

HOW FAR IS TOO FAR? USING DIFFERENT ABSTRACTION LEVELS IN TEXTUAL AND VISUAL STIMULI

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1. Introduction

A successful design is the result of a variety of circumstances and factors that are brought together at different stages of the design process. One of the most important elements that determines how thriving a design solution might be lies on its creativeness. Producing creative ideas is, therefore, an essential preliminary phase to the implementation of innovative design outcomes. However, generating successful design solutions is very difficult and there seems to be no recipes for how to arrive at a creative solution. That raises an important question: what influences the generation of a good idea?

A good idea is invariably creative and it should serve to reach to an intended goal. Therefore, a good idea must be novel in some respect and appropriate to solve the problem at hand [Finke 1990]. Novelty alone will not result in creative ideas, usefulness has to be an integral part of the final result.

It is known that all new knowledge is based on existing one. Hence, new and creative design ideas are firmly embedded in previous information, which has been combined, restructured and modified.

In order to produce creative solutions, designers rely primarily on their knowledge and experiences. When presented with a problem, designers will explore the solution space in order to find a suitable design. However, often the existing solution space does not contain a direct answer to the problem at hand, requiring this to be extended and manipulated. Other situations even call for an exploration and alteration of not only the solution, but also the problem space. For those moments, searching for inspiration is often the most immediate approach. Inspiration sources are ubiquitous, as anything can become a catalyst for an idea. In this sense, designers continually 'build' databases of inspiration sources that they keep throughout their careers in physical and mental collections.

Although the range of possible sources of inspiration vary in all sorts of representation modes, designers mainly search for pictorial stimuli, often not exploring other sources, such as three-dimensional or textual stimuli. Consequently, it is generally accepted that designers are seen as visualizers [Mednick 1962], for their aptitude in manipulating images. It is clear why there is such a higher preference for using pictorial stimuli. Visualising accelerates the translation between different perceptual modalities and enables the sharing of knowledge [Malaga 2000]. However, it is still not clear what type of value other kinds of stimuli, such as textual, may offer. Goldschmidt and Sever [2010] analysed the role of textual stimuli and described the positive influence of using text as inspiration in a design task, when compared with a condition that did not receive any stimuli. The originality of the devised ideas was higher when presented with text, although the same did not happen in terms of practicality. There is still little knowledge on the influence of texts as stimuli, specifically regarding how the information might be perceived by designers during idea generation. Therefore, one interesting question is: How far do texts, entailing different levels of abstraction, may influence designers during idea generation, when compared to pictorial stimuli?

In order to answer this question, we conducted an experimental study to investigate the influence of pictorial and written stimuli with varying levels of abstraction. The remaining parts of the paper are organised as follows. Section 2 will provide a brief overview on the influence of pictorial and written stimuli during idea generation. Sections 3, 4 and 5 will present the set up and results of the empirical study, respectively. The paper goes on to discuss the results of the study in Section 6, finalising with concluding remarks in Section 7.

2. Pitfalls and virtues of the use of visual and textual stimuli in idea generation

Generally speaking, the use of stimuli during creative problem solving generates better results than the complete exclusion of information [Howard et al. 2011], [Goldschmidt and Sever 2010]. However, the outcome is not always positive. The misuse of existing information, in any form or content, can arouse undesired effects instead of being inspirational. In fact, empirical research has demonstrated the dual-effect reaction towards examples, which can result in creative outcome or, on the contrary, in non-creative outcome (e.g. [Jansson and Smith 1991]).

Concerning the use of images, one of the most researched unproductive activities caused by precedent examples is design fixation. This is considered an unconscious tendency to reuse parts or principles of previously seen examples during idea generation, by disregarding its appropriateness [Jansson and Smith 1991], [Cardoso and Badke-Schaub 2009]. The repetition of specific attributes of a given example could hinder the development of alternative solutions. In one of the first studies on design fixation, Jansson and Smith [1991] asked designers (from a mechanical engineering background) to generate new concepts for three ill-defined problems (a car-mounted bicycle rack, a measuring cup for blind people and a disposable spill-proof cup). When presented with exemplar solutions for each exercise, participants tended to conform to parts or principles of the given images, even though they were asked to avoid their design faults.

On the other hand, text may be also considered as having potential drawbacks on creativity. Malaga [2000] explored the impact of textual, visual or textual-visual stimuli combination during creative problem solving (in the design of ice cream flavours). In such study, visual stimuli (either alone or in combination with text) triggered more successful creations than the single use of text. Based on these results, Malaga [2000] speculated that textual stimuli were conducive to functional fixedness - i.e. a variation of design fixation, whereby people can only conceive of an object's primary use and not alternatives ones.

A contrasting result was demonstrated by Cardoso and Badke-Schaub [2009] in a study investigating the relation between the use of pictorial and written stimuli and the occurrence of design fixation. The participants received an ill-defined problem (how to retrieve a book from a high shelf) and two different representations of an example solution. Whilst some participants received a pictorial representation of the example, others were presented a written description of the same object portrayed in the image version. Their results showed that the participants who received the pictorial example repeated many of the priming example attributes, leading to design fixation, which did not happen in the written condition.

This short overview illustrates the ambiguous knowledge that still exists around the influence of text and image stimuli in idea generation. The same type of representation stimulus has the potential to both inspire and constrain design creativity. Thus, to stimulate creativity, it is important to know which type of information should be used and how should it be manipulated. Ultimately, the message conveyed by the stimulus may have a higher importance for design creativity other than whether this stimulus comes in form of an image or a text.

2.1 Turning stimuli into analogies

It is defended that designers make extensive use of pictorial representations, as imagery reasoning is a natural complement to visual and three-dimensional creations. In this sense, visual representations have the potential to facilitate information retrieval, but even more important, to work as a catalyst for the generation of analogies. In turn, analogies enhance one's potential to go beyond current solutions and explore alternative paths. Therefore, analogical reasoning is often applied in design as an approach when trying to generate creative and innovative outcomes.

In the case of visual analogies, mental visual imagery is the responsible cognitive mechanism for the creation of analogies. In this similarity-based reasoning, images are seen as source analogs to trigger ideas to be transferred into the target situation. However, analogies require more than the simply retrieval and transfer of ideas from memory. It is necessary to identify the source and map a possible rough solution according to the target. Only then, there is a transfer but the process is not successful until there is a transformation into new knowledge.

There are different types of analogies, which can be classified according to depth (surface and deep analogies), according to distance (within-domain and between-analogies), or according to result (case-driven and schema-driven analogies).

Regarding the use of different levels of abstraction as source analogs, Casakin and Goldschmidt [1999] developed a study that explored the value of visual analogy in improving design problem solving. They demonstrated that the explicit instruction to use analogies had a positive influence in the quality of the design solutions, particularly in the case of novices. Moreover, these authors revealed the differences between the use of deep and surface analogies, using a variety of within and between-domain images. When designers were able to establish deeper similarities between the stimulus (in this case, images that belonged to remote domains) and the brief, they tended to have a better performance. On the other hand, designers who could not establish any relationship between the images and the target problem followed the tendency to apply surface similarities. Invariably, these led to poor results in terms of design quality. Consequently, it has been argued that between-domain stimuli have the potential to be beneficial to design, when compared to within domain examples.

Contrary to this perspective, Howard, Culley and Dekoninck [Howard et al. 2011] proposed that the influence of stimuli from within the industrial domain of the task at hand would be beneficial for the generation of creative ideas. Their argument was that highly relevant stimuli would stimulate more ideas and, specifically, more appropriate ideas.

Observing the divergence of opposing perspectives about this subject, it is still not clear which abstraction level is the most desired for the development of analogical reasoning in design. Despite the preference designers manifest regarding the use of competitor products and design related stimuli as inspiration sources, are these the most appropriate stimuli for idea generation?

In addition to the aforementioned questions concerning the use of text as stimuli, it is important to assess the influence of different levels of abstraction. As between-domain stimuli can be advantageous to the exploration of creative solutions, when does the abstraction to the problem at hand become too remote and, potentially, not beneficial? In order to verify the influence of distant and unrelated stimuli (text and image) in idea generation, an empirical study was developed and is described in the following sections.

3. Experimental set-up

The experimental study here presented was conducted with the participation of 87 bachelor and master students from an industrial design engineering course. The participants were considered to be novice designers but with sufficient experience in idea generation processes to be able to complete a design task. All participants received the following design brief:

“Your task is to think about how human transportation will be in 2050. You are kindly asked to draw as many different ideas as you can in 45 minutes”.

This design brief was chosen because it was believed to enable the generation of creative ideas without being particularly attached to current examples of human transportation. The participants were also asked to take into account that their solution ideas should enable: the public transportation of at least ten people and a short and safe urban journey. Participants were also asked to clarify their ideas by complementing their drawings with short written sentences or keywords.

To explore the influence of different types of stimuli, we implemented five experimental conditions:

1. Control condition (n=18): this group did not have access to any given stimuli apart from the design brief.
2. Pictorial distant source analog condition (n=20): this group was presented with a visual stimulus representing a cyclone. The cyclone was chosen because it was considered to be

distantly related with the topic of transportation: it conveys the notion of transport, in this case, of air and debris.

3. Verbal distant source analog condition (n=20): this group was presented with a verbal stimulus, which contained an excerpt from 'The Wizard of Oz' describing the main character, Dorothy, being lifted by a cyclone while inside her house:

"Then a strange thing happened. Dorothy felt as if she were going up. The north and south winds met and made it the exact centre of the cyclone. In the middle of a cyclone the air is generally still, but the great pressure of the wind on every side raised it up higher and higher, until it was at the very top of the cyclone; and there it remained and was carried miles and miles away as easily as you could carry a feather."

4. Pictorial unrelated stimulus condition (n=19): these participants received a visual stimulus, which was unrelated with the design brief. This stimulus – picture of a mirage, was chosen randomly (although it had an intentional connection with the representation of the cyclone, by being a weather phenomenon).

5. Verbal unrelated stimulus condition (n=20): this group was given a textual description of a mirage: *"A mirage or fata morgana occurs when two layers of air of different temperatures meet. The basic, or inferior mirage of the sort we see in summer on the roads, arises when the cold air above begins to warm as the heat rises from the hot road surface. This causes the boundary where the layers meet to appear to shimmer like water when viewed from a certain angle. This is due to light refraction, or bending really, and instead of seeing the road, we see the reflection of the blue sky which appears like water."*

All five experimental conditions had the stimulus embedded within the design brief in manner that was clearly presented but not imposed (the participants were not told they had to use it). Each pair of pictorial and text conditions was aimed to carry similar semantic meanings, although we acknowledge that a complete clear distinction would be difficult to attain. Besides the design brief, the participants were asked to answer a pre- and post-questionnaire. The former collected information on the participants' age, gender, education and perception on their own design skills. The latter intended to find out, in a retrospective manner, if and how the participants' might have used the stimulus presented to them.

4. Data analysis

The totality of drawings produced was assessed by two independent expert judges in terms of fluency (number of ideas generated), flexibility (number of different idea categories devised) and originality (the degree to which an idea is novel and uncommon).

Fluency is defined as the total number of understandable and meaningful devised ideas and is based on Guilford's [1950] basic elements of divergent thinking (fluency, flexibility, originality and elaboration). The ability of producing a high amount of ideas obviously does not translate directly into creative outcomes but it is highly appreciated specially during the idea generation phase. A large amount of ideas represents a higher probability to combine and restructure information, in order to converge to the elaboration of a final solution. In this study, the participants were asked to enumerate each idea to avoid uncertainty and explain it through keywords. The rating of fluency was done by counting the number of ideas that were sufficiently clear to be assessed in terms of the function of the solution.

Flexibility is referred as an elemental part of any creative outcome, and even one of the crucial elements responsible for creative thinking [Chakrabarti 2006]. This measure is extremely useful in earlier phases of the design process, when a divergent and exploratory attitude is desired, followed by a later convergent phase. For instance, a higher flexibility would be useful for ideation methods, such as Brainstorming and How to's, where it is important to expand the solution space (and even the problem space) and create multiple alternatives. However, being flexible in terms of categories of ideas is not enough for a person to be creative. This is why other elements are important to take into consideration to assess any creative solution (such as originality and elaboration). Hence, flexibility refers to the ability to switch between different domains [Guiford 1950]. A more flexible behaviour is characterized by a more opportunistic strategy, in which different domains are explored in order to

increase the likelihood of improving the creative result. All the participants' drawings were subsequently assessed and clustered into four main categorical approaches, each one divided in turn into additional sub-categories, making a total of 16 possible classifications (Table 1).

Table 1. Flexibility categories

Type of entity			Transport mode					Powered							
Single unit	Infra-structure	System	Terrestrial-above	Terrestrial-under	Aerial	Fluvial	Tele-transport	Human	Solar	Wind	Electrical	Fuel/gas	Nuclear	Mechanical	Animal

Each idea could fit in several categories (e.g., a car would be a *single-vehicle*, used above the *terrestrial surface*, and *powered by fuel/gas*). This categorization system was the base to analyse the flexibility of ideas in this study, which was measured in two ways:

1. Comparison of the frequencies of use of different kind of categories across the five experimental conditions.
2. Based on an approach used by Jansson and Smith [1991], flexibility was assessed by counting the number of completely different approaches to solve the design brief. Consequently, participants with higher flexibility would be the ones having a higher value in this measurement, as their ideas fall into different categories. Jansson and Smith's approach differs from ours. They counted the number of different approaches, but also divide them by the total number of ideas. This had as consequence that participants with a small number of ideas would tend to have more different approaches for each idea, whilst participants with a higher number of ideas would tend to repeat some categories ultimately presenting a smaller degree of flexibility. Considering this possible problem, flexibility was then assessed by simply counting the number of completely different approaches explored to solve the design brief.

According to Guilford's construct [Guilford 1950], original ideas are the ones that offer a novel and uncommon perspective from existing solutions. Originality is an essential aspect of creativity, as it is usefulness of an idea, both resulting in the overall value of a creation. In this study, originality was assessed by the statistical infrequency of each solution. If an idea was only produced once by the total number of participants, it was considered more original than an idea that was devised several times by different participants. From the 579 ideas generated in total by the five groups, only 80 original ideas were identified as original, whilst the remaining ones were reoccurrences of these. The maximum number of reoccurrence of an idea was 37 times, which established the lowest level of originality. Therefore, the originality scale used in this study ranged from 1 to 37. One (i.e., 1) represented the highest level of originality and 37 represented the lowest. Subsequently, and since participants generated different amount of ideas, we isolated the score of the most original idea per participant and this became the score used for the analysis. With this approach, we enable the possibility that participants were not consistently highly original throughout the exercise. Instead, participants might have used non-original ideas (common solutions for the problem at hand) as starting points to generate highly original ideas. Alternatively, once they arrived at an original idea where their goal was fulfilled, they might not have explored other possibilities. The approach used to assess originality in our study tries to cover these factors.

5. Results

For simplification of terms, henceforth the experimental group who received the textual distant source analog stimulus is referred as '*distant-text*' and the group with a visual distant source analog stimulus as '*distant-image*'. In the same way, the group who received the textual unrelated stimulus is indicated as '*unrelated-text*' and the one who used a visual unrelated stimulus as '*unrelated-image*'.

Non-parametric tests were used for the analysis of the results.

5.1 Fluency of ideas

The counting of ideas and a Kruskal-Wallis analysis of variance revealed that there was a significant difference between the different conditions ($H(4) = 10.88, p < .05$). The distant-text condition

produced the highest number of ideas (154), followed by the distant-image group (132) ideas. The least amount of ideas was attained by the unrelated-image condition (83).

To follow up these results, a Mann-Whitney was used and a Bonferroni correction was applied to adjust the *alpha*-value, to avoid its inflation with multiple comparisons. Therefore, all effects are reported at a .00625 level of significance. Eight comparisons were conducted: control and each of the experimental conditions; distant image and distant text; distant text and unrelated text; distant and unrelated image; and finally, between unrelated image and text. The results showed that the distant-image condition produced significantly more ideas than the unrelated-image ($U = 93.5, r = .06$).

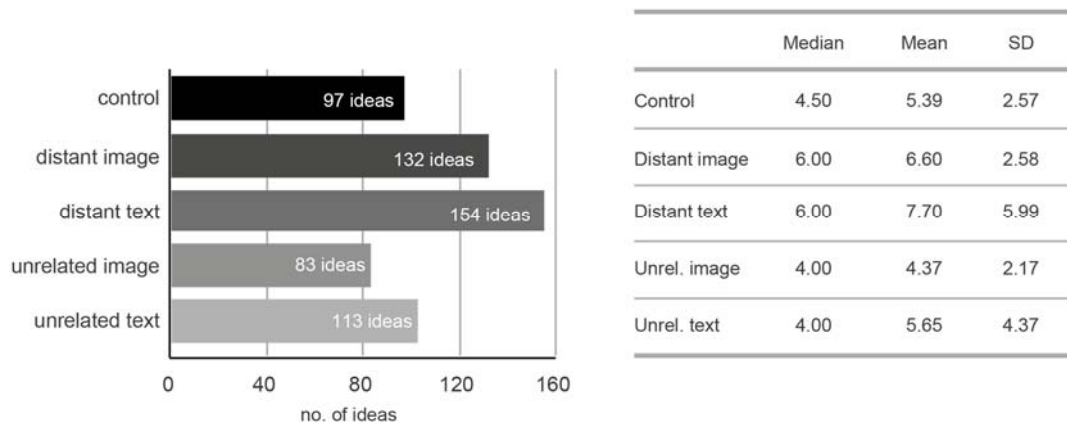


Figure 1. Total number of ideas produced by each group

5.2 Flexibility of ideas

As mentioned before, flexibility was assessed in two ways. Firstly, a comparison of the use of different categories was performed, in which we analysed how different the particular categories of ideas were. A Kruskal-Wallis test revealed that there were significant differences in the use of three sub-categories: Aerial transport mode ($H(4) = 13.83, p < .05$); Wind-powered ($H(4) = 13.12, p < .05$); and Mechanical-powered ($H(4) = 24.17, p < .001$). A Mann-Whitney with Bonferroni correction revealed that the distant-text condition (who were exposed to the ‘The Wizard of Oz’ excerpt) had significantly more ideas depicting aerial modes of transportation, when compared to the control group ($U = 61.5, r = .000$). Similarly, there were significantly more wind-powered vehicles generated by the distant-text group than by the control ($U = 89, r = .002$). Finally, there were significant differences in the creation of mechanical-powered ideas: participants in the distant-text group devised much more ideas within this category than the control group ($U = 99, r = .001$).

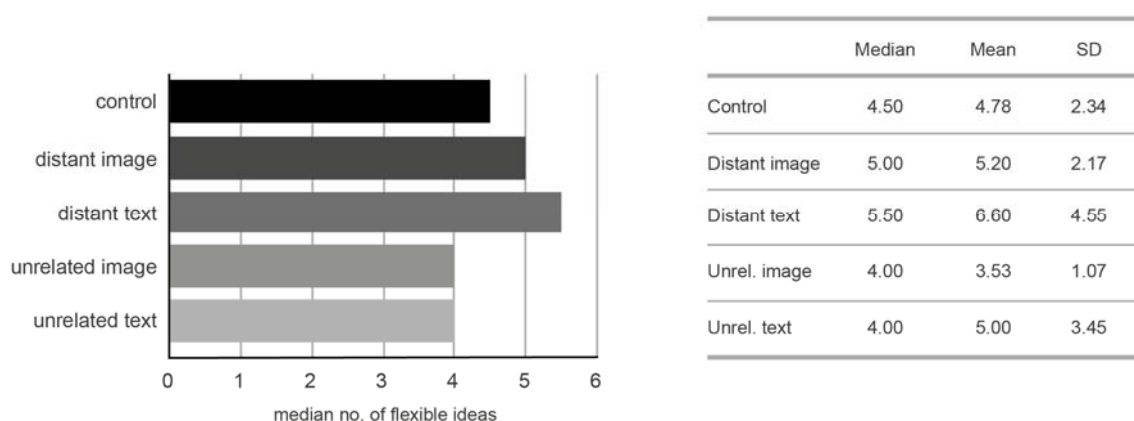


Figure 2. Overall flexibility medians across the five groups

Secondly, we were interested in understanding which were the conditions with overall higher and lower flexibility. In order to compare the flexibility measures obtained by each group, we counted the

number of ideas that followed different strategies to solve the problem. Each idea that fell in a different combination of the main categories was considered to be a different approach to the problem. If the same combination of categories was used in more than one idea per participant, these would not be counted. The total number of different ideas were analysed using a Kruskal-Wallis test, revealing that the flexibility between the five conditions were significantly different ($H(4) = 11.448, p < .05$).

As we can see in Figure 2, the condition with higher flexibility was the distant-text one, closely followed by the distant-image. The lowest flexibility values were attained by both unrelated-stimuli conditions, text and image. Subsequent analysis demonstrated that participants in the distant-image condition succeeded in having a significantly higher flexibility in their ideas than the unrelated-image ($U = 95.5, p = .006$).

5.3 Originality of ideas

A Kruskal-Wallis showed significant differences between the five conditions ($H(4) = 12.44, p < .05$). A subsequent Mann-Whitney analysis with Bonferroni correction revealed that the difference lied between the control and distant-text conditions ($U = 77, r = .002$), demonstrating that participants in the distant-text group generated more original ideas than the control (considering that a low median indicates high originality, as explained in Section 4). Moreover, a marginally significant difference was found between the distant-text and distant-image ($U = 113.5, r = .018$, considering the *alpha*-value correction), which indicates that the distant-text performed better in terms of originality than the distant-image condition.

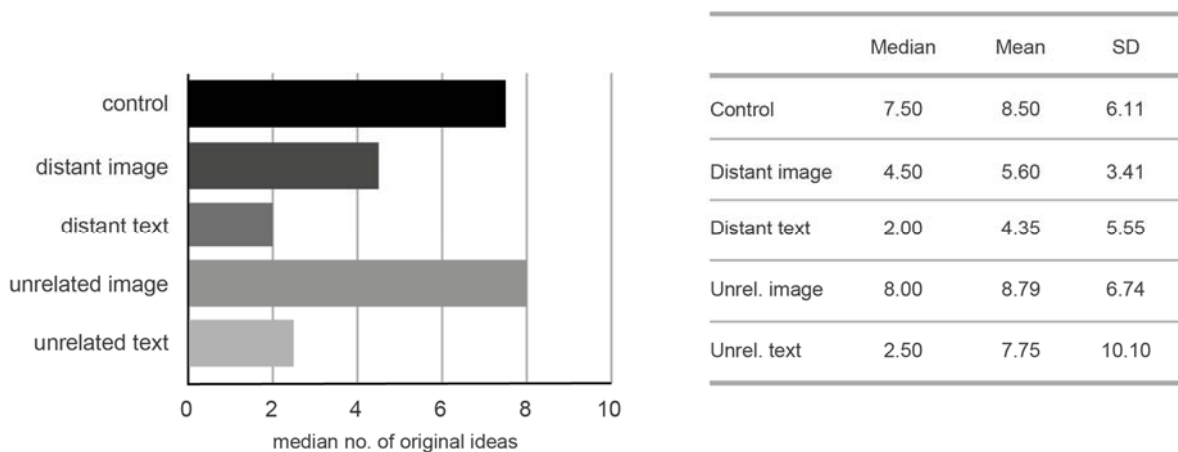


Figure 3. Originality scores medians across the five groups: on the figure on the left, ‘1’ represents a very original idea and ‘10’ not original at all

6. Discussion

6.1 Fluency of ideas

Numerically speaking, the condition which received the excerpt from ‘The Wizard of Oz’ (distant-text) produced more individual ideas than the: distant-image (i.e., 22 additional ideas); the unrelated-text (i.e., 41); the control group (i.e., 57); and, the unrelated-image (i.e., 71).

Previous research has claimed the predominance of visual representations in design. However, in our study, the distant-textual stimulus triggered the generation of a higher number of ideas, although not statistically significant. The fact that they had to read the excerpt and interpret it did not reduce the amount of time to produce ideas, when compared to the more intuitive interpretation of the image of the cyclone. Both visual and textual distant condition received a stimulus portraying the same idea: the cyclone. However, there were slight changes in how the idea was described: whilst the visual condition consisted of a realistic photograph of a cyclone, the textual condition entailed a fictional representation of a cyclone, embellished by the imagination of the writer. Therefore, the use of a fantasy novel excerpt may have an important influence in why the participants from this group were

able to produce more ideas. Nevertheless, the distant-image condition was also very successful in terms of triggering higher fluency. This group devised more ideas than the control group, which suggests that the presence of the stimulus inspired the participants of both distant-stimuli groups. The stimuli used were successful in being able to create a distance from the topic of transportation, without being too detached. Moreover, participants in the distant-image condition produced significantly more ideas than the unrelated-image ones, which indicates that the latter stimulus was 'far too distant'. In this case, the participants did not establish a viable connection between the stimulus and the problem situation, which could explain the reduced number of ideas created. In the case of the unrelated-text condition, participants generated a higher number of ideas in relation to the unrelated-visual and control groups. This may reveal that the textual representation of a mirage had the potential to trigger the generation of a higher number of ideas, when compared with its visual representation. Nevertheless, the unrelated stimuli used in these two conditions may have been 'inaccessible', due to the distance between source and target problem. Instead of inspiring the generation of more ideas, the stimuli may have obstructed the creation process and limited fluency (when compared with the distant stimuli, both visual and textual).

6.2 Flexibility of ideas

As we saw in Section 5.2, there were interesting differences in the use of specific categories across the different experimental conditions. In light of the types of stimulus presented to the pictorial and text conditions, we expected that both groups would have a high number of ideas in the categories of *aerial transportation* and the use of *wind-powered vehicles*. Nonetheless, the distant-text group had numerically more ideas connected with air than any other group. The text group's higher frequency of use of both *aerial transportation* and *wind-powered energy* could be related to two aspects. On the one hand, it could be related to a principle called *recency effect* – i.e. a tendency people have to recall and give more importance to the last perceived items, for example the last words in a text. In this case, the word *carry* and *carried* in the text excerpt, which refers to the transportation of the character in the novel (i.e. Dorothy), showed up in the last sentence of the distant-text stimulus. On the other hand, the whole excerpt describes in a somewhat literary manner the physical elevation and transportation of a person. The distant-image stimulus, though, was only depicting in a very realistic manner a natural phenomenon. Hence, this stimulus was not necessarily conveying the idea that it could serve to carry people around. Therefore, the text stimulus seemed to have prompted its participants to establish possible analogies with the future human transportation problem. Conversely, the distant-image stimulus did not trigger the establishment of analogical connections between the possible source and target situation.

In fact, through the post-questionnaire analysis we found out that some participants from the distant-image group did not consider the image of the cyclone, nor did they understand the possible connection between the task/brief and stimulus. One of the participants reported: "I don't know what it should have to influence. It's not relevant or inspiring to me, it's just a photo".

Still, the distant-image group had more aerial transportation ideas than the control group and the unrelated groups, which indicates that the pictorial example also inspired some participants in that sense. One of them observed: "It puzzled me a bit as to how I could apply it. I only took it along the air in my ideas". As expected, participants of the distant-text group reported much more of the use of the given stimulus in their designs and the potential role to expand creativity: "I did not have to read it but when I did not have more ideas, it helped me".

Regarding the creation of mechanical-powered vehicles, the distant-text group developed much more ideas within this category than the other groups (significantly more than the control and distant-image). Curiously, this category refers almost exclusively to ideas depicting a catapult, in which people would be 'thrown' from point A to point B. Once again, the given textual stimulus in the distant-text enabled the participants to go beyond the cyclone itself and explore other possible categories, but still, somehow, related to air transportation. The distant-visual stimulus, despite to some extent depicting the same natural phenomenon, did not trigger the participants to develop other transportation solutions that explored the terrestrial and air space, such as catapults, for instance.

Comparing the overall flexibility values across the different experimental conditions, also here the distant-text group had the more flexible ideas, closely followed by the distant-image. Both distant-stimuli conditions developed ideas that fell in different combination of categories, which shows that these two conditions particularly explored the solution space. They were able to switch between several domains and had a better overview of the possible solutions for the given problem. On the other hand, the unrelated-image and -text had the lowest scores in flexibility. This may indicate that the stimuli given in the unrelated conditions may have been too remote or unclear to stimulate the participants to explore other categories. Although abstract stimuli can have the potential to expand how one tackles a problem, these stimuli went too far and did not lead the participants to explore other alternatives. In the specific case of the unrelated-image, the distant stimuli conditions managed to have a significant higher flexibility of ideas than the unrelated-image. The unrelated image used as stimulus did not provide the participants with sufficient cues to incite the exploration of different categories and this may have been because of inconsistencies between the image of the mirage and the requirements of the brief. Whilst the image presented a deserted landscape, the brief asked for an urban concept and this created a contradiction. Interestingly, some of the participants from this condition reported in the post-questionnaire that this apparent conflict was beneficial, as it enabled the exploration of divergent fields, as one participant explained: “contradictions are interesting to tackle ideas”. On the other hand, this opinion was not unanimous and some participants reported not paying attention to the image, as it was considered irrelevant. One participant from the unrelated-image condition reported: “I cannot find a relationship between transportation and an isolated place”. Although this is not directly related to flexibility, it is possible that influenced the exploration of the solution space.

6.3 Originality of ideas

The distant-text condition obtained the highest score of originality, significantly more than the control and marginally more than the distant-image. Therefore, the exposure to a distantly related textual stimulus resulted in the generation of a higher number of unusual ideas, than when participants received no stimulus or a visual stimulus. These results help to corroborate the possible positive influence of textual stimuli in design, demonstrated in previous studies [Goldschmidt and Sever 2010]. On the other hand, the unrelated image group performed much poorer than any other condition, which shows that they mainly generated ideas that were reoccurring several times within this sample. Once more, the unrelated image stimulus used in this condition may have been too far and, thus, difficult to access, in order to promote the generation of original ideas.

7. Conclusions

Educators and researchers try to continually improve the education of future designers. This is mostly done by teaching them how to structure their process and how to apply design methods that may help them achieve their desired goals. However, novice designers need to learn by themselves how to generate creative ideas, as educators can only nudge their design process. Whilst the use of visual stimuli is intrinsic in design, textual stimuli can be helpful as well and should not be underestimated, as it can also provide creative stimulation.

Our research study has demonstrated, at least within the setup of this experiment, the possible positive outcome in using textual stimuli during idea generation (despite the typical hegemony of images as inspirational sources). Both textual stimuli from the distant and the unrelated condition utilised outperformed or matched their pictorial counterparts in terms of *fluency*, *flexibility* and *originality* of solution ideas generated. While we have no intention to claim that inspiration should not be provided by images, we argue that text stimuli can also be an inspiring source of creative design. However, an appropriate selection of the most useful inspiration must always be made: as images have the potential to stimulate and hamper creativity, texts – depending on the message conveyed and how it is interpreted – can produce a dual-effect on creativity.

Moreover, as texts are a more abstract type of representation, extracting inspiration from texts can be much more complex, as well as time-consuming, than using images. Designers are visualizers [Mednick 1962] and establishing relationships between pictorial stimuli and a design brief is definitely more straightforward than using textual stimuli. It is, thus, not surprising why professional designers

in industry pay so little attention to potential textual inspiration sources, in order to cope with time limitations. Nevertheless, it is important to encourage novices to recognize all kinds of stimuli and to learn how to appropriately choose them according to the task at hand, since the early years of their education.

Another interesting point that should be restated is the role of abstraction in the use of inspiration in design. The use of between domain or distant analogies in design can be considered as advantageous, as both stimulate the generation of creative ideas, even more when compared to within or close analogies. However, as the level of abstraction of a potential stimuli increases, the relation to the problem at hand becomes more vague, and hence there seems to be a limit to its use as stimulus. In this study, the experimental conditions with apparently unrelated stimuli to the design problem had lower scores in fluency and flexibility. With such unrelated stimuli, participants were unable to recognize the image and the text as stimuli and most of them did not use them at all. Therefore, we can assume that the choice of inspiration sources in design must have a balanced point, where a certain level of abstraction promotes the exploration of creativity, but provides sufficient cues to establish relationships between target and source.

Finally, it is important to consider the possible mismatch of meanings between the visual and textual stimuli. For instance, in the distant-text and distant-visual conditions, both stimuli depicted a cyclone but they may have been perceived differently. For one reason, images tend to offer precise and specific information, whilst texts are much more vague, enabling the exploration of multiple interpretations. In addition, the excerpt used for the distant-text condition was taken from a fictional book and may not fully represent the characteristics of a real cyclone. The image used as stimulus for the distant-visual condition depicted the actual phenomena, without any other symbolism attached to it. Being so easily accessed and direct may have worked against the use of images as stimulus, even though it depicted a possible distant analogy. Consequently, the textual stimulus, being abstract by nature and symbolic by meaning, left enough room for other interpretations and exploration of alternative ideas.

Further investigation on this topic is required, as it is important to continue to integrate also feasibility and other quality measurements of the ideas devised and its relation to flexibility, fluency and originality values here discussed. Producing a high amount of ideas that are flexible and original are important factors to consider when evaluating creativity, but they are not enough. One can generate plenty of ideas, all of them exploring different domains, and not be suitable to the design brief in question. Nevertheless, this study can provide another perspective for the research of the influence of inspirational sources in creative design.

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