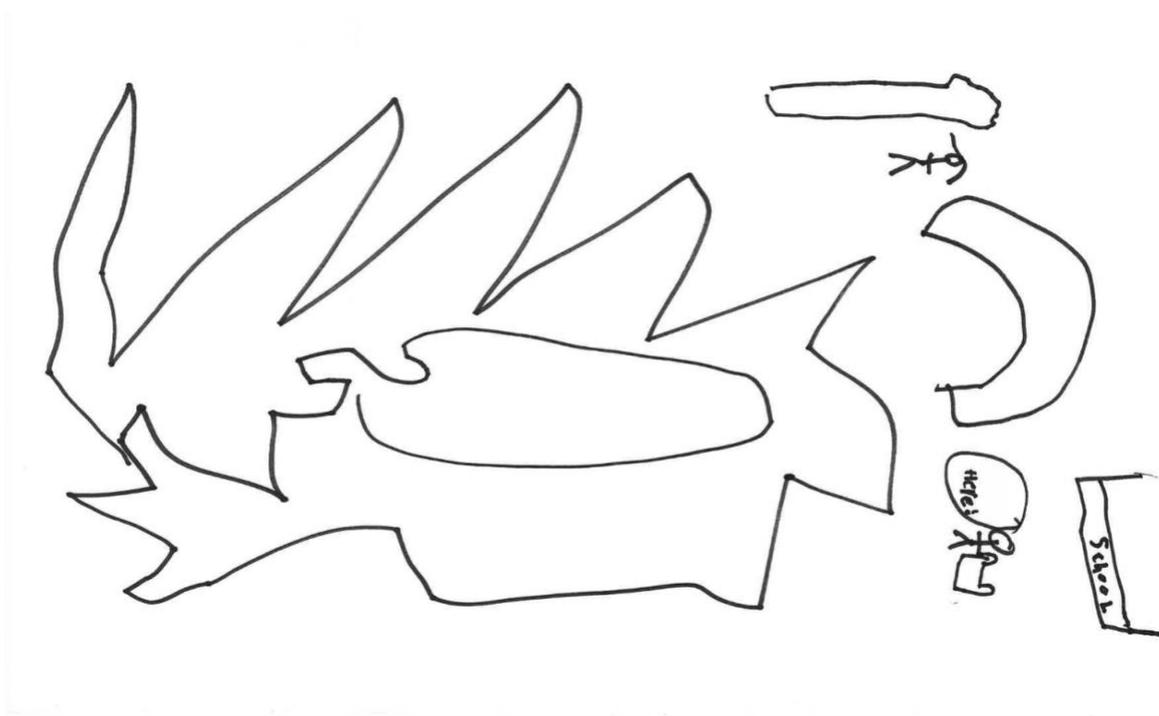


Figure 3. Unconnected squiggle and subsequent drawing

Affordances. What affordances of the iPad encouraged this layering effect, and what affordances of the paper and pens encouraged children to leave more space available for the other participant's engagement? There was a material aspect to this – the ease and fluidity with which the line drawing on the iPad materialised through application of direct touch. This physical experience appeared to draw the participants in, as did the spontaneous changes in the colour and effect of the line, which was enabled through this particular app. When drawing on the iPad, children appeared to be 'glued' to the iPad screen and their experience of filling it up through line drawing, in a way that was not apparent in the paper drawing. As a result, the screen quickly filled with visual activity and not much empty space was left for the other participant. As well as this physical element, the need to leave room for the other person's drawing was more conventionalised and articulated in the paper drawing. For example, when one participant was engrossed in their line drawing on the page and engaged in filling the page quickly the other participant chastised them: 'you're not leaving any room for me!'. Drawing on the iPad was perhaps less constrained when it came to leaving a specific space on the canvas that would be used for the contribution of the other participant, because the second participant had fewer qualms about drawing on top of the first participant's iPad squiggle.

Implications for collaborative creativity. While the use of space in the paper drawings might demonstrate a kind of respect for each other in the collaborative drawing, since it enables both participants to make a significant contribution to the development of the drawing, the lack of overlapping lines on the page can also suggest that the experiences of the children making the drawing were often distinct and unintegrated. Both of the paper drawings given as examples above suggest a level of separateness between the participants. In the first example (Figure 2), there is a superficial kind of integration between the frame and the object in the middle of the frame. This is superficial because adding a frame is a general solution to the problem of how to collaborate in drawing, rather than a specific solution arrived at in this particular instance in relation to this particular squiggle. In the second example (Figure 3), the two participants have made separate drawings in separate parts of the page – there appears to be no attempt to integrate these contributions, though they certainly 'respect' the lines of each drawing. On the other hand, the layering on the iPad screen can look like a messy muddle where neither participant is aware or respectful of the others' contribution, but this need not indicate a complete lack of integration in the drawing experience. To determine whether children are attuned to one another during the layering of lines, we need to look at what children are actually doing while the other child was drawing. This is discussed further in the third theme on representations, where I argue that true collaboration can give rise to visually messy non-representations, because the collaboration manifests as a positive shared affect between the participants and this is visible through interaction and not through the visual product.

Momentum of the line. In drawing on the iPad, participants often seemed to get caught up in the enjoyment of creating the line for its own sake, rather than as part of a larger representation. Following on from the theme above, the extra momentum of the line in the iPad drawing meant that the screen often quickly filled up with something denser than the term ‘squiggle’ suggests and participants had to layer drawings on top of each other.

Figure 4 gives a sense of this momentum, with the line on the screen going round and round, and the facial expression of the boy drawing suggesting eager involvement. We see the pressure in the finger, visible through the bend in the top knuckle, and there is a slight blur that surrounds the hand, demonstrating the fast pace with which the line expands.



Figure 4. Sense of momentum of line drawing on the iPad

The sense of momentum in the line is also apparent in the audio recordings of the children as they drew or watched the other participant drawing on the iPad. Participants sometimes narrated the adventure of the line: ‘like this and then it goes up and down and around like this... and then over there... and over there.’ Spontaneous non-linguistic vocalisations, comparatively infrequent in the context of the paper drawing, were an important part of the experience of drawing on the iPad, as seen in Table 1, which shares a selection of the vocalisations made during the iPad drawing episodes. I have interpreted these vocalisations to be an audible demonstration of the dynamism and momentum of the line as it unfolds visually.

Table 1	
<i>Non-linguistic vocalisations in the iPad drawing episodes</i>	
Episode	Vocalisation
2	la la la la! DA! Da.
3	Wooooooooooooooooo, chicicicicic
6	agaaahhhhh, ahh, ahhh, weeee, weeeee, arrghhhh, argghhh, woou, weeeeeee
13	huhhhh?; heeee? Hmmmmmm; woah!; woahhhh!; woou; huh; begghh; chickcalalakckc;
14	bigaalloooggigigoo
18	woahhh, woo
20	Ooobbaabaa

Affordances. It is possible that drawing directly onto the iPad screen with a finger, as opposed to using an inscription instrument, leads to a greater sense of momentum in the line, since there is a more direct link between the sensation of physical contact and the creation of a visible line. In contrast, when we draw on paper with a pen, the pen mediates the relationship between the physical sensation of drawing and the creation of the visible line. This contrasts with a common view that interactions with screen interfaces are characterised by the loss of rich touch experiences (Mangen, 2010; Kress, 2005; Crescenzi, Price & Jewitt, 2014). In the observations presented here, the iPad allowed an immediacy of touch, which in turn impacted on the sense of momentum in the drawn line, and this did not occur when a pen was used.

In addition to differences in the physical sensation, drawing on the iPad may be less bound by social conventions that surround drawing, and particularly the tendency to gravitate towards representational drawing. Previous research has demonstrated that children believe that adults place greater value on representations in drawing, and as a result, children also tend to develop a preference for representation and want to produce representational drawings, with visual realism as the ultimate aim (Anning, 2002, 2003; Duncum, 1999, 2010; Rose, Jolley & Burkitt., 2006). Interestingly, very young children have been shown to display a preference for abstract art (Winner & Gardner, 1980), suggesting that children may only develop a preference for discernible representations in art as a result of the cultural prioritisation of visual realism in art. As a set of semiotic resources, the affordances of the iPad are yet to be ‘fully and finely articulated’ (Jewitt & Kress, 2003, p. 2) through social convention, and as a result, this may open up a space for non-representational drawing on the iPad where the line itself has the momentum rather than an idea for a visual representation. Labbo’s (1996) description of the computer screen as a playground or stage resonates with the moments recorded in this study where the children seemed to be overtaken with excitement for the

momentum of the line and the movement of their finger across the immediately responsive screen.

Implications for collaborative creativity. We might expect that the individual intensity involved in drawing a ‘runaway line’ and the subsequent filling of space on the screen would dampen the other participant’s contribution and lead to an individualistic experience. In some episodes though, the physical momentum in the creation of the line seemed to be a contagious element in the interaction and led to the generation of shared positive affect in the collaboration. This was most visible when the other participant would engage in vicarious touch while watching the ‘runaway line’ emerge – they might draw on the table with their finger or move their hands through the air (figure 5). When both children were more engaged by the excitement of seeing what the line on the screen would do, they were both less bound by the desire to see their own ideas for representation through to completion. Thus the development of a ‘runaway line’ could facilitate a positive affect between participants that in turn opened space for a more surprising collaborative drawing to emerge. The ‘runaway line’ is a sort of visual equivalent to the ‘collaborative floor’ of speech found in collaborative creative writing tasks, whereby children talk over the top of one another (Vass, Littleton, Miell & Jones, 2008; Rojas-Drummond et al., 2008). Both phenomena might seem on the surface to be unsupportive of collaborative creativity, but observations demonstrate that they can actually generate a contagious joyfulness in the experience which in turn facilitates high levels of collaborative creativity.



Figure 5. Moments of vicarious touch

Pathways to representation. Although the instructions for the game of Squiggle explicitly indicate that participants should develop a representation through their collaborative efforts, how representations featured (or did not feature) varied considerably between episodes. The rules of the game were broken in both drawings on paper and on the iPad, but in different ways. Drawings on paper were characterised by a more linear development of representation, and the rules of Squiggle were typically violated when the first participant created a fully-

fledged representation rather than creating a squiggle for the other participant to turn into a representation. On the other hand, iPad drawings tended not to arrive at a full representation – representations appeared through experimentation and dialogue but were highly mutable as the following example demonstrates.

The following dialogue between Ella and Reza (pseudonyms) relates to a drawing on the iPad in which there is not a single representation. Instead, the children's ideas move back and forth with evolving suggestions about what the lines on the screen represent. So in this episode, representations emerge, fluctuate and disappear rather than following the linear progression from squiggle to single representation suggested through the rules of Squiggle. In the context of these fluctuating representations, collaborative creativity comes about as the children respond together to what they see arising. For example, Ella suggests the line looks like a dinosaur and Reza decides it is a dinosaur; when Reza then suggests it's a squiggly snake, Ella echoes the adjective of 'squiggly' but suggests that the line represents a slide. We also see responsiveness that extends beyond verbal descriptors and occurs via non-linguistic utterances.

Ella: agaaahhhhh

Reza: ah ahhh

Ella: that looks like a mouse, now it looks like a dinosaur

Reza: It's a dinosaur

Ella: I knew it's a dinosaur. I want one colour... arugh, what's this??

Reza: What's that?

Ella: Oh no, not dotty again

Reza: It's so funny

Ella: Weeee, that's better

Reza: It's like a squiggly... like a squiggly snake...

Ella: It looks like a slide that's so squiggly

On the paper, representations were more likely to be predetermined and voiced at the beginning of the episode rather than emerging over the course of the interaction. Participants voiced ideas that preceded the action of drawing, such as in episode 9 where the participant who would be drawing second said 'I want to make a tree' while the first participant was just beginning to draw. A wide range of representations were produced on paper, from a 'talking burger' to a ladybird to a dinosaur pirate. These representations did often go through shifts, but these shifts tended to happen at the point when the resources were passed from one participant to the other. At these moments, the ladybird might be re-imagined as a pizza, or the dinosaur pirate would become an 'angry pirate dinosaur'. In contrast, as discussed above,

mutability in the representations produced via the iPad drawing was a more constant feature of the dialogue between participants and was not confined to the handover of the resources.

Affordances. Representations in the iPad drawings were highly mutable because ideas for representation could not keep up with the line as it unfolded on the screen. As discussed in the theme above, the line in iPad drawing often seemed to have its own momentum and as a result, representations were emergent and responsive rather than something that preceded the visual creation. I have discussed this characteristic of digital art-making in previous research involving various digital technologies, including a laptop computer and interactive whiteboard (Sakr et al., 2016; Sakr, 2017). So the immediacy of touch in the iPad environment and the ‘runaway lines’ that seem to emerge as a result, afford a different role for representation in drawing. On the other hand, drawing on paper is so strongly associated with the creation of representations - with visual realism as the ultimate ideal (Duncum, 2010) – that even when told explicitly not to create a representation (and instead to produce a squiggle), many of the participants began immediately to imagine what representations they would produce.

Implications for collaborative creativity. In episodes that seemed to show a high level of collaborative creativity, the representations that arose through the drawings were co-owned rather than personally owned by one of the participants. Both participants felt that they could comment on and contribute to the developing representation, and neither participant felt that they had to protect the representation from the interference of the other. The co-ownership of representations was most likely when representations were responsive rather than something pre-planned; responsive representations were likely to emerge during iPad drawings because the line seemed to unfold on the screen often with its own momentum and at a pace that meant it preceded a representational idea. In addition, responsive representations developed through a language of ‘it looks like’ rather than a language of ‘it is’. This resonates with descriptions of possibility thinking, in which creativity is seen as the transition from ‘what is’ to ‘what if’ thinking (Craft et al., 2012; Craft et al., 2013; Craft & Chappell, 2016). In the latter kind of thinking, there is space for endless possibilities and ideas and action to develop according to their own ‘lines of flight’ (Knight, 2013, Thompson, 2014). Responsive representations allow for this ‘what if’ to be embedded in the dialogue between participants who both voice ideas about what the emerging line might look like, rather than feeling possessive about an idea that precedes the development of the line on the canvas – whether this is the page or screen.

Discussion. To summarise the findings from the observations in this study, when drawing on the iPad, space filled up more quickly because the children appeared to find drawing on the touchscreen through their finger pleasurable and immediate. While at times this could lead to the other participant feeling excluded from the collaborative drawing process, most often enjoyment in the momentum of the line was shared between participants and was

demonstrated through the vicarious touch of the non-drawing participant. On the iPad, representations appeared to emerge rather than being planned; because of this, the representations that occurred were more fluid and there was a stronger sense of co-ownership surrounding them, with less need to protect personal representations from interference by the co-drawer. Overall, these comparisons suggest that collaborative drawing on the iPad is characterised by a shared responsiveness to the affordances of the tablet and the particular drawing app used, and that this can draw participants together in moments of heightened positive affect, characterised by smiling, giggling and spontaneous vocalisations. This common aspect of the interactions involving the iPad arises from the distinct affordances of the device and the specific app used in this study Kids Doodle. These affordances comprise physical properties (such as the touch-screen interface) but also, perhaps even more significantly, the relative lack of expectation that surrounds the iPad as a drawing instrument. While drawing on paper is typically surrounded by discourses of self-expression (Hawkins, 2002) and the tendency of adults to value representations and ultimately visual realism (Duncum, 1999, 2010; Rose et. al, 2006), drawing on the iPad is a freer pursuit, with less cultural investment and constraint of possibilities. This echoes early findings of Labbo (1996) with regards to children's text-making on a PC computer in the kindergarten, demonstrating how 20 years on, digital technologies as semiotic resources can widen the possibilities for meaning-making as a result of their relatively novelty. I am not arguing that drawing on paper is inevitably limited by the discourses of self-expression, but just that it is more likely to be shaped by this way of thinking and talking about creativity. The findings presented in this paper have important implications for facilitating collaborative creativity in early childhood education. Firstly, they suggest that the common concern that surrounds the use of digital technologies in early learning and play, and the popular suggestion that tablets support neither collaboration nor creativity, may be misplaced. Popular concerns about children's use of digital technologies include the fast-paced nature of the activity that unfolds in digital environments. The observations in this study did indeed show fast-paced visual activity to be an important element in how collaborative drawing on the iPad unfolds. However, while this can be perceived negatively, the observations reported here suggest that fast-paced visual activity can contribute to a shared responsiveness in the context of collaborative creativity. If the line of a drawing unfolds more quickly than the conscious decision-making of the drawer, this might impede traditional notions of self-expression but may instead foster a sense of co-ownership over the experience, and a more expansive opportunity for collaborative possibility thinking. Previous research has suggested that adults tend to underplay the importance of responsive 'lines of flight' in children's art-making and what emerges through the relationship between a child (or children) and the social and material conditions of the environment (Knight, 2013; MacRae, 2011). Observations presented here of the creative process as it unfolds through a touch-screen interface bring this facet of the interaction to the fore and show how this can bring children closer together as they create.

Of course, we need to remain aware that fast-paced visual activity may have negative (as well as positive) implications for creativity. As the artists interviewed by Denmead and Hickman (2012) note, ‘slowness’ – a mindful engagement with materials – can be an essential part of the creative process. Drawing on the iPad as it was observed in this study did not seem to offer the best platform for ‘slowness’. However, by carefully unpicking how the particular affordances of the resources fed into the interaction, we can also think productively about how small changes in the design of the semiotic resources might open up the possibility for alternative forms of engagement. As van Leeuwen (2005) notes, one of the main reasons for observing and cataloguing the affordances of different semiotic resources as they unfold in activity, is to see the potentials in the design of new resources or the modification of existing ones. In the case of drawing on the iPad, it seems that using an inscription instrument rather than a finger might slow down the creation of the line and the subsequent fill of the screen. Choosing a drawing app that does not spontaneously change properties of the line (e.g. colour, visual effect) might also slow down the overall interaction.

The findings presented here are based on a small observation study. The characteristics of collaborative creativity that I have noted here in relation to iPad drawing might not apply in other circumstances, and those that I have discussed do not constitute a comprehensive account. The intended outcome of this paper is not to provide a definitive comparison of resources in relation to collaborative creativity. Instead, the paper extends the discussion that surrounds the affordances of digital tablets and apps in relation to children’s collaborative creativity. It challenges some of the common perceptions found in popular media and among practitioners in early childhood education and art education, and in particular it suggests that the fast-paced visual activity associated with digital creative environments may foster a sense of shared responsiveness and positive affect between participants in tasks of collaborative creativity.

Further research could look more closely at the component characteristics of possibility thinking (imagination, immersion, question-posing, risk-taking, innovation, self-determination and playfulness) and how these manifest when different semiotic resources are used in tasks of collaborative creativity. It would be helpful for future studies to consider other contexts of collaborative creativity, such as creative writing or role play, in order to see whether (and how) differences noted in collaborative drawing are applicable in other domains of creativity. We also need to engage with the nuances that exist within digital technologies and indeed within paper-based technologies. Studies in the future might look at different apps for example or might compare between using the finger for drawing on the tablet screen with using an inscription instrument. Through a specific analysis of the affordances that different semiotic resources make available we can develop important insights into the relationship between the social and material conditions of the environment and how collaborative

creativity unfolds. This in turn supports us to set up learning environments that bring children together in exciting moments of possibility thinking.

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