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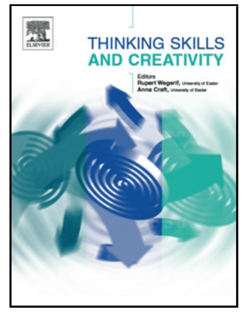

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Many hands make light work: The facilitative role of gesture in verbal improvisation

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Highlights

- The relationship between improvisation and hand gestures was examined.
- Gestures were in analysed in a within-subjects design where participants improvised and completed a control equivalent.
- Participants gestured significantly more when improvising
- Different types of gesture use related to the quality of improvisation, as well as improvisation when compared to everyday speech.

Abstract

Verbal improvisation is cognitively demanding, placing great burden on working memory as the speaker is tasked to generate a novel, spontaneous narrative. It is at this point of cognitive overload when individuals pursuing other creative tasks would typically shift the burden and externalise some of their thinking. How do successful verbal improvisers manage without shifting some of their workload into an external space? We argue in this paper that the improviser makes use of what is, quite literally, to hand. Ninety participants were asked to take part in a one-to-one improvisation task and a control task, order counterbalanced, in which they were engaged in a brief conversation to elicit every day speech. Participants' gestures were analysed in both conditions and improvisations rated for quality. As predicted, participants gestured significantly more in the improvisation condition. An analysis of gesture type revealed that improvising elicited greater iconic and deictic gestures, whereas everyday speech was more likely to be accompanied by self-adaptor gestures. Gesture rate was related to the quality of the improvisation, with both the strongest and weakest improvisers producing the most gestures. These gestures revealed the extent to which participants used gestures to facilitate the improvisation task. The strongest improvisers elicited a higher gesture rate for iconic and beat gestures, while weakest improvisers produced more gestures in reference to the abstract, improvisation object. Findings are discussed in relation to the idea that gesture can facilitate performance in verbal improvisation.

1.0 Introduction

Creativity is most commonly referred to as the ability to generate ideas that are novel, yet useful (Runco & Jaeger, 2012; Sternberg & Lubart, 1999). Ideas that are high in novelty are recognised as demonstrating a greater degree of creativity. While creativity is clearly present in varied art forms, everyday life both demands and demonstrates various expressions of creative thinking and acting. While we are all creative to some extent, individuals who excel in creative pursuits are said to be more imaginative, exercising fluent and flexible ways of thinking (Goncu & Perone, 2005; Guilford, Christensen, Merrifield, & Wilson, 1978). However, the nature of creativity often only allows us to observe the product of the creative process. Since "creative thought is invisible" (Tversky, 2008, p.1), capturing the process of creativity is problematic and as such, evaluating the creative outcome does not necessarily indicate the creative process.

Improvisation is one of the few, if not the only, form of creativity that is seen as the process *and* the product of creativity (Montuori, 2003; Nooshin, 2003; Sawyer, 2000). Improvisation, the process of creating something new on the spur of the moment, can take many forms. In this paper we focus on verbal improvisation; the spontaneous process of generating strings of words that avoids the use of pre-planned phrases. Verbal improvisation is of interest given the significant challenge that it presents to the speaker. There is little respite for the improviser, as novel information must be generated continuously within short time frames, a process that is best when performed outside of the recipient's conscious awareness and likely to quickly exhaust the mental workspace. It is at this point of cognitive overload when individuals pursuing other creative tasks would typically shift the burden and externalise some of their thinking (Wilson, 2002), making use of sketches. Tversky (2002) suggests that the physical act of sketching allows us to "externalize thought, expand the mind, force abstraction, provide a playground for exploration of new ideas, make ideas visible to self and others" (p.1). Individuals can then reflect on these sketches in order to improve the creative product. These sketches are schematic in nature (Tversky, 2002) and the creative process allows these schemas to be expanded into novel ideas. Thus, for a range of creative endeavours, sketches not only ease the burden but provide insight into the creative production process. However, improvisation does not afford the uses of sketches, as the product *is* the process. How do successful improvisers manage without shifting some of their workload into an external space?

Verbal improvisation is cognitively burdensome. We know speakers experience cognitive overload when improvising because the quality of their speech suffers.

The fluency of speech has long been held as a marker of the processing load experienced by the speaker during speech planning (e.g. Bock & Levelt, 1994; Levelt, 1989; Maclay & Osgood, 1959). A comparison of the fluency of speech produced during an improvisation task and normal conversation revealed a greater production of pauses and filled-pauses when improvising, indicating higher cognitive load (Pawley & Syder, 1983). Disfluency is also heightened when a greater range of speech options are available to the speaker (Schacter, Christenfeld, Ravina, & Bilous, 1991), as is the case in improvisation. Put simply, when there are more words to choose from the frequency of filled pauses (Ums and ers) increases (Schacter, Rauscher, Christenfeld, & Crone, 1994).

Thus the task of producing improvised speech is cognitively demanding, as revealed by a decrease in speech fluency. How do successful verbal improvisers manage without shifting some of their workload into an external space? We argue that the improviser makes use of what is, quite literally, to hand. The hand gestures that accompany speech have been demonstrated to lighten the cognitive load of the speaker. The cognitive load hypothesis, advanced by Susan Goldin-Meadow, argues that gesturing reduces demands on a speaker's cognitive resources, freeing up cognitive capacity to perform other tasks. Goldin-Meadow, Nusbaum, Kelly, and Wagner (2001) asked children and adults to complete a math problem, and then gave them a list of items to remember. Participants were asked to explain their math solutions before being tested on their recall of the items on the list. Half of the time, participant's gesture was restricted when giving their explanations to the math problem. The proportion of correctly remembered items was significantly higher when children and adults were free to gesture than when their gestures were restricted. Not only did restricting gesture have a negative impact on item recall, but in addition those individuals who were free to gesture but chose not to remembered significantly fewer items than participants who spontaneously gestured. The authors concluded that gesturing frees up cognitive resources that can be successfully expended elsewhere. Subsequent work by Ping and Goldin-Meadow (2010) demonstrated that gestures lighten the load on working memory regardless of whether they refer to present or absent objects. Gesture is argued to make absent objects present and it is through this mechanism that gesture reduces cognitive burden. Ping and Goldin-Meadow (2010) suggest that the global nature of gesture (compared to the linear and segmented constraints of speech, McNeil, 1992) brings “mental coherence” (p.616) to the speaker’s thoughts.

Gestures have been demonstrated to perform a range of intrapersonal functions, assisting the speaker at various stages of speech production, from lexical retrieval (Pine, Bird, & Kirk, 2007; Rauscher, Krauss, & Chen, 1996) to information packaging (Alibali, Kita, & Young, 2000; Kita, 2000). Thus gesturing while improvising may facilitate lexical access and the packaging of ideas into units ready for speech. Moreover, gesture may play an active role in the generation of novel ideas. McNeil views the processes of utterance formation and gesture creation as the continuous transformation of thought. Thus for McNeil, there is ‘thinking in speech’ (McNeil, 1992, p.247), and according to this view we would expect that thought is transformed by the act of speaking (and gesturing). An analysis of children’s hand gestures in the classroom revealed that children’s gestures not only provide a mechanism to externalise the problem that they are working on, but making their ideas visible with their hands altered their course of thinking about the problem (Crowder, 1996). Thus, seeing one’s hands move in space can change the way that we think and influence what we say.

In generating an improvised narrative, the speaker will likely be conjuring image-rich mental representations and will need to keep these in mind as they translate these novel ideas into speech. Gesturing may facilitate this process by maintaining mental imagery in working memory during speech production, as suggested by the Image Activation Hypothesis (IAH; De Ruiter, 1998; 2000; Wesp, Hesse, Keutmann, & Wheaton, 2001). Wesp et al. (2001) suggested that the repeated motor activity of hand gestures maintains any spatial features that have been activated as a result of the cognitive task that is being required of them.

Recent research has begun to explore how physical movement may impact upon creative thought processes (Oppezzo & Schwartz, 2014; Slepian & Ambady, 2012). In a series of experiments, Slepian and Ambady (2012) examined whether fluid, relative to non-fluid, hand movements would enhance creative generation. Participants were asked to trace one of two sets of drawings, one of which contained fluid, curved lines and the other non-fluid, angular lines. Participants then completed a number of measures of creativity. Participants who made fluid movements scored higher on a creative problem-solving task (the Alternate Uses Task, AUT; Guilford et al., 1978), generating significantly more uses and scoring higher in originality than those who made non-fluid movements. Similarly, participants who made fluid movements scored higher on cognitive flexibility and the Remote Associates Test (Mednick, 1962). This is good evidence to suggest that creativity can be influenced by the fluidity of physical movement. The authors propose that the fluid movements 'cue a metaphorically similar fluid thought process, enhancing creative processing and generation' (Slepian & Ambady, 2012, p.629). More recent research suggests that the effect of movement on creativity is more generalized. Oppezzo & Scwartz (2014) found that walking boosted creativity. Whether walking outside or on a treadmill facing a blank wall, participant's scores on the AUT were significantly higher than when sat still. Effects were residual too - going for a short walk and then performing the AUT was just as good as asking participants to generate alternate uses whilst walking.

These findings indicate a positive relation between movement and divergent thinking, however research has not yet considered the spontaneous gestures produced by individuals when they engage in the creative process. We sought to explore whether gesture would provide us insight into the creative process by examining the extent to which individuals make use of hand gestures when performing a verbal improvisation task. Our rationale was that the verbal improvisation task would generate a high cognitive load and speakers would gesture to externalise their thinking. We compared the gesture production of individuals when improvising compared to a task designed to elicit everyday speech (low cognitive load). We predicted that participants would produce significantly more gestures when improvising compared to everyday speech, and that doing so would be related to better performance. This formed part of a larger study that investigated the impact of improvisation on cognitive processes. We made use of videotaped footage of participants completing a subcomponent of this experiment.

2.0 Method

2.1 Participants

A convenience sample of 90 Psychology undergraduate students (79 females and 11 males) was recruited. The mean age of the sample was 21 (*SD* = 4.16) and participants were ethnically diverse. Inclusion criteria for this study required participants to have English as their first language. This study formed part of a larger study looking at improvisation and received approval from the ethics committee at the University of Hertfordshire.

2.2 Design

A within-subjects design was employed. The independent variable was the treatment condition, with two levels; improvisation and control. Order of condition participation was counterbalanced across participants. The dependent variable was gesture rate, calculated by the number of gestures made divided by the total duration of the participant's speech.

2.3 Materials

All sessions were filmed using a tripod mounted video recorder. The Observer XT, a computer aided coded system, was used to analyse the videotaped observations.

2.4 Procedure

Participants were invited into the lab, allocated into groups of five and taken through 10 minutes of simple improvisation games with the experimenter in order to familiarize them with improvisation (Appendix A). These tasks were derived from Johnstone (1979) and designed to encourage spontaneous speech production that could not be planned in advance. Participants were asked to take part in tasks consisting of pairs or small groups, which included telling stories and having conversations with made-up characters. Participants were then tested individually in a separate room. Each participant completed both the improvisation and control conditions, order counterbalanced across participants. In the verbal improvisation task, the experimenter explained to the participants that verbal improvisation is defined as “the act of making something up on the spot.” The experimenter then asked the participant “What’s that bleublepip on your shoulder?” The experimenter engaged with the participant, encouraging them to talk for approximately two minutes (see Appendix B for an example transcript of the improvisation task). In the verbal discussion task, the experimenter told the participant that they would be asked a number of questions and that they should answer truthfully. The experimenter asked the participant three questions: “Tell me about the secondary school you went to”; “Why did you decide to come here and study Psychology?”; and “What would you like to do after this degree?” This lasted approximately two minutes. Upon completion, participants were thanked for their time and debriefed. All sessions were videotaped.

2.5 Coding speech and gesture

Participants’ videotaped sessions were analysed using version 8 of the Observer XT, a computer aided coding system, by two separate coders. The amount of time that participants spent talking during the session was coded, with pauses in speech defined as longer than two seconds. A gesture was identified from the point where the participant’s hands left an equilibrium position where the hands were still, and was broadly defined as any hand, finger or arm movement. The gesture was identified to have ended when the participant’s hands returned to a position of equilibrium. Using McNeill’s (1992) coding system, iconic, deictic, beat and self-adaptor gestures were coded. Iconic gestures convey semantic information and are described as hand movements “that in form and manner of execution exhibits a meaning relevant to the simultaneously expressed linguistic meaning" (McNeill, 1985, p.354). For example, flapping one's arms while saying "flying" . Deictic gestures are referents to space, i.e. pointing at either an abstract or concrete referent. For instance, participants pointed towards their shoulder to indicate the location of the Bleublepip. Beat gestures are rhythmic hand movements that place emphasis; unlike iconic gestures these do not contain any semantic information. Self-adaptors typically involve self-touch, often taken to be fiddling movements or nervous behaviour, for example, scratching one's nose.

Upon viewing the videos of the improvisation task, it was observed that many participants made similar hand movements towards their shoulder area where the 'Bleublepip' had been suggested by the experimenter to reside. They often looked at or touched their shoulder, and even lifted their arm up as if to get a better look of the 'Bleublepip' on their shoulder. To capture these 'Bleublepip' gestures, an additional gesture code was identified. This included any iconic or deictic gestures that referred to the shoulder as well as any overt actions towards the 'Bleublepip', including pulling clothes on the shoulder, looking at shoulder and, raising the elbow.

The gesture rate for each participant in each condition was calculated by dividing the number of gestures (iconic, deictic, beat, self-adaptor and total bleublepip gestures) per session by the total duration (seconds) of the participant's speech, thus controlling for differences in verbosity. Two separate researchers coded the data. Inter-rater reliability for speech and gesture coding was established by checking the agreement between the coders on 10% of the sample of videotaped sessions. Inter-rater reliability was high ($k = .71$)

2.6 Rating improvisation

Improvisation quality was assessed using Amabile's Consensual Assessment Technique (CAT; Amabile, 1982, 1983). Two independent raters, both with expert knowledge in the field of creativity and improvisation, were asked to watch each improvisation video. Once all videos had been observed, raters were told to use their own subjective definition of improvisation (in accordance with the CAT) and asked to watch the videos a second time, assigning each a score between one (poor quality improvisation) and five (excellent improvisation). Improvisations were scored according to the four main dimensions of creativity, as defined and continually used by Guilford (1959): fluency, originality, elaboration and flexibility. High scores therefore consisted of improvisations that were verbally fluent, that were more original ideas and where participants elaborated beyond the original idea, with flexibility in their answers to the experimenter. Agreement between the two raters was high, r =.77, n=90, p = .001.To test for internal consistency and to control for the possibility that participants' nonverbal behavior was influencing the raters, a new rater and rater 1 were asked to blindly rate the quality of the improvisations again from a transcription of the sessions. Agreement between the two raters was high, r =.80, n=10, p = .006. Furthermore, Cronbach's alpha for rater 1's scores between video and manuscript ratings was high (α = .93). Original ratings of the video observations were subsequently used for analysis.

3.0 Results

As this was part of a larger study, a final decision to record a control condition was approved after testing had commenced. Therefore, of the 90 participants who took part in the study, 19 participants did not complete the control condition, resulting in 71 participants for within-groups comparisons.

3.1 Did improvising elicit greater gesture production?

First, we examined whether there would be a difference in the gesture production of participants in the control and improvisation task. Five participants did not gesture at all when improvising while six participants made no gestures in the control condition. Mean gesture rates throughout the improvisation and control conditions (presented in Table 1) were compared via paired sample t-tests.

* *p* <.05

***p* <.01

Results revealed that the improvisation task elicited a significantly higher overall gesture rate than the control condition, $t(69) = 2.70$, $p = .009$, $r = .31$. When improvising, participants produced significantly more iconic gestures, $t(69) = 2.05$, $p = .044$, $r = .24$ and deictic gestures, $t(69) = 5.06$, $p < .001$, $r = .52$. In contrast, the control task elicited a significantly higher production of self-adaptors than the improvisation task, $t(69) = -3.60$, $p = .001$, $r = .40$. No further significant differences were found ($p > .05$).

3.2 Did gesture rate differ according to quality of improvisation?

Having established that the improvisation task elicited greater gesturing, we then sought to explore this relationship further to determine whether gesturing was associated with the quality of improvisation. Each participant's improvisation had been rated on a scale of 1 (poor) to 5 (excellent). The mean gesture rates for improvisations rated 1 – 5 are reported in Table 2.

Due to violations in normality, Kruskal-Wallis tests were conducted, comparing the gesture production by participants according to the rating of their improvisation quality (1-5). Jonckheere's tests were also conducted, in order to observe whether any trends were evident.

Kruskal-Wallis showed a significant difference between improvisation ratings and total gesture rate, $X^2(4) = 21.54$, $p <. 001$. Jonckheere's test revealed a borderline significant trend in the data, $J = 1844.50$, $z = 1.96$, $p = .05$, $r = .21$. Pairwise comparisons with adjusted p-values showed significant differences between improvisation ratings 2 and 4 ($p = .002$, $r = .51$), 2 and 5 ($p = .001$, $r = .62$), 3 and 5 (*p*=.006, *r* =.46). Means indicate a peak in gesture production by the weakest and strongest improvisers.

To further investigate this relationship and whether the specific type of gesture had different impacts on improvisation, separate Kruskal-Wallis tests were carried out for each gesture type.

Kruskal-Wallis revealed significant differences between improvisation ratings and total gesture rate, $X^2(4) = 21.54$, $p <. 001$; iconic gesture rate, $X^2(4) = 23.27$, $p < .001$; deictic gesture rate, $X^2(4) = 16.51$, $p = .002$; beat gesture rate, $X^2(4) = 18.30$, $p = .001$ and bleublepip gesture production, $X^2(4) = 22.95$, $p <.001$. A significant trend was observed in all of the data ($p < .01$ in all cases) other than for deictic gestures for which no significant trend was present ($p = .94$).

Pairwise comparisons with adjusted p-values revealed different effects of gesture rate. Iconic and beat gesture rates exhibited the same pattern, with significant differences, between improvisation ratings 1 and 5, 2 and 4, 2 and 5 ($p < .01$ in all cases). The only significant difference between groups for deictic gestures, however, was between improvisation ratings of 2 and 5 ($p = .007$, $r = .50$), suggesting the weakest and strongest improvisers produced more deictic gestures. Finally, bleublepip gestures showed a significant difference between groups 1 and 3 ($p <.001$, $r = .55$), 1 and 4 ($p = .001$, $r = .56$), 1 and 5 ($p = .004$, $r = .51$). Furthermore, groups 2 and 5 were close to significance ($p = .009$, $r = .48$), again suggesting that the weakest and strongest improvisers produce the highest number of gestures that reference the bleublepip.

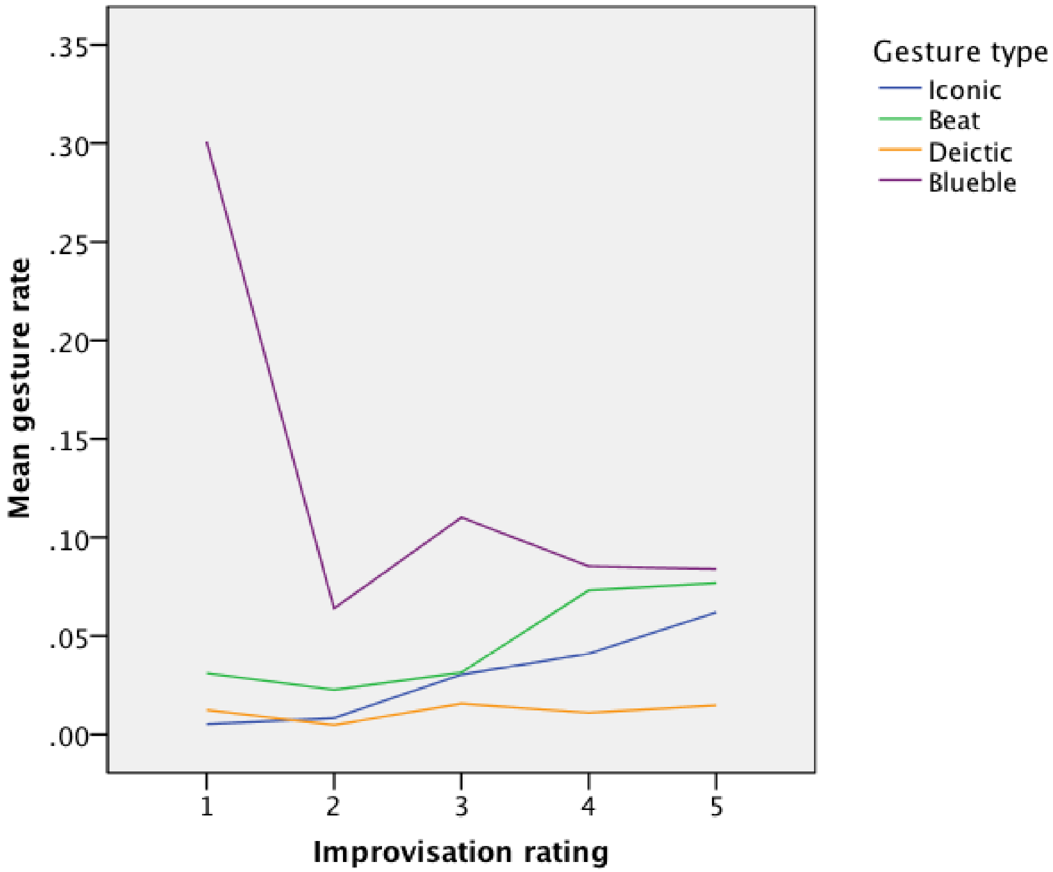

Figure 1. Mean gesture rate according to improvisation quality by gesture type (*n* = 89)

Figure 1 demonstrates these relationships with bleublepip gestures revealing a different pattern to other gesture types, and accounting for the higher gesture rate in low quality improvisations. Iconic gesture rates were the only type of gesture to show a steady increase between each improvisation rating, while deictic gesture reflected the least change across improvisation ratings.

4.0 Discussion

Verbal improvisation presents a significant challenge to the speaker. Novel information must be generated continuously within short time frames, a process that is likely to quickly exhaust the mental workspace. We predicted that speakers would shift the burden and externalise some of their thinking via gesture. Indeed, we found that compared to everyday speech, asking people to improvise boosted their gesture rate. Upon closer inspection of the types of gestures that accompanied improvised speech compared to everyday speech, we found that participants generated significantly more iconic and deictic gestures when improvising compared to when in everyday conversation. On the other hand, participants were more likely to produce self-adaptors in everyday speech than in improvised speech.

Not only did people gesture more when improvising, but the amount they gestured was related to the quality of their improvisation. Interestingly, the participants who gestured the most were those whose improvisations were rated as the strongest *and* the weakest by expert improvisers. Indeed, it is thought that unconscious thought processes, which are required to be successful in these improvisation tasks, encourage creativity (Dijksterhuis & Meurs, 2006) and the use of gestures, as an unconscious process, may provide further support for this idea. Further analysis took into consideration the type of gesture, revealing that the best improvisers produced significantly higher rates of iconic and beat gestures. The weakest improvisers, however, produced higher rates of 'bleublepip' gestures; hand movements that physically orientated to the body area that the bleublepip was suggested to be situated. The more iconic and beat gestures that individuals produced, the higher the improvisation was rated. It is important to note that the experts additionally coded transcriptions of the improvisation and the high rate of reliability indicated that ratings were not influenced by the participant's gestures. However, it is likely that the iconic gestures accompanying the speech impacted upon the properties of the spoken message. Research by Beattie and Shovelton (2002) asked judges to rate transcribed propositions on imageability and found that propositions that had been accompanied by iconic gesture when originally spoken were more evocative of images that those that had not been accompanied by gesture. Thus, the iconic gestures produced by our improvisers likely generated speech higher in image ability which contributed to the positive evaluation of the improvisation.

As such, the finding that we gesture more when improvising and produce more iconic gestures when improvising most successfully, provides support for the idea that improvisation is a cognitively demanding task and that gesturing may play a facilitative role in the improvisation process. According to the cognitive load hypothesis, gesturing while performing the verbal improvisation task would relieve the speaker of some of the cognitive burden, shifting some of the demands from verbal working memory into visuospatial working memory (Goldin-Meadow et al., 2001). It is via this mechanism that we can explain why greater gesture production was associated with better quality improvisations.

Additionally, these findings could be explained by the lexical retrieval hypothesis (Rauscher et al., 1996). Gesturing may increase the fluency and production of ideas by offering a greater choice of vocabulary and subsequently offering greater flexibility. Thus, the vocabulary of the improvisations rated as higher in quality may have been more diverse than the weaker improvisations. Furthermore, the image activation hypothesis (De Ruiter, 1998; Wesp et al., 2001) can account for the greater gesture production of weak and strong improvisers. Both types of improvisers were attempting (some more successfully than others) to activate representations and to hold these in working memory as they simultaneously planned and produced their speech. While the gestures of the weak improvisers were fixed on maintaining representation of the 'bleublepip', the gestures of the strongest improvisers maintained a greater range of diverse images as they concurrently produced their creative narrative.

Participants whose improvised narratives were judged to be poor were inflexible in their gesture use. Their gestures fixated on the bleublepip on their shoulder, indicating rigidity in their representations that did not expand or develop beyond the construct suggested by the experimenter. The gestures of the participants whose representations of the bleublepip were more abstract (as evidenced by their high score on the quality of their improvisation) were detached from the physical representation of the construct and were more likely to refer to abstract semantic and deictic features related to their more elaborate narratives. This progression of gesture production, shifting from more concrete to greater abstract gestures, reflects that observed in problem solvers. In a study of gesture production during in a mental rotation task, Chu and Kita (2008) report similar distancing in participant's gestures which were initially mimetic, veridically tied to the concrete object, but became more abstract as their strategy representations became internalized and less dependent on the physical world. Chu and Kita likened this to the developmental trajectory described by Piaget (1968) in which children's internalised schemas are built through sensorimotor experience with the world. In the verbal improvisation task, gesture provides us insight into the process of creativity. Successful improvisation requires physical and representational distancing from the (albeit imaginary) referent.

The reliability of the improvisation and gesture coding was of a highly acceptable level. In addition, there was a high level of agreement between video and manuscript improvisation ratings leading the authors to conclude that despite the subjective nature, the CAT was an effective and reliable method of rating improvisations. However, it is worth noting that the content of the speech generated by the control and improvisation conditions was different. Though there were individual differences, the improvisation task elicited narratives that were typically high in imagery. In contrast, the control condition required participants to reflect on their choice of degree and personal experience. Some may have found this uncomfortable which could account for the increased self-adaptor gestures that were observed; self- touching behaviours are known to be more frequent in high stress situations (Ekman & Friesen, 1974). Future studies should consider a closer comparison between improvisation and a control in future, for example by asking participants to recount a well-known fairy story.

In addition, while in this investigation we have demonstrated a relation between gesture and improvisation, one might question the extent to which it is our particular improvisation task that elicits this relationship. In subsequent work, we have tested the extent to which this relationship generalizes to other creative acts with comparable results. One such study examines the link between creative thinking and gestures. Thus it appears that in different creative contexts, both adults and children demonstrate a close link between physical movement and creative thought.

In separate areas of study, both encouraging people to gesture and encouraging people to improvise has been demonstrated to facilitate problem solving (Goldin-Meadow et al., 2001; Lewis & Lovatt, 2013). This relationship would be worth exploring further. Are those who gesture more during a series of improvisation tasks the same people who both gesture the most and achieve the biggest changes in problem solving scores? By actively encouraging people to use gestures when taking part in a verbally creative process, can we increase the quality of the creative output or that of creative problem solving? Work in our lab has addressed this by examining the relationship between gesture and creativity in children, suggesting that the more children gesture spontaneously, the more novel uses they generate on the Alternate Uses Task. We then encouraged children to gesture as they thought of novel uses and found this significantly boosted the fluency and originality of their responses (Kirk & Lewis, In prep). Thus gesture offers a route to enhancing divergent thinking, a finding that has significant implications for the classroom.

Our findings add to the growing literature that demonstrates a positive effect of physical movement on performance on creative tasks (Oppezzo & Schwartz, 2014; Slepian & Ambady, 2012). While previous studies have manipulated the movement of participants and tested the effect on performance, we have shown that spontaneous movement is positively related to creative performance. Gesture provided an insight into the process of improvisation, revealing the extent to which participants had distanced their representations from the concrete to the abstract.

Thus, our findings support our prediction that improvisers would make use of what is to hand, gesturing their way to creative narratives.

5.0

References

Alibali, M. W., Kita, S., & Young, A. J. (2000). Gesture and the process of speech production: We think, therefore we gesture. *Language and cognitive processes*, *15*(6), 593-613.|

Amabile, T. M. (1982). Social psychology of creativity: A consensual assessment technique. *Journal of personality and social psychology, 43*(5), 997-1013.

Amabile, T. M. (1983). The social psychology of creativity: A componential conceptualization. *Journal of personality and social psychology, 45*(2), 357.

Beattie, G., & Shovelton, H. (2002). What properties of talk are associated with the generation of spontaneous iconic hand gestures?. *British Journal of Social Psychology*, *41*(3), 403-417.

Bock, K. & Levelt, W. (1994). Language production. Grammatical encoding. In M. A. Gernsbacher (Ed.), *Handbook of Psycholinguistics.* (pp. 945–984). Academic Press, San Diego, CA.

Chu, M., & Kita, S. (2008). Spontaneous gestures during mental rotation tasks: Insights into the microdevelopment of the motor strategy. *Journal of Experimental Psychology: General*, *137*(4), 706.

Crowder, E. M. (1996). Gestures at work in sense-making science talk. *The Journal of the Learning Sciences*, *5*(3), 173-208.

De Ruiter, J. P. (1998). Gesture and speech production. Unpublished Doctoral Dissertation, Radboud University, Nijmegen.

De Ruiter, J. (2000). The production of gesture and speech. *Language and gesture*.

Dijksterhuis, A., & Meurs, T. (2006). Where creativity resides: The generative power of unconscious thought. *Consciousness and Cognition, 15*(1), 135-146.

Ekman, P., & Friesen, W. V. (1974). Nonverbal behaviour and psychopathology. In R.J. Friedman & M. M. Katz (Eds.) The psychology of depression: contemporary theory and research. Washington D.C.: Winston & Sons.

Goldin-Meadow, S., Nusbaum, H., Kelly, S. D., & Wagner, S. (2001). Explaining math: Gesturing lightens the load. *Psychological Science, 12*(6), 516 - 522.

Goncu, A., & Perone, A. (2005). Pretend play as a life-span activity. *Topoi, 24*(2), 137-147.

Guilford, J. P. (1959). Traits of creativity. *Creativity and its cultivation*, 142-161. New York:Harper.

Guilford, J., Christensen, P., Merrifield, P., & Wilson, R. (1978). *Alternate uses: Manual of instructions and interpretation.* Orange, CA: Sheridan Psychological Services.

Johnstone, K. (1979). Impro: improvisation and the theatre. *Lontoo: Faber and Faber Ltd*.

Kirk, E. & Lewis, C. (In prep). Creativity at your fingertips: The relationship between gesturing and divergent thinking in children.

Kita, S. (2000). How representational gestures help speaking. *Language and gesture*, 162-185.

Levelt, W. J. M. (1989). *Speaking: From intention to articulation.* Cambridge, MA: MIT Press.

Lewis, C., & Lovatt, P. (2013). Breaking away from set patterns of thinking: Improvisation and divergent thinking. *Thinking Skills and Creativity, 9*, 46 – 58.

Maclay, H., & Osgood, C. E. (1959). Hesitation phenomena in spontaneous English speech. *Word, 15,* 19 - 44.

McNeill, D. (1992). *Hand and mind: What gestures reveal about thought*. University of Chicago Press.

Mednick, S. (1962). The associative basis of the creative process. *Psychological Review, 69*(3), 220–232.

Montuori, A. (2003). The complexity of improvisation and the improvisation of complexity: Social science, art and creativity. *Human Relations, 56*(2), 237-255.

Nooshin, L. (2003). Improvisation as' Other': Creativity, Knowledge and Power-The Case of Iranian Classical Music. *Journal of the Royal Musical Association, 128*(2), 242 - 296.

Oppezzo, M., & Schwartz, D. L. (2014). Give your ideas some legs: The positive effect of walking on creative thinking. *Journal of Experimental Psychology: Learning, Memory, & Cognition*. DOI: 10.1037/a0036577

Pawley, A., & Syder, F. (1983). Two puzzles for linguistic theory: nativelike selection and nativelike fluency. *Language and Communication*, 191 - 226.

Piaget, J. (1968). *Six psychological studies.* New York: Random House.

Pine, K. J., Bird, H., & Kirk, E. (2007). The effects of prohibiting gestures on children's lexical retrieval ability. *Developmental Science*, *10*(6), 747-754.

Ping, R., & Goldin-Meadow, S. (2010). Gesturing saves cognitive resources when talking about nonpresent objects. *Cognitive Science, 34*(4), 602-619.

Rauscher, F. H., Krauss, R. M., & Chen, Y. (1996). Gesture, speech, and lexical access: The role of lexical movements in speech production. *Psychological Science*, *7*(4), 226-231.

Runco, M. A., & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity Research Journal, 24*(1), 92 - 96.

Sawyer, R. (2000). Improvisation and the creative process: Dewey, Collingwood, and the aesthetics of spontaneity. *Journal of Aesthetics and Art Criticism, 58*(2), 149-161.

Schachter, S., Christenfeld, N., Ravina, B., & Bilous, F. (1991). Speech disfluency and the structure of knowledge. *Journal of Personality and Social Psychology*, *60*(3), 362 - 367.

Schachter, S., Rauscher, F., Christenfeld, N., & Crone, K. T. (1994). The vocabularies of academia. *Psychological Science, 5*(1), 37 - 41.

Slepian, M. L., & Ambady, N. (2012). Fluid movement and creativity. *Journal of Experimental Psychology: General*, *141*(4), 625.

Sternberg, R. J., & Lubart, T. I. (1999). The concept of creativity: Prospects and paradigms. In R. J. Sternberg (Eds.), *Handbook of creativity* (pp. 3-15). USA: Cambridge University Press

Tversky, B. 2002. What do sketches say about thinking? *Sketch Understanding*, *Papers from the 2002 AAAI Spring Symposium*, 148–151.

Tversky, B. (2008). Making Thought Visible. In J. S. Gero (Ed.), *Proceedings of the International Workshop on Studying Design Creativity*. The Netherlands: Springer.

Wesp, R., Hesse, J., Keutmann, D., & Wheaton, K. (2001). Gestures maintain spatial imagery. *The American journal of psychology*, *114*(4), 591 - 600.

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic bulletin & review*, *9*(4), 625-636.

Appendix A: Improvisation group tasks

Activity 1 – Random number generation. Every person has to shout out a random number each time the experimenter claps. Highlight how easy it is to get into patterns and repeat asking them to break away from any patterns they find themselves doing.

Activity 2 – One word at a time story – In groups, go around in a circle taking it in turns to say one word at a time to form a story. At the end of a sentence, simply say full stop and start another sentence. These should make up coherent sentences! (Can be done twice if needed)

Activity 3 – In pairs, get one person to tell a story which includes three unrelated words and then swap pairs for another three random words:

Version 1: Banana, Cup, Chisel

Version 2: Ash, Umbrella, Pig

Activity 4 – In pairs, give the other person a character and ask questions about their character. (Then swap).

Activity 5 – In pairs, give each other a character. The characterisation should always be accepted. e.g. A: Hello John, how's your bee collection?

B: It's great, got nearly 3000 now. I'm sorry to hear about your wife's affair.

A: Your brother's welcome to her…

Activity 6 – Exit on fourth line. This can be done in pairs and groups.
A is on and B enters with a line. A replies, B replies, A replies and exits. B stays on and another A enters on line in a different character if the same person. This is repeated. This can also be done where the same character is taken on. (This can also be done by clapping each time someone should exit).

Appendix B: Example transcript

Gestures are described in brackets and the speech that the gesture accompanied is in bold/

Participant 4

(Improvisation rating: 5)

(01:18)

I: So, what's that bleublepip on your shoulder?

P: Sorry?

I: That bleublepip – what is it?

P: Oh – it's like this little thing – this unicorn **came along** [left hand arc motion] and it like, **ran past me and as it flew the wing touched me on the shoulder** [right hand up and down wave motion from right to left] **and then it just like sparked this little thing on my shoulder** [right hand moves to left shoulder, hand opens and fingers spread open].

I: So, is it alive?

P: Is it alive? I'm not sure – it's like this little glittery thing. I think it's like an enchanted creature **but um, hopefully it doesn't grow too much otherwise I'm gonna put on loads of weight and people will be like what's that thing on your shoulder?** [right hand touches left shoulder and remains there, left hand raises palm up to point to the left distance]

I: Oh, so is it attached to you?

P: Yeah!

I: So, it can't come off?

P: **No it's actuall – like the wing touched me on the shoulder and then this is like implanted in my shoulder and then it grows and then apparently it's gonna like, cre – like, be – like, be - like give birth or something and then it'll just fly away.** [right hand in mid air, palm down, gliding motion from right to left to move to touch left shoulder. Taps left shoulder, hand opens and the left hand is raised simultaneously, palm open. Right hand then moves in sweeping motion from left shoulder to front of body and both hands returned to equilibrium]

I: Oh – so once it's given birth that's it – its gone. So, when does it give birth?

P: When does it give birth? **Oh – it like apparent – well the unicorn didn't stick around very long cos it kinda just flew past but what I've heard from the other people it happened to on cloud nine, erm, it just like, I think it's about three weeks(?) so I've not got that long to wait but apparently they come back and visit you cos they remember who they came from.** [right hand touches left shoulder, left hand raised to point to left distance, right hand raised on right hand side of body, quick motion back and forth and then hand returns to shoulder. Left hand returns to equilibrium, followed by right hand. Left hand raises and moves in space in front of body back and forth}

I: Aah, It's kind of like your little friend isn't it?!

P: [Laughs]

I: Ok – that's great. Thank you very much.

Table 1*A Within-Samples Comparison of Mean (SD) Gesture Rates by Condition (n = 71)*

Gesture type	Improvisation	Control	*t*-value

Total	.18 (*.14*)	.14 (*.11*)	2.70**
Iconic	.05 (*.06*)	.03 (*.05*)	2.05*
Deictic	.06 (*.08*)	.01 (*.02*)	5.06**
Beat	.05 (*.07*)	.05 (*.06*)	-0.75
Self-adaptor	.02 (*.03*)	.04 (*.04*)	-3.60**

Table 2*Mean (SD) Gesture Rates According to Improvisation Quality Ratings (n = 89)*

Gesture type	**1 (*poor*)** (*n* = 17)	**2** (*n* = 16)	**3** (*n* = 21)	**4** (*n* = 21)	**5 (*excellent*)** (*n* = 14)
Total Gestures	.22 (*.12*)	.09 (*.13*)	.13 (*.13*)	.21 (*.13*)	.25 (*.11*)
Iconics	.03 (*.07*)	.01 (*.01*)	.03 (*.04*)	.07 (*.07*)	.08 (*.06*)
Deictics	.13 (*.12*)	.03 (*.05*)	.04 (*.06*)	.04 (*.05*)	.07 (*.05*)
Beat	.02 (*.03*)	.03 (*.07*)	.04 (*.07*)	.07 (*.07*)	.07 (*.05*)
Self adaptors	.03 (*.04*)	.03 (*.04*)	.01 (*.03*)	.02 (*.02*)	.02 (*.02*)
Bleublepip	.31 (*.22*)	.06 (*.09*)	.09 (*.10*)	.08 (*.10*)	.13 (*.09*)