CREATIVITY INTERVENTION: USING STORYTELLING AND MATH PROBLEMS AS INTERVENING TASKS FOR INDUCING INCUBATION

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Abstract

Past studies have intermittently shown evidence of incubation effects. In the design field, incubation can occur when designers step away from a problem but continue to think about it unconsciously. However, little is known about which kind of activities should designers engage to prompt creative results. The purpose of this research is to investigate the role of two types of intervening tasks during idea generation, in order to induce incubation effects. A math quiz and a storytelling task were used to represent two different types of intervening tasks. Based on our findings, when compared to the control condition, the math task was able to induce incubation effects, especially on fluency and overall creativity score. Conversely, the storytelling task did not seem to induce incubation effects when compared to the other conditions, although it had an influence on the originality of the ideas. This study shows that it is preferable to switch from creative to well-structured tasks to promote incubation effects. Nevertheless, swapping between creative tasks can contribute to the generation of more original ideas, but less feasible, which can be beneficial for brainstorm sessions.

Keywords: Creativity, Early design phases, Incubation, Storytelling

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1 INTRODUCTION

Idea generation is an essential phase in a designer's process. It builds up the foundation of any design project, which subsequently has a major impact on the development of final products (Ulrich and Eppinger, 2004). Design research has continually tried to support designers, especially during idea generation, a phase where ideas are born and built, but where many difficulties are encountered. Such difficulties are due, for instance, to the ambiguity design problems inherently have but also due to impossibility of producing highly creative ideas on demand. When unable to continue creating ideas, one strategy that many designers resort to is to put the problem aside for a while. This is typically referred to as incubation. Incubation is a psychological phenomenon firstly described by Wallas (1926), commonly perceived in real world situations but unpredictable to observe in experimental settings (Seifert et al., 1995; Kohn, 2005). For this reason, the study of incubation has been difficult and many theories have been put forward as hypothetical explanations of the mechanisms behind it (e.g., Smith and Blankenship, 1991). Incubation has been discussed extensively in the field of psychology. However, little is known of incubation within the design field, during idea generation, using different types of intervening tasks. Thus, the purpose of this research is to obtain a better understanding of incubation in the design process, focusing on the role of different types of intervening tasks to induce incubation effects, which eventually can help us improve designers' creativity process.

1.1 A brief overview on incubation studies

Incubation can be described as the period of time wherein a problem solver steps away from the problem but continues to think about it unconsciously (e.g., Tsenn et al., 2014). In that sense, incubation effects are defined as the unexpected insight into how to solve a problem during this period away (Smith and Blankenship, 1991). These sudden insights, when incubation effects do occur, can lead to ideas that are less obvious, less accessible and more creative (Dijksterhuis and Meurs, 2006), thus increasing novelty. Ellwood et al. (2009) also pointed out that a break from the main task allows individuals to alter their mindset, restructure the problem and approach it differently. Since novelty and divergent thinking are crucial elements to drive innovation, it is important to facilitate incubation periods and, preferably, enhance the occurrence of incubation effects.

Although the causes of incubation are not unanimously agreed on (Kohn, 2005), a large quantity of studies has shown evidence of the incubation effects occurrence (Snyder et al., 2004; Dijksterhuis and Meurs, 2006; Ellwood et al., 2009). There are several variables that may affect the incubation process. Some of them, such as the stimuli available during incubation, the type of problem or whether participants were fixated, have proven to be influential (e.g., Smith and Blankenship, 1991). Other variables, such as time given to the incubation period, ability, and gender, have insufficient evidence to demonstrate their effects and require further investigation (Tsenn et al., 2014; Dodds et al., 2004).

1.2 Types of problems

Design problems are considered to be ill-structured (Simon, 1973), as the goal is often vague with unknown elements and the number of possible solutions is usually unlimited (Jonassen, 2000). On the furthest side of the spectrum, there are logical problems (well-structured), which are characterized by having exact and verifiable solutions, as well by being possible to apply logical and foreseeable principles to solve them (Jonassen, 2000). When considering ill- and well-structured problems in a continuum (Jonassen, 2000), as seen in figure 1, it is possible to classify different types of tasks, in comparison to design problems.

In this study, we focus on the manipulation of different types of problems during the incubation period, a topic that has yet to receive empirical attention. Snyder et al. (2004) and Segal (2004) demonstrated that having a non-related intervening task in-between the main problem improves the fluency of ideas. Ellwood et al. (2009) found that doing a completely different task during the break is clearly more beneficial than doing a similar task. This can imply that, during idea generation, solving a well-structured problem as an intervening activity could improve idea fluency better than to continue working on the same task. Nonetheless, most existing literature on incubation focus only on well-structured problems as intervening tasks and it is still largely unknown what is the possible influence of using ill-structured problems as an intervening activity, in order to induce incubation in a design task. During design practitioners' daily work, it is unlikely that designers would interrupt their schedule to calculate algorithmic problems, for the sake of creativity stimulation alone. Instead, it is plausible that designers would switch between different projects, also ill-structured. One example of a similar ill-structured type of problem is storytelling and the creation of stories. As design problems, storytelling has ambiguous goals, allows many possible solutions and storytellers are usually required to be creative. Moreover, storytelling can be useful for designers. According to Kallegri and Verbeek (2012), storytelling has been used by humans as a widespread strategy to cope with information complexity. Likewise, it helps constructing social agreement in engineering design teams, as it can be used by designers to explain what they actually do, rather than what they should do (Lloyd, 2000).

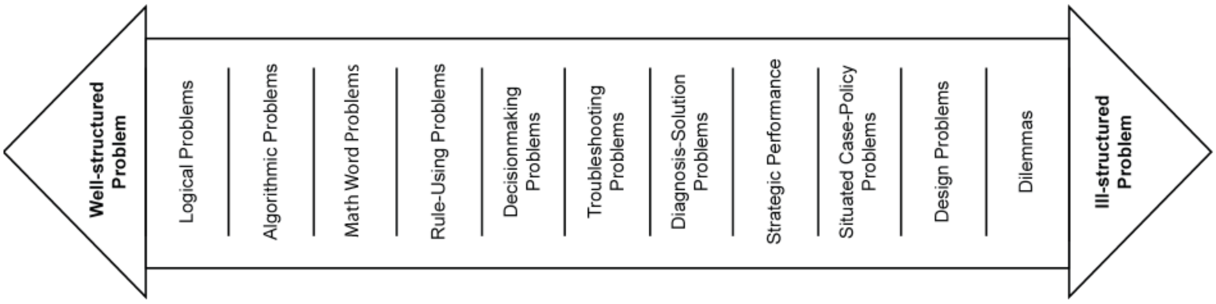

Figure 1: Diagram adapted from Jonassen's (2000) typology of problem solving ranging from well-structured to ill-structured

2 RESEARCH OBJECTIVES

2.1 The influence of intervening tasks

This research aims to investigate the influence on incubation activation of two different types of intervening tasks in between a design idea generation process. A math task, or more specifically, an algorithmic problem, was chosen as one of the intervening tasks. This type of problem is considered to be convergent (as it converges into a single solution) and it is unrelated to idea generation type of problems (Jonassen, 2000; Snyder et al., 2004). Thus, in the math condition, the intervening task consisted of 30 mathematical problems, with simple operations. Evidently, these equations could only be solved with one possible right answer. Although designers do not often deal with mathematical problems, it is widely accepted that in design engineering fields they engage in well-defined tasks, such as cost estimations and material calculations. Furthermore, this type of intervening task was chosen because it is a well-structured problem, which enabled the comparison with an intervening ill-structured task.

The other intervening task was storytelling, as its type of problem is similar to idea generation's (towards the right end of the diagram on figure 1). In the storytelling condition, the participants received 'carte blanche' to create any story they wished, and there was no specific correct answer. Figure 2 illustrates the experiment process, which was divided in three phases. Both tasks provided a diversion from the main task but still continued to demand cognitive effort.

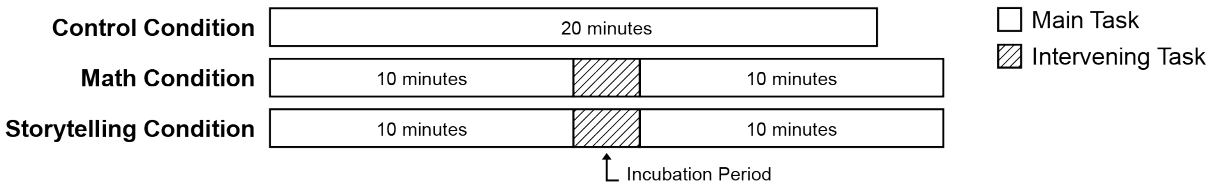

Figure 2: The experiment process

For the storytelling task, Rory's Story Cubes (RSC) were chosen as a tool to assist the participants to tell stories. RSC is a storytelling game based on the combination of randomly distributed, existing image tokens on nine dice (O'Connor, 2005; Kallergi and Verbeek, 2012). In total, there are 54 different images across nine dice, and combinations are virtually unlimited. The game is designed to enhance storytelling but it is also promoted as an aid for designers, since it allegedly supports creativity. Since the pictograms on the cubes are relatively abstract, people can create different associations when looking at the same image. This gives the possibility for individual interpretation,

leading to the creation of a story, which can be partly inspired by the RSC and its aleatory combinations, and partly influenced by the storyteller's own memory and associations. Since each facet of every cube contains an image, which can be interpreted as a visual stimulus, RSC can also act as random stimuli in an idea generation task. In fact, exposure to visual stimuli was shown to have a positive effect on design creativity (e.g., Casakin, 2004; Goldschmidt, 2001).
As indicated on section 1.2 (Types of problem), storytelling as a task is ill-structured, which is similar to the type of problems designers deal with on a daily basis. On the other hand, the pictograms of the RSC do not share any obvious connection with the chosen design brief. Thus, it is assumed that the pictograms can influence the participants' outcome, but in a distantly related manner. According to Fu et al. (2013) and Gonçalves et al. (2013), distantly related stimuli seem to be the most appropriate to generate creative ideas, when compared with closely related and unrelated stimuli.
Therefore, the use of the RSC is considered to be appropriate to both investigate the influence of the type of intervening task, and the possible influence of random pictorial stimuli and storytelling in the second part of the idea generation task.
In conclusion, the main research question we aim to answer is: *To what extent does the type of intervening task, namely math or storytelling tasks, influence novice designers on their creative outcome, during idea generation?*
According to previous findings (Snyder et al., 2004; Segal, 2004), we expect that the Math condition group will generate more creative outcomes than the other groups, mainly in terms of fluency. On the other hand, we expect that the storytelling task can be beneficial for the originality of ideas produced, as the stories might be used as distantly related stimuli (Fu et al., 2013; Gonçalves et al., 2013).

3 THE EXPERIMENT

3.1 Subjects

45 industrial design master students, from the faculty of Industrial Design Engineering at Delft University of Technology, accepted to participate in this study. The average age of the participants was 24.29, where 22 participants were men. 27 participants were Dutch students with a homogenous background, while 18 participants were international students. No reward was given.

3.2 Procedure

The experiment was carried out with each participant individually in a controlled environment. The 45 participants were randomly assigned to one of following three conditions (figure 2), in which different genders, nationalities, and master specializations were evenly distributed:
Control condition (N=15): participants from the control group performed an idea generation task without interruptions, during 20 minutes.
Math condition (N=15): participants were asked to produce ideas for the same design brief, during 10 minutes. Subsequently, the participants' sketches were removed and they were asked to perform the incubation inducing task, which in this case was a math problem, for 3 minutes. Afterwards, participants were asked to continue with the idea generation task for another 10 minutes.
Storytelling condition (N=15): participants were asked to perform the same idea generation task during 10 minutes. With the conclusion of this phase, the participants' sketches were removed and they were asked to roll RSC and tell a story inspired by the resulting combination of dice. In this condition, the storytelling was the incubation inducing task. They were given a maximum period of 3 minutes and only one throw of the dice but their rearrangement was possible. Immediately after the storytelling task, participants were asked to resume the idea generation task for another 10 minutes.
In both experimental conditions, the participants were not aware that there would be a break nor that they would continue generating ideas for the main task afterwards. In previous studies on the topic of incubation, the awareness of the participant that a problem or task is yet unanswered is a common element. However, in those cases, the participants tend to continue thinking consciously about the problem during the break, which can hinder incubation effects (Snyder et al., 2004). Thus, to support unconscious thought, the participants were not informed about the set up of the experimental study.
For every condition, participants were asked to generate solutions for the following design brief: *"People generally use their mobile phone or a traditional alarm clock in order to wake*

themselves up every morning. Yet, they are not always effective and can sometimes cause oversleeping. What would be other possible ways to wake up in the morning in a certain time without using any form of alarm clock? Generate as many ideas as possible. Only the ideas that are self-explaining will be counted!"

To verify the effectiveness of the tasks and the time given, pilots were conducted for every condition prior to the experiment. From the pilots, it was possible to conclude that, during the period of 20 minutes, participants would be able to produce a large number of ideas but these would dwindle before the task's conclusion. Moreover, we observed that three minutes for the math and storytelling tasks were sufficient time to complete them. Considering that Segel (2004) demonstrated that the length of the intervening task does not have an impact on the incubation effect, we assumed that three minutes was a reasonable time for the incubation period.

3.3 Ideas' outcome assessment

Two independent judges evaluated the ideas created by the participants using the following metrics: Fluency, Novelty (composed by Originality and Rarity), Usefulness and Feasibility. Although there are many overviews that attempt to reach a comprehensive creativity metric, until now there is no consensus on the most adequate metrics to evaluate how creative an idea is (e.g., Dean et al., 2006; Kudrowitz and Wallace, 2013). The discussion of creativity metrics is outside of the scope of this paper, thus, we have opted by using an adapted version of Kudrowitz and Wallace's metrics (2013): novelty, usefulness and feasibility. These metrics enable an efficient evaluation of a large number of ideas, which are still at the stage of 'quick and dirty' sketches (instead of finished products).

Fluency is defined as the quantity of comprehensive and non-redundant ideas generated in a specific period of time. Although fluency was not included in the original set of metrics suggested by Kudrowitz and Wallace (2013), their own results support its integration, as they concluded that the prolific creation of ideas is highly correlated with creativity. Contrary to the other metrics, fluency was counted by the authors, who eliminated any idea that was insufficiently clear. To enable comparison between metrics, fluency was computed into a 1 to 5 scale, where 1 was attributed to the participant with the least amount of ideas and 5 to the most prolific participant.

As previously mentioned, novelty was divided into two metrics, as we consider that both originality and rarity bring different elements into the evaluation of a novel idea. Originality concerns how new an idea is, in the world's context. Rarity concerns how rare an idea is, in the context of the idea pool generated by the participants in the present study. Their measurements are also different: Originality was rated on a scale of 1 to 5, where 1 describes an already existing and common idea and 5 represents a very original idea, never seen before. Conversely, rarity was evaluated by assessing the statistical infrequency of each idea. A rare idea would be a solution created only once by one participant, while a non-rare idea re-occurred many times by different participants. Using the occurrence of ideas, it was possible to compute rarity into a 1 to 5 scale, to compare with the other metrics. Thus, 1 refers to common and repeated solutions, while 5 describes unique ideas.

Usefulness, also referred as relevance (Dean et al., 2006), expresses how well does the idea solve the problem, in terms of practical implications. To be creative, an idea cannot only be novel, but it also needs to have value and purpose. Usefulness was rated on a 1 to 5 scale, where 1 indicates an idea that does not solve the problem, and 5 represents a useful and valuable idea.

Feasibility refers to the degree to which an idea is feasible, i.e., possible to manufacture and implement. Considering that the participants had only 20 minutes to generate ideas, their solutions were usually not extensively elaborated. Nevertheless, feasibility is an important element to assess how creative an idea is, as a creative solution needs to be novel, beneficial but also to be possible to realize considering existing constraints. Feasibility was rated on a 1 to 5 scale, where 1 was attributed to unfeasible ideas, and 5 was given to easily implementable and manufactured ideas.

Together, the function of these metrics enables the calculation of an overall creativity score for each idea, using the following formula:

Creativity score = Fluency x Novelty (Originality x Rarity) x Usefulness x Feasibility

3.3.1 Inter-rater agreements of the metrics

There was no inter-rater reliability computed for Fluency and Rarity. Instead, these two metrics were counted or assessed by three judges (the authors), as these were the only metrics that were not possible to evaluate using a 5-point Likert scale. Regarding Rarity, one judge initially categorized the ideas in terms of similarity, grouping ideas on how they solved the design problem. Subsequently, the two other judges went through the categories to verify and refine them, if needed.

Originality, Usefulness and Feasibility were judged by two external judges. Pearson's Correlation Coefficient was computed, in order to test the inter-rater agreement. Both Originality and Feasibility scales showed a strong and significant correlation effect ($r = .547$, $N = 626$, $p < .001$ and $r = .708$, $N = 626$, $p < .001$), which indicates that the judges achieved a good agreement. On the other hand, the Usefulness scale obtained a moderate, yet significant correlation effect ($r = .448$, $N = 626$, $p < .001$).

4 RESULTS

4.1 Comparison between the three conditions

Table 1: the descriptive data shows the differences in means and standard deviation across the three conditions. The overall Creativity score is a function of all the other metrics.

	Fluency		Rarity		Originality		Usefulness		Feasibility		Creativity	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Control condition	2.13	0.83	3.87	0.70	2.26	0.47	3.70	0.40	4.41	0.59	299	145
Math condition	3.01	1.14	3.85	0.42	2.40	0.32	3.90	0.40	4.45	0.33	481	202
Storytelling condition	2.51	0.81	3.86	0.47	2.55	0.44	3.77	0.26	4.36	0.38	401	151

The results of the three conditions were compared statistically, using mainly the Analysis of Variance (ANOVA) test. Table 1 shows an overview of the main descriptive data comparison across the three conditions. In total, there were 626 ideas generated across all conditions (M=13.9). The control condition had an average of 11.9 ideas, the math condition of 16.5 and the storytelling of 13.3 ideas.

According to the Kolmogorov-Smirnov (K-S) test, the results did not significantly deviate from normal. Also, Levene's test showed that the variances within the data were not significantly different.

In terms of Fluency, there was a significant difference between the conditions ($F(2,42) = 3.28$, $p = .047$). In fact, Fluency of the Math task condition was significantly higher than that of the control (Mdiff = .88, 95% CI [.02, 1.73], $p = .043$).

Similarly, the ANOVA test demonstrated that there was a significant effect between the conditions on the overall Creativity score ($F(2,42) = 4.39$, $p = .019$). Post-hoc tests showed again that the Math condition had a higher Creativity score than the control condition (Mdiff = 181.27, 95% CI [28.36, 334.18], $p = .015$). These significant differences between math and control group indicate that the math task was able to induce incubation effects, on Fluency and Creativity, when compared with the control. No significant differences were found between the storytelling condition and the others.

4.2 Influence of the intervening tasks

In order to investigate the influence of the intervening tasks in the two experimental conditions, ideas created before and after the tasks were analysed using paired sample t-tests.

In the math condition, regarding Originality, the ideas created before (M=2.25, SD=.42) differed significantly from the ideas produced after the math task (M=2.57, SD=.40), $t(14)=-2.80$, $p=.014$. The t-test indicated that, for the storytelling condition, there was a significant difference on originality before the storytelling task (M = 2.22, SD = 0.46) and after (M=2.89, SD=0.55), $t(14)=-4.99$, $p<0.001$.

Concerning rarity, there was a marginally significant difference between the ideas produced before (M=3.69, SD=0.48) and after the math task (M=4.07, SD=0.16), $t(14)=-2.09$, $p=.055$. The storytelling task did not significantly influence the rarity of ideas.

In terms of feasibility, there was a significant difference between the period before (M=4.36, SD=.25) and after the storytelling task (M=3.98, SD=.40), ($t(14)=3.82$, $p=.002$), which indicates that feasibility decreased significantly after the storytelling task. No differences were found in the math condition regarding feasibility. Fluency, Usefulness and overall Creativity did not differ after the tasks.

Table 2: means of the sub creativity scores from before and after the intervening tasks. Paired sample t-tests show that both tasks influenced Originality, Feasibility and Rarity.

		Fluency		Rarity		Originality		Usefulness		Feasibility		Creativity	
		Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Math condition	Mean	3.06	2.77	3.69	4.07	2.25	2.57	3.92	3.87	4.31	4.12	435.13	444.00
	S.D.	1.15	1,18	0.48	0.61	0.42	0.40	0.30	0.49	0.37	0.31	201.37	174.63
Storytelling condition	Mean	2.43	2.19	3.77	3.94	2.22	2.89	3.85	3.77	4.36	3.98	344.67	357.27
	S.D.	0.22	0.17	0.53	0.68	0.46	0.55	0.28	0.34	0.25	0.40	157.35	108.90

4.3 Relationship between the storytelling condition's outcome and ideas' sources

Furthermore, we investigated how the storytelling task and Rory's Story cubes influenced the generation of ideas, specifically on that condition. The pictograms on RSC could also be understood as stimuli and we were interested in understanding how they were integrated in the ideas. The ideas after the storytelling task were examined in three dimensions: *the source of the idea*, *the level of relatedness between ideas and source*, and *the way stimuli were used in each idea*. To examine these dimensions, participants' stories were recorded and photographs were taken of the RSC in the order they appeared in their story. Examination of the ideas produced after the storytelling task showed that they could be influenced by three sources: by the pictograms on RSC; by the story each participant came up with; or by the combination of both sources. It was also possible to observe that ideas differed in terms of relatedness with the source. Thus, we rated the relatedness between idea and its source in a scale of 1 to 3, in which 1 represents ideas that were distantly related and 3 refers to ideas closely related to the source. To rate the relatedness level, we considered form, function or principle of the stimuli, but it was possible that participants used more than one dimension when integrating the stimuli on the ideas.

From the 95 ideas created after the storytelling task, 40 were noticeably influenced by the cubes' images (42.1%). From these, six ideas seem to have been influenced solely by RSC' pictograms, where participants generated ideas using the images as stimuli, as illustrated in figure 3. Participant A obtained a light bulb pictogram from the RSC, which was later used in one of the ideas. In his story, however, participant A interpreted the light bulb to indicate an "eureka" moment, without mentioning a light bulb. Thus, it was possible to identify the RSC' pictogram as the source of his idea. 14 ideas were derived solely from the participants' interpretation of RSC pictograms and integration in their stories. An example of an idea using the story as the main source is shown in figure 3, participant B. Although there was no rabbit in the RSC' pictograms, the participant used a rabbit as main character in her story, which was integrated as one idea during the second idea generation phase.

20 ideas were influenced by both sources: RSC' pictograms and stories. In figure 3, participant C's idea shows a tepee (conical tent), which is present on one of the RSC' dice and also occurred in his story (as a tent). We could conclude that the idea was influenced by both RSC and story.

In order to analyse in how far the different sources did have an impact on the ideas produced, we compared all sub creativity scores across possible sources (dice pictograms, stories or combination of both). An ANOVA test showed that there was a significant effect of the source of ideas only on Feasibility ($F(3,91)=2.66$, $p=.053$). Bonferroni's post hoc test revealed that ideas that were not influenced by either story or dice did have a significant higher Feasibility score compared to ideas that were influenced by the story (Mdiff = -0.09, 95% CI [0.01, 1.63], $p = .044$).

In the storytelling condition, the use of sources was obvious in some of the ideas, but the relatedness level was less noticeable in others. As previously mentioned, the influenced ideas could have different levels of relation with the source they derived from. In figure 3, ideas from participant A and B show examples of ideas in level 3, which are closely related to the source. Participant C's idea is a representation of ideas that fall into level 2, a mid-point relatedness. On the other hand, participant D's idea is an example of the less obvious relatedness, which was rated with 1. The average of the level of relatedness of all the influenced ideas was 1.7, in a 3-point scale. Consequently, this seems to suggest that it was easier to create ideas closely related to the source, as 18 of the influenced ideas were closely related, 16 were related at a medium point and only 6 were distantly related.

From the 40 ideas influenced by the storytelling task, it was also possible to discriminate different ways in which the stimuli were used. In 12 ideas, form was the main element to take from stimuli as inspiration, as it is displayed in participant C' idea (figure 3). Participant C used the image of a tepee to represent his idea – to wake up by wild surrounding sounds.

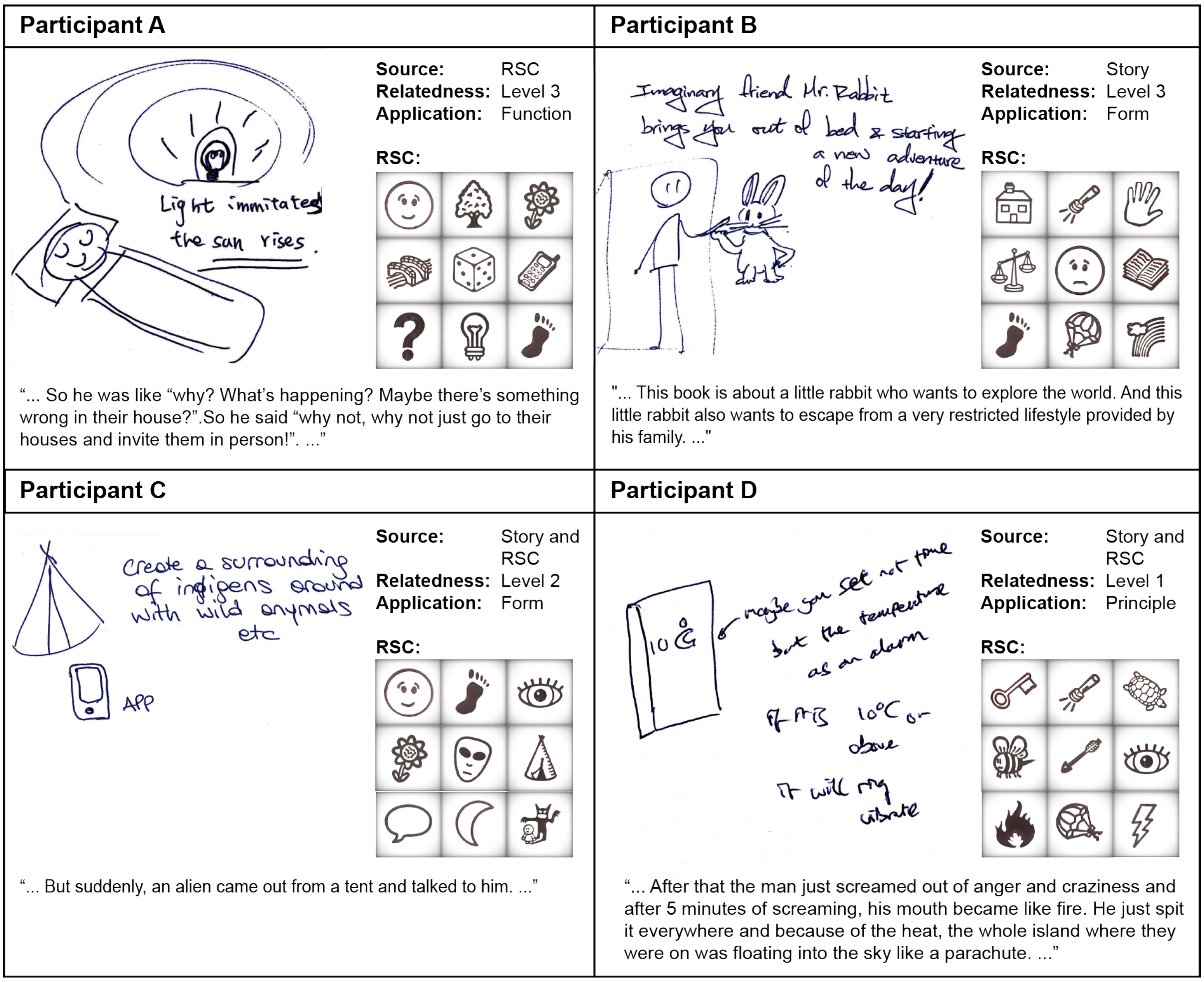

Figure 3: Examples of ideas generated after the storytelling task

In 17 ideas, participants retrieved inspiration from the function depicted in the dice. As it is illustrated in figure 3, participant C employed the function of a light bulb in his idea and used it to produce light to wake a person up. Finally, participants of the storytelling condition used also principles, which occurred in 18 ideas. An example of an idea using a principle is depicted in figure 3, participant D. One of the pictograms showed 'fire', and the participant used its principle in his idea, where he employed temperature (and not fire) as the solution to awaken someone.

5 DISCUSSION AND CONCLUSIONS

The purpose of this study was to investigate the role of two types of intervening tasks, as breaks to induce incubation effects. We analysed the influence of interrupting an idea generation session with a well-structured problem, such as a math task and an ill-structured problem, a storytelling task. Our results indicate that, when compared to the control condition, the math task was able to induce incubation effects, which positively influenced the creativity of the ideas produced, especially in terms of Fluency and overall Creativity score. When directly comparing ideas resulting from before and after the intervening task, the math condition participants also showed improvement on Originality and, to some extent, on Rarity. The math task, a well-structured problem, was completely unrelated to the creative problem at hand and it seemed to provide the participants with an occasion to recover from fatigue and to approach the problem differently (Ellwood et al., 2009; Smith and Blankenship, 1991).
On the other hand, the storytelling task was not able to induce incubation effects when compared to the other conditions. These results indicate that, in order to promote incubation effects, a switch

between different ill-structured tasks might not be the most appropriate strategy to have a burst of creative ideas. For this, it is preferable to move from the creative task to well-structured problems.

Nevertheless, swapping between creative tasks, such as idea generation and storytelling can have its advantages. When compared to the ideas produced before the incubation period, the storytelling task contributed to the generation of more original ideas, but which were also less feasible. Particularly, retrieving inspiration from the storytelling seemed to have a detrimental effect on Feasibility. Some participants from the storytelling condition, who considered their own stories as stimuli, created less feasible solutions than participants who did not use them as stimuli. Force fitting is a common method in creative facilitation sessions, where stimuli from apparent unrelated sources are forced to integrate new ideas, which can result in unexpected creative insights (van Boeijen et al., 2013). However, in this case, force fitting the stories as stimuli could have contributed to the generation of more original solutions but significantly deteriorate their feasibility. These results indicate that, especially in an initial idea generation period and during brainstorm sessions, when there should be a suspension of disbelief, the creation of stories with the Rory's Story Cubes might be beneficial for the generation of original ideas. However, for later phases of the design process, when creative solutions need to be both original and feasible, the integration of RSC as creative tool can cause undesirable effects.

We were also interested in whether the RSC dice were able to influence the creation of ideas in the storytelling condition. It was possible to observe that the pictograms on the dice and the stories influenced the ideas produced by the storytelling condition, which supports, to some extent, the prepared-mind perspective (Seifert et al., 1995). These authors proposed the opportunistic assimilation hypothesis to explain how incubation effects occur. This hypothesis assumes that insight can be reached when the mind is prepared to opportunistically process information in a new way. The storytelling task provided not only a distraction but also possible stimulation. After encountering new stimuli provided by the storytelling task, participants were able to transfer it to the second idea generation phase. However, most of the transfers between stimuli and solutions might have been too direct and did not involve transformation, only transfer between source and target (Goldschmidt, 2001). Therefore, although new information was used opportunistically after the task, incubation effects were not reached in the storytelling condition.

5.1 Limitation and future research

There are some limitations, which call for caution when interpreting the results. Firstly, the experiment was done in English. Although the researchers, judges, and all participants could speak English fluently, none had English as native language. This could have led to misunderstandings and misinterpretations of the ideas and stories during the experiment. Secondly, Kaplan and Davidson (1989) suggested that a ratio between 'the time the main task takes before the intervening task' and 'the time the intervening task takes results' is important. Moreover, a meta-analysis done by Sio and Ormerod (2009) indicated that a longer initial idea generation period could produce larger incubation effects. In our case, both creative sessions lasted 10 minutes each. Although there is no agreement on the ideal length of incubation, in this research our incubation period lasted only three minutes and it might have not been enough to induce incubation in both experimental conditions. Thus, more research is needed to investigate further on how different lengths of time may influence incubation effects and creative output. Finally, the focus of this research was on the type of problem used as intervening task. Only two types of problems were chosen, as they were diametrically opposed and enabled a clear distinction. However, future research could be implemented to explore other dimensions, which might be influential to induce incubation effects in design creativity (e.g., other types of problems or social versus individual activity as intervening tasks).

5.2 Practical Implications

Knowledge on how to effectively generate ideas and stimulate creativity is important in the design domain. This research contributes to the existing body of knowledge on incubation effects and demonstrates the influence of using different types of problems as intervening tasks on creativity. Our study reveals that, in order to continue generating creative ideas, it is beneficial for designers to take breaks and, preferably, take part of tasks that are not ill-structured. We do not claim that designers should interrupt their work to do math equations in order to produce creative results. Instead, we suggest that, considering the positive effect on switching between different types of problems,

professional designers could implement this knowledge and plan their activities in order to achieve higher creative results, without losing efficiency.
Furthermore, when searching for inspiration in an initial phase of the design process, where ideas do not need to be feasible yet, it can be useful to use Rory's Story Cubes, to compose a short story or use the dice as random stimuli. When mastering this tool, original ideas might be achieved, at the expense of their feasibility. Therefore, caution should be employed when using RSC as a creative tool in the design field.

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