The right tool for the right task: Structured techniques prove less effective on an ill-defined problem finding task

Abstract

Problem finding represents an essential skill, with research showing that training using structured thinking techniques can benefit performance. We examined whether such benefits would remain when addressing a more ambiguous type of problem. 118 participants were recruited and randomly allocated to one of three groups (*six men*, *six hats*, *control*) and, after reading a synopsis of their allocated technique, restated a problem in as many ways as they could. Performance was measured in terms of the *fluency*, *quality*, *flexibility* and *originality* of responses. Results showed those using the *six men* technique exhibited greater fluency and flexibility in their responses. However, their restatements were also classified as lower quality compared to either the *six hats* or *placebo* control. The reduced impact of the *six men* technique might, we argue, be due to the ambiguity of the problem, exacerbated by inadequate training.

Keywords: six good men; six thinking hats; ill-defined problem; problem finding.

Introduction

The notion of creative problem solving (CPS) as a framework largely stems from the early work of Osborn (1953), who attempted to outline the creative process and provide a structured approach to creative problem solving. While this framework has been developed and modified over time (see e.g., Buijs, Smulders, & van der Meer, 2009; Isaksen & Treffinger, 2004; Puccio, Murdock, & Mance, 2005), there is general agreement that the problem solving process begins with problem finding (see, Basadur, Graen, & Graen, 1982; Reiter-Palmon & Robinson, 2009), which can refer to the anticipation of problems, identifying problems when none are evident, and the structuring of an ill-defined problem so that problem solving efforts can proceed (Mumford, Reiter-Palmon, & Redmond, 1994; Runco & Nemiro, 1994).

The importance of problem finding has been stressed in the past with previous researchers identifying links between problem construction ability and creative output (see, e.g., Mumford, Baughman, Threlfall, Supinski, & Costanza, 1996; Reiter-Palmon, Mumford, & Threlfall, 1998). This has led to suggestions that problem finding may be a more important process and/or skill than problem solving (e.g., Moore, 1985; Wakefield, 1985), and that it may lead to more innovative solutions (Lee & Cho, 2007). Given the seeming importance that problem finding can have on the outcome of the creative problem solving process, training to enhance such performance would be of value. In particular, both industry (e.g., Fontenot, 1993; Thompson, 2003) and education (e.g., Murdock, 2003; Pithers & Soden, 2000) have extolled the virtues of training to enhance such skills. In response to this, many and various training schemes have been developed and assessed, with a general consensus in the literature that such training can have both significant and applied benefits (see, DeHaan, 2009; Fontenot, 1993; Ma, 2006; McIntyre, Hite, & Rickard, 2003; Pithers & Soden, 2000; Scott, Leritz, & Mumford, 2004; C. Wang & Horng, 2002). However, while such reviews suggest that training schemes in general can benefit performance there is a lack of detailed research focusing on the potential benefit of the specific techniques used and at what stage in the problem finding/solving process they may help (see, Vernon, Hocking, & Tyler, 2016). Clearly identifying the potential benefit of specific techniques within each of the creative problem solving stages would help target and develop more effective interventions as well as inform theoretical understanding. The problem finding process is a complex one, but, nevertheless, there is general agreement that variability in performance can be captured in a participant's ability to provide 'restatements' (broadly speaking) of given problem scenarios (e.g. Fontenot, 1993).

Two such techniques that have recently been shown to benefit problem finding skills are the *six good men* (Kipling, 1902) and the *six thinking hats* (de Bono, 2009). The *six men* of

Rudyard Kipling (Kipling, 1902) simply refer to the six common question words: who, how, what, why, where and when. The rationale for this technique is that such questions are thought to provide an explicit structure to the individual's thinking to encourage diverse responses and facilitate understanding (see e.g., Annesley, 2010; Paterson, 2006). The *six hats* technique is similar in that it refers to six distinctly coloured hats, each of which emphasises a style or approach to thinking. For instance, the yellow hat encourages the individual to focus on the positive issues while the black hat forces the individual to think about negative consequences or risks (see, de Bono, 2009). The underlying rationale for this technique is that it provides an explicit framework to scaffold or facilitate creative thinking (see, Rizvi, Bilal, Ghaffar, & Asdaque, 2011). Recent work has shown that learning to use either of these techniques can facilitate problem finding performance relative to a no-intervention or placebo control group (Vernon & Hocking, 2014, 2016). However, such benefits have been reported when focusing on only a simple, clearly defined problem. It is not clear whether such benefits would remain if participants were required to tackle an ill-defined type of problem.

It has long been known that there are various ways of classifying problems in terms of how evident they are or whether they require an element of discovery (see, Dillon, 1982; Getzels, 1979, 1982). Problems can also be distinguished in terms of whether they are clearly defined or more ambiguous (e.g., Paletz & Peng, 2009; Reiter-Palmon & Illies, 2004). A clearly defined problem is often characterised as having a known goal, apparent methodology and/or a way of reaching an answer and possibly a single correct solution. For instance, the enhanced problem finding performance reported by Vernon and Hocking (2014; 2016) utilised a problem which asked participants to restate the given problem 'I'm in a new city and need dinner'. Here it is clear what the problem is and this likely helps provide cues in terms of what needs to be done to solve it, as well as when it will be solved (i.e., when 'dinner' is obtained). In contrast, poorly or ill-defined problems are often characterised by multiple goals, requiring diverse avenues of exploration that highlight a range of possible solutions (Reiter-Palmon & Illies, 2004). Furthermore, Paletz and Peng (2009) propose that ambiguous, ill-defined problems are more difficult to solve and require greater cognitive effort. In addition, some have suggested that such challenging problems not only provide an opportunity for creative thought but have a need for such creativity of thought in order for the individual to be able to solve them (see e.g., Hong, Hwang, & Tai, 2013).

It should be noted that while it is possible at present to subjectively distinguish between clearly defined and ill-defined it is not possible to precisely define the level of clarity or complexity of a given problem. To some extent this represents a limitation within the general discipline of creative problem solving as the level of problem difficulty (i.e., its ambiguity and/or complexity) is likely to influence the amount of time needed to reach and produce useful and/or original solutions. Nevertheless, a database of problems that have been used at any or all of the three key stages of the CPS process would be a valuable resource, particularly if information was available relating to the level of complexity/ambiguity of each of the problems[1].

Thus, while the structured thinking techniques of the *six men* and the *six hats* have been shown to facilitate problem finding performance when focusing on a reasonably simple and well defined problem (see, Vernon & Hocking, 2014, 2016) it remains an open question whether such a benefit would remain evident when faced with an ill-defined problem. For instance, Paletz and Peng (2009) classify the following problem scenario as potentially complex by virtue of its ambiguity: 'You are a scientist who is studying monkey behaviour in Africa. You see some of the monkeys eating dirt. Usually they just eat leaves and fruit'. In this scenario, the problem itself remains unclear and as such requires what Paletz and Peng (2009) refer to as 'deeper problem finding, or more cognitive effort' (p.6). This may be an opportunity for the structured thinking techniques of the *six men* and the *six hats* to show greater effects when compared to a control group. Furthermore, using a more ill-defined problem scenario may be helpful in distinguishing between the potential benefits of the two techniques. For instance, previous work has shown slightly superior performance for those using the *six men* (see, Vernon & Hocking, 2016). However, this could in part be a simple, straightforward problem fitting well with a straightforward technique such as the *six men*. In contrast, a more ambiguous problem may benefit more from a structured technique such as the *six hats* that encourages a greater level of conceptual processing, which, in turn, might activate a wider range of information that could then be utilised to represent the problem and direct the efforts of the individual more effectively (see, Mumford et al., 1994).

Thus, the aim of this study was to compare the effectiveness of the two structured thinking techniques (i.e., the *six men* and the *six hats*) to that of a placebo group on a problem finding task utilising a complex problem scenario. The placebo approach adopted here was the same one as used in previous research and simply required participants to take six deep breaths

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[1] With this in mind we would like to use this opportunity to send out a call to all researchers to upload their problems to our website (at, http://cccupsychology.com/creativitycognition) so that we can begin the construction of such a database of problems that eventually would identify the clarity/ambiguity and/or complexity of the problems whilst making them freely available for all to use.

and focus on the task at hand (see, Vernon & Hocking, 2016). Six deep breaths was used simply because a plausible argument could be proffered such that deep breathing increased blood flow to the brain and thereby could benefit cognitive performance. Furthermore, the fact that six breaths were taken allowed us to match the number of elements to that of the other conditions. On the basis of evidence showing the facilitative effect of effortful, structured thinking (e.g., Reiter-Palmon & Robinson, 2009), and research showing that the *six men* and the *six hats* facilitate problem finding performance (Vernon & Hocking, 2014, 2016), we predict that participants using either technique will exhibit *improved* problem finding ability compared to the placebo-intervention control group. However, it is not clear at this stage what if any differences may emerge in problem construction performance between the two experimental techniques.

Method

Participants

One hundred and eighteen participants (22 male; 96 female) aged 18y to 35y (mean age 19.5y) took part in the study[2] during an undergraduate psychology induction session. Participants were randomly allocated to one of three groups with each group focusing on the use of a specific technique (40-*six hats*, 40-*six men*, 38-*placebo*). All participants provided informed consent and it was made clear that they were free to withdraw at any time and have their data removed/destroyed. The study obtained ethical approval from the University Faculty Ethics Committee (Ref: 14/SAS/191C).

Materials

The study was conducted using specifically constructed workbooks. Each workbook recorded demographic (name, age, gender) information and contained seven self-report questions created using a 5-point Likert response scale. The first two assessed the participant's views on creativity (Q1: How creative do you think you are? Q2: How important to you think creativity is in life?). The remaining five were used at the end of the study to obtain feedback on participant's motivation to complete the task (Q3: How motivated were you to complete the

[2] This problem construction study represented part of a larger study, the remainder of which has been reported elsewhere.

task?), familiarity with the allotted technique (Q4: Have you ever used the specified technique before?), and feedback on use of the technique (Q5: How easy/difficult did you find it to use the technique? Q6: How useful did you find it to use the technique? Q7: How likely is it that you would use the technique in the future?). The workbooks also contained an introduction to the technique (i.e., *six hats*; *six men*; *placebo*) along with an example problem chosen specifically to be relevant to the students (*How can I improve my academic grades?*) with examples of how the technique could be used to help explore and understand the problem. In the six men condition, for instance, under the 'red/emotion' hat, the following examples were given: 'How do I feel about my poor grades? How would improving my grades make me feel? Why should I bother with grades?' This was followed by a brief explanation of problem finding and the focus on restating the problem to aid understanding and finally the problem used in the main part of the study, which was the same for all participants: '*You are a scientist who is studying monkey behaviour in Africa. You see some of the monkeys eating dirt. Usually they just eat leaves and fruit'*, which was taken from Paletz and Peng (2009). Given that the participants were psychology undergraduates in their first week at university, this scenario should have been reasonably engaging without drawing upon any in-depth knowledge. Individual engagement, i.e. intrinsic motivation, is an important factor in drawing out creative performance (see, e.g., Runco & Nemiro, 1993). Beneath this was a grid containing 18 boxes for the participants to write in their restatements, with one box per restatement.

Design

The study used a between-participants design with a single factor of Group with three levels (*six hats; six men* and *placebo*). Four dependent measures were used to assess problem construction performance. The first was *fluency*, which referred to the number of problem restatements (see, Fontenot, 1993). The second, *quality/usefulness*, captured the degree to which the problem restatements were likely to result in a logical/workable approach to the situation, and was scored by two blind coders on a five point Likert scale from 1 (very low quality) to 5 (very high quality) (see, Mumford et al., 1996). The third measure was *flexibility*, which referred to the number of conceptual categories into which the restatements could be classified by the coders (after, Sowden, Clements, Redlich, & Lewis, 2015). The fourth and final measure was *originality* and assessed using the formula: originality = 1- the frequency of a given restatement / total sample size (after, Sowden et al., 2015; Zenasni & Lubart, 2009).

Procedure

There were four timed phases in the experiment and each participant completed them in the same order. Phase 1, which took 5 minutes, was used to introduce the study as a 'creative problem construction task' and provided information on the nature of the study, as well as obtaining informed consent. Phase 2, which also took 5 minutes, required participants to enter their demographic information into their workbook and read through the explanation of the technique and example given. In Phase 3, twenty minutes were allocated for participants to read through the brief explanation of problem finding and complete the main task by entering as many restatements to the posed problem as they could in the grid below. Following this, participants were given three minutes to complete Phase 4, which comprised the post-problem construction questions regarding motivation, familiarity with the technique, how easy/difficult it was to use the technique, how useful they thought using the technique was and whether they would consider using the technique in the future. Once completed, the workbooks were collected, the participants were thanked and the two experimenters debriefed them regarding the aims and objectives of the study providing additional contact details should they wish to ask any further questions.

Results

Two independent raters blind to the aims/objectives of the study were used to code and rate all responses. Example responses are 'Is there an obvious age difference in the monkeys?' and 'Maybe compare blood tests to see if any ailments are present'. Consistent agreement was obtained for responses to self-report questions and the measure of fluency. For quality, where coded responses differed by more than one rating point in either direction (<26%), a third blind rater was brought in to arbitrate the decision. Inter-rater reliability as measured by intra-class correlations (Shrout & Fleiss, 1979) was 0.70. For flexibility, intra-class correlations between the number of conceptual categories identified by each rater was good at 0.80. This classification included categories such as health, diet, social interactions, environment, threat, preferences, time and age. While the intra-class correlations of the originality score were also good at 0.82 it should be noted that using the formulaic approach, as outlined above, to identify originality means that it is not simply that participants in one group produce a restatement that participants in another group do not, but in order for a particular group to obtain a higher originality rating it would mean that participants within this group produce the more unusual (i.e., more original) restatement more of the time.

Descriptive statistics regarding responses to the initial questions on participants' views of creativity are presented in Table 1. This shows that participants in each group rated their own creativity levels similarly, at around the mid-way point. However, they all rated the 'importance of creativity in life' as significantly more important (grand means of 2.96 and 4.02 respectively; $t(118)=10.81$, $p<0.001$, $d=1.87$).

Table 1 about here

To test the predictions that the structured interventions (i.e., *six men; six hats*) would lead to improved creativity performance relative to controls (i.e., *placebo*) a one-way analysis of variance (ANOVA) was carried out on each of the four creativity measures (i.e., fluency, quality, flexibility, originality) with orthogonal planned contrasts comparing performance of each intervention to placebo, see Table 2 for descriptive statistics.

Table 2 about here

For *Fluency* this led to a main effect of Group $F(2,115)=7.768$, $p=0.001$, $Mse=8.78$, $\eta 2=.12$, with contrasts showing that those using the *six men* technique produced significantly more restatements than the *placebo* group (mean fluency 9.07 vs. 6.89 respectively; $p=0.002$, $d=0.68$), though there was no difference between those using the *six hats* and the *placebo* group (mean fluency 6.72 vs. 6.89, $p=0.8$). Post-hoc analysis showed greater fluency for those using the *six men* compared to the *six hats* techniques (mean fluency 9.07 vs. 6.72 respectively; $t(78)=3.41$, $p=0.001$, $d=0.8$). Analysis of *Quality* showed a main effect of Group $F(2,115)=6.884$, $p=0.001$, $Mse=0.219$, $\eta2=.11$, with contrasts showing that those using the *six men* technique produced restatements of a lower quality than the *placebo* group (mean quality 3.70 vs. 4.09 respectively; $p=0.001$, $d=0.83$), though there was no difference between those using the *six hats* and the *placebo* (mean quality 3.93 vs. 4.09, $p=0.14$). Post-hoc analysis showed lower levels of quality for those using the *six men* compared to the *six hats* techniques (mean quality 3.70 vs. 3.93 respectively; $t(78)=2.092$, $p=0.04$, $d=0.47$). For *Flexibility* there was a marginal effect of Group $F(2,115)=2.414$, $p=0.094$, $Mse=2.959$, $\eta2=.04$, but planned contrasts revealed no significant effects (all ps >0.1). Nevertheless, post-hoc analysis did show greater flexibility for those using the *six men* compared to the *six hats* techniques (mean flexibility 5.71 vs. 4.91 respectively; $t(78)=2.299$, $p=0.024$, $d=0.52$). Analysis of *Originality* revealed no main effect of Group $F(2,115)=1.617$, $p=0.203$, $Mse=.001$, with contrasts showing no significant effects (all ps >0.1).

Descriptive statistics of responses to the post-restatements questions regarding the difficulty of the task, the use of the technique and possible future use are given in Table 3.

Table 3 about here

A one-way ANOVA conducted on participants ratings of their motivation levels showed no main effect of Group $F(2,115)=0.241$, $\eta2=.00$, $p=0.786$. In terms of how easy/difficult it was to use the technique there was a main effect of Group $F(2,113)=7.047$, $\eta2=.11$, $p=0.001$. Further comparisons using a Bonferroni correction showed that those using the *placebo* technique found this easier than those using the *six hats* (mean ease of use 3.57 and 2.80 respectively; $p=0.001$, $d=0.78$) and that those using the *six men* found it easier than those using the *six hats* (mean ease of use 3.34 and 2.80 respectively; $p=0.037$, $d=0.62$). There was no difference in reported difficulty of use between the *six men* and the *placebo* group. Analysis of how useful participants found using the techniques produced a main effect of Group $F(2,113)=9.61$, $\eta2=.15$, $p=0.001$. Further comparisons using a Bonferroni correction showed that those using the *six men* technique found this more useful than those using the *six hats* (mean usefulness 3.73 and 3.17 respectively; $p=0.03$, $d=0.62$) and those using *placebo* (mean usefulness 3.73 and 2.78 respectively; $p=0.001$, $d=1.07$). Finally, analysis of how likely it is that participants would use the technique in the future produced a main effect of Group $F(2,113)=8.678$, $\eta2=.13$, $p=0.001$. Further comparisons using a Bonferroni correction showed that those using the *six men* technique would be more likely to use this technique again in the future compared to those using the *six hats* (mean usefulness 3.78 and 3.10 respectively; $p=0.01$, $d=0.71$) and those using *placebo* (mean usefulness 3.78 and 2.84 respectively; $p=0.001$, $d=1.01$).

Discussion

The aim here was to assess whether using the structured thinking techniques of the *six men*, or *six hats* would enhance problem finding performance relative to a *placebo* group when addressing an ill-defined problem scenario. The results showed that there was no initial difference in the level of reported motivation between the three groups. In terms of performance those using the *six men* technique produced more restatements with a marginally greater level of flexibility. However, their restatements were also classified as lower quality compared to those using either the *six hats* or the *placebo* control. Across all measures, there was no benefit for the *six hats* technique. Post-study questions show that those using the *six men* found this technique easier to use, more useful, and hence would be more likely to use it again in the future compared to those using the *six hats*.

That use of the *six men* technique led to greater fluency and marginally better flexibility is to some extent consistent previous findings suggesting that creative problem solving can benefit from producing more ideas (Runco, 2010; Vernon & Hocking, 2014, 2016; C. Wang & Horng, 2002). Such a technique provides the individual with the opportunity to explore the conceptual problem space in a structured and methodical manner with the aim that, over time, more original and better quality ideas would emerge (see, Silvia et al., 2008). However, while more restatements were made using this technique, they were not of a better quality or more original. Such a finding suggests that the relationship between fluency and quality/originality may not be a simple linear one. To some extent, this is evident in literature showing that interventions that benefit fluency don't necessarily improve novelty (see e.g., Chan & Schunn, 2015), while others have shown that short-term interventions that can lead to more original output fail to have any impact on fluency (Sowden et al., 2015). Given that previous work has shown that using the *six men* technique can lead to benefits in originality when focusing on a simple problem (see, Vernon & Hocking, 2014, 2016), it may be that there are limits to the benefits of such a technique in terms of the ambiguity and/or complexity of the problem. As noted in the introduction, it is difficult to establish precisely how clear, ambiguous and/or complex a problem might be. Nevertheless, we would argue, along with Paletz and Peng (2009) that the 'monkey' problem used in the current study represents a more ambiguous problem than the one used by Vernon and Hocking (2014; 2016), and therefore might induce a higher cognitive load. One way in which such a load might manifest itself is increased processing time. In the present study, the limited benefits seen when using the *six men* technique could be due to the restricted time allowed for task completion, which may have been too short to permit sufficient variability in our dependent measures. At present such an idea is speculative, as no direct comparison has yet been made on the impact that various time durations may have on use of the *six men* when faced with either a clear or ambiguous task. However, research by Haman (1996) suggests that when attempting to generate ideas the initial generation phase typically produces old and unoriginal ideas and that only with sufficient time are these foundational ideas reconstructed to help form new and novel ideas. Such a view is also consistent with the notion that sufficient time may be needed to re-represent the problem in order to generate truly original responses. For instance, Mumford et al. (1994) have proposed that problem finding relies on the construction of problem representations. Such representations are thought to include schematic and/or categorical knowledge structures based on prior experience as well as information on the nature and goals of the problem, including the possible procedures, operations and constraints that may arise during an attempted solution. Such representations are thought to be activated in part by cues in the current situation. A key aspect of this theoretical approach is that original ways of dealing with the current problem occur when the initial representations are later *re-combined* into new representations. Such a process is only likely to occur if sufficient time is given to initially represent the problem and then allow for such foundation representations to be re-combined. Of course, this should not be taken to imply that the relationship between the amount of time given over to the task and the potential benefit seen when using a technique such as the *six men* would be a linear one. It may be that such a pattern is better represented by a quadratic relationship reminiscent of the inverted U model initially proposed by Yerkes and Dodson (1908), where insufficient time may result in a lack of original/quality responses which could be improved with time. However, too much time could also lead to a reduction in the level of originality and quality of the responses. The difficulty, at present, is in identifying the ideal time duration to elicit the most useful/original and high quality responses. Nevertheless, future research could help elucidate and clarify such issues.

That there was no benefit in any of the creativity measures when using the *six hats* technique contrasts with previous findings (see, Vernon & Hocking, 2014, 2016), though it echoes the null results reported by Birdi (2007). However, despite the fact that this particular technique has been around for some time there is very little empirical research focusing on its impact (see e.g., Vernon et al., 2016). As such, it is not entirely clear at this stage why no beneficial effect was found in the current study when previous attempts have shown clear benefits in fluency, flexibility and originality.

It could simply be that when faced with a more ambiguous problem scenario, participants' motivation levels were reduced, making them less willing to complete the task. It is generally agreed that motivation is a key predictor in creative problem solving performance and lower levels of motivation could have a detrimental performance (see e.g., Amabile, 1996; Baer & Kaufman, 2005; Fasko, 2001; Sternberg & Lubart, 1999). However, if this were the case it is not clear why it would predominantly influence use of the *six hats*. Also, self-reported motivation levels of the participants in this study were not different between the conditions.

A plausible though speculative alternative possibility is that the *six hats* technique is more complex and difficult to use than the *six men* and as such requires more time and cognitive resources to master. It is possible that when faced with a clear problem the required cognitive resources needed in order to effectively use the *six hats* had little or no impact on performance. In contrast, when the individual is faced with a more ambiguous problem scenario, which would necessitate access to greater cognitive resources, there is a greater level of competition for these limited resources which could have a detrimental impact on the effectiveness of the technique in question. We know the *six hats* is a comparatively more difficult technique to use than the *six men* because it was rated as such in this study. The idea that a technique requiring explicit, effortful processing can initially interfere with the behaviour it is supposed to benefit is speculative but to some extent can be informed by research that has focused on the effects of mnemonic training on memory performance. For instance, it is well known that training to use a mnemonic can significantly benefit memory performance (see, Vernon, 2009). However, what such research also shows is that there are clear effects with regards to the nature of practice when using such techniques. For example, initial use of a mnemonic has been shown to slow down recall performance (see e.g., Corbett, 1977) as time and cognitive resources are taken up with processing the particular mnemonic strategy. Nevertheless, with practice the time taken to form associations using the mnemonic strategy decreases, and with continued practice use of the mnemonic leads to greater benefits compared to not using a mnemonic (see, A. Y. Wang & Thomas, 1995; Wyra, Lawson, & Hungi, 2007). Such a pattern is suggestive of shift in learning from effortful processing to one more reliant on automatic processes. Where the initial effortful processing of the mnemonic interferes with memory processing of the to-be-remembered material by competing for access to the limited cognitive resources. Nevertheless, once the mnemonic has been thoroughly learnt its use becomes more automatic, thereby reducing any possible competition for cognitive resources and in turn facilitating memory performance. Such a proposal is consistent with the well-argued notion that mental operations differ in the level of required conscious attention and that, over time, there is a shift along a continuum from effortful to automatic processing (see e.g., Kahneman, 1973; MacLeod & Dunbar, 1988; Sehcneider & Shiffrin, 1977). Adherents to such views argue that complex operations such as driving a car only become possible after extensive practice so that the once seemingly disparate and effortful movements become automatic and fluid. Hence, with increased training, the use of a potentially complex technique, such as the *six hats*, would be expected to become more automatic and make fewer demands on the limited resources available, which could then be focused on addressing the problem at hand. While speculative, such an idea can be tested by allowing more time for individuals to learn and familiarise themselves with the *six hats* technique. Our expectation would be that greater training on use of the technique would lead to significant benefits, even when addressing a more ambiguous problem scenario. Performance on the *six men*, on the other hand, may not show such a training benefit if participants are at, or close to, a performance ceiling on that technique. Furthermore, such a proposed pattern would also be consistent with research showing that while short duration training may have little impact on creative problem solving performance (Daniels, Heath, & Enns, 1985) longer-term training can lead to significant improvements (C. Wang & Horng, 2002). The complexity explanation can be extended to the placebo condition, which, arguably, is the least complex of the three, given that our main justification for its use as a control was based on the number of elements, six in each case. The relatively good performance in the placebo condition for the quality of restatements is consistent with the idea that reducing the cognitive overhead associated with a technique frees up more resources to tackle a less well-defined problem. On the other hand, a pure complexity-based explanation for the placebo group performance would suggest comparatively better performance for fluency, flexibility and originality, which we do not find.

Moving on from complexity, it is worth noting that we need to be careful when generalising conclusions about techniques from individual problem scenarios because the representativeness of a given scenario is difficult to determine. Thus, we cannot be sure of the extent to which our findings result from effects specific to this particular combination of technique and problem scenario versus the properties of a technique and problem construction in general. To minimise the 'fixed problem effect', we would, ideally, test participants repeatedly with different materials, but given the time it takes participants to produce problems, and the resources involved in coding them, this is beyond the scope of the current paper; patterns should, however, appear as consistencies across studies as findings accrue.

Overall, we found only a limited benefit for using the *six men* thinking technique when addressing a more ambiguous type of problem and no benefit when using the *six thinking hats*. It is possible that the pattern of findings may be accounted for in terms of the increased cognitive load associated with dealing with a more ambiguous problem and that more time and/or more training may produce a different pattern of effects. As such, these findings represent an important step in our continued exploration of the parameters and issues that may influence creative problem solving performance and provide some useful hints on how future research can extend them.

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Table 1. Showing mean responses, with standard deviations (SD), to initial self-report questions on a scale from 1 (not at all) to 5 (very) from participants within each group.

Condition	**How creative do you think you are?**	**How important do you think creativity is in life?**
6 Hats	3.10 (1.25)	3.92 (0.79)
6 Men	2.90 (0.84)	4.17 (0.91)
Placebo	2.89 (1.01)	3.97 (0.91)

Table 2. Showing mean responses, with standard deviations (SD), for fluency (i.e., number of restatements), quality (1=very low; 5=very high), flexibility, and originality.

Condition	Fluency	Quality	Flexibility	Originality
6 Hats	6.72 (2.37)	3.93 (0.44)	4.91 (1.68)	0.0738 (0.029)
6 Men	9.07 (3.31)	3.70 (0.54)	5.71 (1.41)	0.084 (0.026)
Placebo	6.89 (3.12)	4.09 (0.39)	5.55 (2.02)	0.846 (0.033)

Table 3. Showing mean responses, with standard deviations (SD), to post-restatement task self-report questions on motivation (1=not at all; 5=extremely motivated), task difficulty

(1=extremely difficult; 5=extremely easy), usefulness (1=not at all useful; 5=extremely useful) and likelihood of using the technique in the future (1=not at all likely; 5=extremely likely).

Condition	**How motivated were you?**	**How easy/difficult to use the technique?**	**How useful did you find the technique**	**How likely to use the technique in the future?**
6 Hats	3.10 (0.84)	2.80 (0.91)	3.17 (1.03)	3.10 (1.15)
6 Men	3.22 (1.18)	3.34 (0.85)	3.73 (0.76)	3.78 (0.77)
Placebo	3.05 (1.33)	3.57 (1.05)	2.78 (1.01)	2.84 (1.10)