FIND YOUR INSPIRATION: EXPLORING DIFFERENT LEVELS OF ABSTRACTION IN TEXTUAL STIMULI

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Abstract: The selection of inspirational sources is a crucial step while designing, which potentially can enhance creativity. However, empirical investigations have demonstrated a dual-effect that some stimuli might have during idea generation. Therefore, it is valid to discuss whether designers are disregarding other stimuli, such as textual representations. To test the impact of different textual stimuli during ideation phases, we exposed novice designers to three types of written stimuli, with different abstraction levels. The results demonstrate that participants exposed to distant textual stimuli tended to generate a higher number of more flexible and original ideas. The most 'appropriate' stimuli seem to be the ones that enabled the establishment of enough association links with the problem, yet keeping a sufficient level of abstraction for the exploration of creative ideas. Looking into alternative stimuli, with different levels of granularity, can potentially raise designers' awareness about the usefulness of other valuable inspirational sources.

Keywords: textual stimuli, abstraction levels, originality

1. Introduction

Research has continually demonstrated that designers' creative performance during idea generation is influenced by formerly acquired knowledge (Liikkanen and Perttula, 2006). Purcell and Gero (1992) described two main sources from where designers retrieve pertinent knowledge for their tasks. The first is knowledge resulting from everyday encounters, in a more serendipitous manner. The second, knowledge that arises from intentional learning, therefore structured and specific domain oriented. Both types of knowledge can play an important role in the design process. Under this perspective, the inclusion of specific stimuli can potentially influence the way one retrieves, interprets and transforms information. Ultimately, the exposure of stimuli during idea generation has the potential to prompt access to different associations and the exploration of creative ideas.

Inspiration has been defined as "the process that takes place when somebody sees or hears something that causes them to have exciting new ideas or makes them want to create something, especially in art,

music or literature" (Oxford Advanced Learner's Dictionary, 2000). This definition of inspiration can also be extended to design. In this case, a moment of inspiration during a complex problem-solving can bring a feeling of accomplishment and it can bring reassurance. However, finding the inspiration is not necessarily a straightforward procedure, as there is no certainty that an inspiration source will lead to a highly creative and successful outcome. To understand the nature of a problem, designers often search for similar solutions within the same domain, which helps them establishing a benchmark position of what has been done before and what could be improved. However, instead of being inspirational, these examples can result in restrictive frames of reference that will obstruct possible creative exploration. Therefore, external stimuli have both the potential to stimulate the generation of new ideas, as well as to anchor the reasoning process to existing solutions. Consequently, it is important to thoroughly investigate the influence of inspiration sources on idea generation.

In the search for new stimuli, designers prefer using visual representations (Gonçalves, Cardoso and Badke-Schaub, 2011). Conversely, textual stimuli, for instance, seem to generally be disregarded as a potential inspiration source. It is understandable that designers prefer to search for inspiration in visual stimuli. Designers are considered visualizers (Mednick, 1962), as they are generally highly competent in the use of images.

Whilst the extensive use of visual representations in design has been proven, it is still unclear whether equivalent textual counterparts could also prompt the generation of creative results. It is important to consider that any potential stimulus holds two important elements crucial to the creation of an appropriate stimulation: content - what the stimulus conveys; and representation - how the stimulus is shown (Sarkar and Chakrabarti, 2008). Consequently, it is important to investigate the possible impact of textual stimuli in design idea generation. The objective of our study was to understand the possible influence that textual stimuli, with different levels of abstraction, might place upon novice designers during an idea generation exercise.

1.1. The role of textual representations in design

Language plays important roles in our thinking process and, thus, it influences design (Mougenot and Watanabe, 2010). As source of inspiration, language can support the mental manipulation of abstract concepts and stimulate the creative process. Despite being a highly ordered system, language can offer enough ambiguity to stimulate the creative generation process and is potentially a valuable stimulus for design (e.g., Chiu and Shu, 2007 and 2012).

Nagai and Noguchi (2002) examined the role of keywords in the creative process, by using drawings to generate visual images for design solutions. According to their study, drawings are considered low-level information and abstract keywords (portraying feelings or intangible concepts) high-level information. In order to produce visual information from textual input, a higher level of abstraction may be required. This may contribute to the explanation of why so many designers prefer to work with visual stimuli instead of textual when generating ideas.

Goldschmidt and Sever (2010) have empirically shown the positive influence that text can have during idea generation when used as stimuli. They found that groups exposed to textual stimuli exhibited higher originality ratings, when compared with the control group. These results suggest that the use of textual stimuli can be potentially beneficial for inspiration in creative design idea generation.

1.2. The role of different levels of abstraction in design

Plucker and Beghetto (2004) argued that, for creativity to flourish, there must be a balance between domain general and domain specific knowledge. As they explained, people who tackle problems using

domain-general approaches may be constraining themselves to superficiality, without even coming near of the gist of the problem. Conversely, those that usually approach problems in a domain-specific manner may be shutting down the access to fresh and different perspectives. Consequently, although specific design knowledge is a valuable and indispensable asset in design problem-solving, other domains can complement the development of creative ideas.

In an experimental study in the area of software intensive systems, Zahner et al. (2010) developed an experimental study where they came across similar conclusions. The authors examined the role of concrete and abstract stimuli in fixation, during the development of new ideas. Their results indicated that a certain level of abstraction can be helpful in a divergent phase (but generally not in a convergent phase). Abstract stimuli contributed to the production of novel ideas but decreased their usefulness and fit to the problem, which indicates that a latter re-evaluation of the ideas is needed.

Regarding the use of general and specific design domain knowledge within the realm of analogies, Christensen and Schunn (2007) demonstrated that the use of within-domain exemplars can constrain creativity. When using design-related stimuli, designers used more within-domain than between-domain analogies, which resulted in a smaller exploration of different alternatives. Conversely, the ambiguity offered by between-domain exemplars led to the expansion of more diverse solutions. Therefore, we set out to investigate the role of different levels of textual abstraction, potentially used as inspiration stimuli during an idea generation exercise.

2. Experimental set up

We performed a study with 68 novice designers, bachelor and master students from an industrial design-engineering course. The participants were asked to carry out an idea generation exercise. All participants received the following design brief:

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

The design brief provided was intended to enable the generation of diverse ideas without being particularly attached to current examples of human transportation. Participants were asked to illustrate their solutions through sketches and text/keywords (for further clarification of their ideas) and to number each sketch in a chronological manner. To investigate the influence of textual stimuli we devised three written excerpts, which presented three levels of abstraction. The 68 participants were randomly allocated into the following conditions:

- Control (n=18): This group did not have access to any given stimuli beside the design brief.

- Textual related stimuli (n=19): This group (henceforth referred as 'related') received a textual stimulus: a description of the 'Straddling Bus', an example of a transportation concept for the near future (1-5 years), by Shenzhen Hashi Future Parking Equipment Co., Ltd.

- Textual distant (n=20): The textual distant group (i.e. 'distant') was presented with a textual stimulus, which contained an excerpt from the book The Wonderful Wizard of Oz by L. Frank Baum. In it, Dorothy, the main character, is lifted by a cyclone while inside her house. The concept of a cyclone was used due its distant relation with transportation, as it conveys the notion of movement.

- Textual unrelated stimuli (n=19): This group (i.e. 'unrelated') was given a textual description of a mirage. Although this choice was arbitrary, it has an intentional relation with the cyclone, as both of them are weather phenomena.

As we did not want to impose the stimuli, these were included along with the design brief in a 'subtle' manner: "You can choose whether you would consider (or not) this text when generating ideas". The aim was to suggest they could read the text and use as they saw fit.

3. Data analysis

Two independent expert judges assessed the participants' drawings, regarding: fluency of ideas, flexibility and originality. These are three of the four basic elements of divergent thinking, 'elaboration' being the fourth (Guilford, 1950). Fluency is defined as the quantity of ideas produced and was measured by counting the number of comprehensive ideas, portraying the purpose and functionality of a solution in sufficient detail. Sketches that did not offer clear indication of their functions and purpose were disregarded, even if these were enumerated by the participants as ideas.

Table 1. Categorization scheme of type of entities, transport modes and power for the generated ideas

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

Flexibility is considered to be the capacity to switch between different domains of ideas and thus, being able to alter how a problem is approached. Prior to the analysis of idea flexibility, the sketches were clustered into four main categorical groups, each one divided into further sub-categories. There were 16 possible classifications (Table 1) and each idea could be allocated to more than one sub-category (e.g., a car would be a *single-vehicle*, *terrestrial-above*, and *powered by fuel/gas*). This categorization system enabled the analysis of flexibility in two ways:

14. Comparison of the frequencies of use of certain categories over others, between conditions.

15. Comparison of a general measurement of idea flexibility, adapted from an approach used by Jansson and Smith (1991): flexibility was computed by counting the number of completely diverse solutions to answer the design brief. A high number of different approaches by participant reflects higher flexibility exploring wide-ranging solutions for the same problem. Conversely, participants who explored a small set of categories received a low flexibility grade.

Originality, within Guilford's construct (1950), refers to the capacity to develop novel and uncommon ideas. Originality is considered an important factor to define creativity, along with the usefulness and appropriateness of the idea (Amabile, 1996). Following the approach applied by Mednick (1962), an original idea was defined as an uncommon response to the design brief and was assessed by the statistical infrequency of each solution. Thus, originality is inversely correlated to the probability to be generated by the participants: one idea was considered less original if it was produced by a large number of participants, whilst another idea was more original if it was generated by a limited number of participants. From the total number of ideas generated across the four conditions (467 ideas in total), 82 completely original ideas were found, whilst the others were reoccurrences of these. After prior analysis, it was observed that the maximum number of reoccurrence of an idea was 30 times, which established the lowest level of originality. Consequently, the originality scale used in this study ranged from 1 occurrence (very original) to 30 occurrences (not original). Furthermore, as the participants generated more than one idea, an average of the reoccurrences of each idea was calculated, resulting in the final score.

4. Results

In the following section, the results obtained from the analysis of Fluency, Flexibility and Originality are presented. A One-way analysis of variance (ANOVA) was used to compute the results, as it was necessary to analyse four groups.

4.1. Fluency

The analysis revealed that there was no significant difference between the four conditions ($F (3, 72) = 1.41$, $p = .248$), despite the apparent numerical difference. The 'distant' group generated the highest amount of ideas (i.e. 154 ideas, Figure 1a). The lack of significance derives from the inconsistency of the number of ideas produced between individuals under the same experimental condition. In the 'distant' group, for instance, there were participants who were highly stimulated by the given text excerpt and created approximately 20 ideas, whilst other participants in the same condition generated a much more reduced number. The same inconsistency is patent in the other conditions.
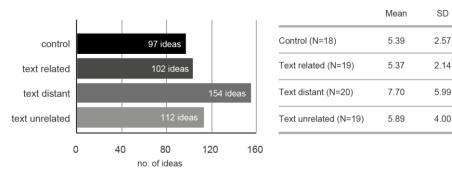

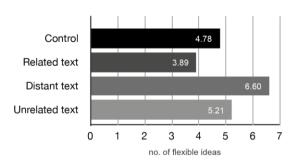|	Mean	SD	Total # ideas
Control (N=18)	5.39	2.57	97 ideas
Text related (N=19)	5.37	2.14	102 ideas
Text distant (N=20)	7.70	5.99	154 ideas
Text unrelated (N=19)	5.89	4.00	112 ideas

Figure 1. Fluency of ideas

4.2. Flexibility

As aforementioned, flexibility was assessed in two ways. Firstly, we analysed how differently the categories were explored by the groups, according to the categorization scheme explained on section 3 (table 1). Results showed significant differences in the use of four sub-categories: *Single vehicle* (type of entity) ($F(3, 72) = 5.35$, $p < .005$); *Aerial transportation* mode ($F(3, 72) = 8.70$, $p < .001$); *Wind-powered* ($F(3, 72) = 5.76$, $p < .005$); and *mechanical-power* ($F(3, 72) = 6.04$, $p < .001$).

Subsequent analysis revealed that, in the case of *single vehicle* categories, the 'related' condition developed significantly more ideas portraying an apparatus (instead of developing an *infrastructure* or *system*) than the 'control' ($p < .01$). In the same way, the 'distant' condition also had significantly more *single vehicle* ideas than the 'control' ($p < .05$). Regarding the generation of *aerial transportation* vehicles, the 'distant' condition (who received the passage about the cyclone in *The Wonderful Wizard of Oz*) developed significantly more airborne vehicles than the 'control' ($p < .01$), the 'related' ($p < .01$) and the 'unrelated' groups ($p < .05$). The 'distant' condition generated significantly more *wind-powered* vehicles than the 'control' ($p < .05$) and the 'related' conditions ($p < .01$). Finally, there were significant differences in the development of *mechanical-powered* ideas, in which the 'distant' group devised much more ideas within this category than the 'control' ($p < .01$) and the 'related' ones ($p < .01$). Furthermore, a second analysis was performed to assess which were the groups who performed better regarding the overall score of flexibility. The analysis revealed that there was a marginally significant difference between the different groups ($F(3, 72) = 2.28$, $p = .087$). Further analysis showed a medium-seized effect, $\eta_p^2 = .087$, which indicates that the ANOVA would be significant providing a larger sample. An examination to the overall flexibility means indicated that the 'distant' group performed better than any of the other conditions ($x= 6.60$), whilst the 'related' group received the lowest score in flexibility ($x= 3.89$) (Figure 2).
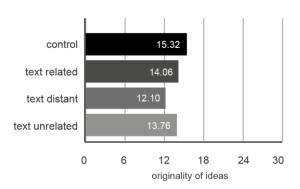
	Mean	SD
Control	4.78	2.34
Text related	3.89	2.23
Text distant	6.60	4.54
Text unrelated	5.21	3.41

Figure 2. Flexibility overall

4.3. Originality

Regarding originality, results revealed a marginally significant difference for the between-groups ($F(3, 72) = 2.81$, $p = .098$). Once again, despite the ANOVA itself only being marginally significant, it is likely that it would have turned out significant given a slightly larger sample, as indicated by the medium-sized effect, $\eta_\text{p}^2 = .083$ (Figure 3).

	Mean	SD	Rank
Control	15.32	3.73	4
Text related	14.06	4.30	3
Text distant	12.10	3.15	1
Text unrelated	13.76	4.41	2

Figure 3. Originality scoring: on the figure on the left '1' represents a very original idea and '30' not original at all.

The analysis of originality scores demonstrated that the 'distant' group ($x= 12.10$) had the best performance in the generation of unusual ideas (a higher mean value refers to lower originality, whilst a lower mean value indicates higher originality, Section 3). The high standard deviations and a meticulous analysis of the sketches generated suggested that even the participants with better original scores could not maintain a consistent level of originality across their entire process. In fact, participants from the 'distant' group produced recurrent ideas as the other groups, but they were also able to generate more unusual ideas.

5. Discussion

5.1. Fluency

Regarding the fluency of ideas, there was no statistical difference between the four conditions. However, numerically speaking, the 'distant' group generated more ideas than the other groups. The textual stimulus used in this condition (excerpt from the novel *The Wonderful Wizard of Oz*) may have played a role in such a high production of ideas. In fact, and accordingly the high standard deviation values, there was a large variation in terms of fluency. In all experimental conditions, whilst some participants generated a large quantity of ideas, others produced scarcely any. This may suggest that the given stimulus was not as inspiring for some as it was for others. As previously mentioned, designers are widely-known as preferring visual material and hence some of these participants may have not successfully recognized the text stimulus as a viable inspiration source.

As prior research has supported, high ideation fluency is related to the development of successful ideas, whose probability will be higher when many ideas have been created. Independently of how feasible the concept is, the generation of many solutions may provide the exploration of other approaches and promote more creative results. According to our results, the textual stimulus with a distant reference to the problem may have enhanced the fluency of the participants' ideas, when compared to exposure to a related or an unrelated stimulus, or no stimulus. Furthermore, as shown in Figure 1, it seems that there is an optimal stage regarding the use of less abstract and more abstract stimuli and the fluency performance. As we move from the very concrete/related example to a more abstract/distant one, fluency improves. However, when the abstraction of the stimulus reaches a level of (un)relation that is beyond a between-domain example (in reference to the problem at hand) fluency seems to decrease.

5.2. Flexibility

Only marginal significances were observed in regard to flexibility between the groups. Participants who received the 'related' stimulus produced significantly more ideas that entailed a *single vehicle* when compared to the 'control' group. The example of a single apparatus may have prompted the 'related' group to generate more ideas exploring this sub-category. On the other hand, the 'distant' condition also produced more *single vehicle* ideas than the 'control' group, although they did not receive a description of a public transport, but an excerpt about a cyclone. As a result, the 'distant' condition created a significantly higher number of ideas in the categories of *aerial transportation* and the use of *wind-power*, when compared with practically every other condition. Such high frequency on these categories can potentially be explained by the *recency-effect*, which is a principle that assumes that the last perceived elements/words of a text will be easier to recall or considered more important. Thus, the verb *carry* in the end of the 'distant' excerpt - "(…) and there it remained and was *carried* miles away as easily as you could *carry* a feather (…)" may have prompted the participants to apply the cyclone as a mean of transportation and to explore airborne or wind-related solutions. The *mechanical-powered* transportation was significantly more explored by the 'distant' condition than by the 'control' and 'related' groups (who did not create any idea devising that sub-category). This result is even more intriguing as this sub-category includes almost exclusively ideas related with catapults, where the transportation is made by 'throwing' people from one location to another. Although this sub-category is not directly related with aerial transportation *per se*, a relation with airborne solutions can be made and it is interesting that the narrative describing a cyclone enabled the exploration of so many diverse solutions.

Subsequently, regarding the general comparison of idea flexibility between the four groups (and taking into account the only marginally significant results), the 'distant' condition tended to be more flexible than the other groups. The 'distant' group seem to have developed more ideas that fell in different sets of categories, especially when compared to the 'related' condition, who had the lowest levels of flexibility. Once again, a pattern seems to emerge from figure 2: on the one end of the spectrum, the 'related' stimulus may have fixated the participants from that group to repeat certain within-domain types of ideas, impeding further exploration; on the other end, the 'unrelated' stimulus may have been too vague or irrelevant for the participants, not yielding enough links to establish possible associations between stimulus and problem. At the midpoint, the 'distant' stimulus seemed to have encouraged enough abstraction from the more obvious solutions, yet enabling sufficient cues to relate with the problem at hand.

5.3. Originality

In regards to originality, the 'distant' group seemed to have devised a higher number of unusual ideas when compared to the other conditions. This suggests that the exposure to the distant text excerpt resulted in higher originality. Our results are in agreement with Goldschmidt and Sever' findings (2010), which demonstrates the usefulness of text as a possible source of inspiration. Nevertheless, it is important to note that in this study, an original idea was considered to be a singular and atypical response, disregarding its feasibility or usefulness. A detailed observation of the devised sketches revealed that a number of the original ideas were, occasionally, also possibly inappropriate (although this was not thoroughly assessed). Therefore, analysing originality is not enough to assess how creative and valuable an idea is and further research on this should follow. Nevertheless, originality is an important factor in creativity and, once again, a pattern is visible from these results (Figure 3), although reversed (due the inversion scoring in originality, as explained in section 3). These results seem to indicate that between very concrete and very abstract stimuli lies an 'optimal' range of abstraction that makes a stimulus an appropriate trigger for the generation of original ideas.

6. Conclusions

Indubitably, visual representations are essential within the design realm. Its role is of high importance in order to communicate with others and to create rapid understandings (Malaga, 2000). Visual representations are the one preferred 'language' of designers, architects and artists. Nevertheless, research has demonstrated the dual-effect visual stimuli can provoke, both positive and negative (Cai, Do and Zimring, 2010). Hence, it is reasonable to reflect on the role that other possible sources of inspiration may play during idea generation and why designers overlook such potential stimuli. According to our results, and leastwise within the setup described here, written stimuli have the potential to enhance creativity in terms of fluency, flexibility and originality of ideas. It is, therefore, important to reflect on the role of diverse inspirational stimuli, and encourage novice designers to appropriately choose and use the myriad of possible stimuli available.

Concerning the role of abstraction in stimuli, we argue that inspiration can be provided both by domain-specific and domain-general stimuli. As Plucker and Beghetto (2004) explained, creativity is potentially both context-dependent and independent, with its combination being the most appropriate for the development of creative ideas. Designers, intuitively or by education, tend to firstly look for inspiration in the most immediate domain of the problem and only further on, expand their inspiration search to other areas. Searching for similar solutions to a design brief offers an overview of what has been done and what remains unexplored, and may be the first step to originate diverse ideas. However, a broader perspective of the problem and an appropriate choice of information brought from another domain can support creativity. Naturally, a too strong focus on domain specific knowledge can bring designers to a design fixation behaviour. Conversely, a too abstract and domain general information can impede designers from fully answering the problem (Plucker and Beghetto, 2004). Thus, there is an optimal situation, with a balance between domain specific and general, or between too related and abstract stimuli, as demonstrated in this experiment. The 'distant' group, who received a stimulus that combined concreteness and abstraction, tended to perform better in terms of ideation fluency, flexibility and originality, in relation to the other groups.

Hence, and congruent with previous research, this study suggests that as the content of the textual stimulus becomes more abstract, more diverse and potentially more creative ideas can be produced. However, as we increased the abstraction level, such type of stimulus can also become too unrelated to enable the participants to establish any link between stimulus and problem presented. Consequently, an unrelated example, with no links to the problem at hand, might not be inspirational.

Further research will continue to investigate the role of inspiration sources in design ideation, with the ultimate aim of supporting the appropriate selection and use of available inspirational stimuli material.

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