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FROM TEXT TO DESIGN SOLUTION: INSPIRING DESIGN IDEAS WITH TEXTS

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ABSTRACT
A design is said to be as successful as the leading idea that drives it is. Mature designers make frequent use of 'stock ideas' accumulated over time and stored in memory and personal archives. Novices do not yet possess developed collections of sources that can be tapped. Previous research proved that the intentional exposure of novice designers to visual stimuli can provide cues that act as sources and inspire the generation of design concepts. In this study it was hypothesized that stimuli in the form of texts presented to student-designers along with a design problem, would improve the quality of their design solution. In an experiment participants solved two short design problems under three conditions: without stimuli, with stimuli in the form of texts related to the problem at hand, and with texts unrelated to the problem. Outcomes were graded by naïve judges for originality and practicality. Results show that both types of text yield designs that receive higher originality grades compared to the no-stimulus condition, but practicality is not affected. We propose that textual stimuli may be useful as part of the design process and as a pedagogical tool in the design studio.

Keywords: Design, concept, creativity, idea, originality, practicality, stimulus, text

1 INTRODUCTION
Design products of the tangible kind such as objects or buildings are said to be designed on the basis of a 'design concept', sometimes termed 'leading idea', 'overarching idea', or the like. This major idea, or concept, governs the looks and feel of an object and often its functioning as well. Where do such major design ideas spring from? Are they inferable from the givens of the design problem itself? This is almost never the case, and designers know it and are aware of the fact that more information must be 'imported' into the problem space in order to hit upon an end of a thread that would lead them onto a promising solution path. Successful leading ideas are those that fuel innovative and creative products, and are therefore of such value – in design and in other fields – that organizations and individuals are willing to exert considerable efforts in order to secure them. The demand has given rise to a host of methods and techniques for the elicitation of new ideas, in the hope of arriving at greater creativity. Some of the better known methods developed specifically for design (mostly engineering) are: Brain Sketching, Gallery, 6-3-5 and C-Sketch e.g., [1], [2]. However, substantial criticism of such methods has been voiced since we still lack a sound theoretical basis and empirical evidence that would allow us to understand the affects of the use of such methods (e.g., [3], [4], [5]).
Since in all cases seemingly unrelated information is brought into the design space in order to stretch it and increase the probability of new solution opportunities, a question we must ask is: what kind of information can or should be 'imported' into the process in order to trigger ideas? There is anecdotal evidence that designers store, physically or in memory, visual images that they consider potentially helpful as sources for future design ideas. That is, images, when elicited at the appropriate moment, may be helpful. For example, fashion designers prepare 'inspiration boards' to demonstrate how they come to think of their concepts (e.g., [6]). Le Corbusier had an archive of newspaper clippings and other images, and kept found objects in his office, from which he occasionally drew items that elicited design ideas [7]. Keller [8] [9] has recently proposed a digital equivalent of the traditional 'Cabinet' in which treasured objects of inspiration are stored for future reference. Denys Lasdun [10] generalized in saying:

"In the course of creation an architect may receive inspiration from a large number of sources from works of

the past and the present and from right outside architecture. He must have something to work on; he is certainly no less creative if he spreads his net wide and has an eye that remembers." (p. 107).

Curtis [7] commented about Le Corbusier's design process:

"His mind was well stocked with ideas, devices, configurations and images gleaned form tradition, from painting, from observation, and of course from his own earlier works… At the right moment images would flow to the surface where they would be caught, condensed and exteriorized as sketches." (p. 11).

What these examples have in common is the visual nature of the inspiring sources that designers capture, store and surface as per need, when in search for leading ideas in new design searches. Design research has demonstrated empirically that exposure to visual stimuli at the conceptual search phase in designing, with or without instructions to make use of such stimuli, has indeed a positive effect on idea generation in terms of the judged creativity of preliminary solutions (e.g., [11], [12]). There are also many specific anecdotal accounts of imported concepts that, represented visually, had an impact on new designs. In many cases the source serves as a metaphor or analogy for the target design (for example, icon design, such as the 'recycle bin').

While it is not surprising that the visual properties of a design concept are inspired by visual images, we postulate that visual stimuli are not exclusive sources of inspiration. Musicians have been inspired by visual art and in return visual art has been inspired by music; why, then, should not design concepts be inspired by ideas derived from non-visual sources? We know that many factors may impact problem solving: for example, the formulation of the design task ('open' vs. 'closed') may extend or constrict the designer's search, leading to results that are judged to be more or less innovative, respectively [13]. Environmental factors are also of considerable influence (e.g., [14], [15]). Remaining with stimuli, however, we concentrate in this study on texts, which are particularly accessible and prevalent everywhere. Can the reading of texts have an impact on design idea generation? And if so, is there a difference among different types of texts? After a brief review of the impact of visual stimuli on design in section 2, our hypotheses regarding texts as stimuli are presented in section 3 of this paper. Sections 4 and 5 describe experimental work we carried out and the results obtained. In section 6 we present our conclusions which expand on the potential of texts, and possibly other extraneous stimuli, to impact design creativity. We also comment on the potential we see for design education in developing structured methods for the use of stimuli.

2 THE IMPACT OF VISUAL STIMULI ON DESIGN CREATIVITY

Problem solvers who are required to devise designs for tangible products (or concepts for products) comprising forms, shapes, colors, and other visual properties, naturally manipulate such properties while searching for solutions. They represent forms and shapes (and colors etc.) internally, using mental imagery, or externally, by drawing or modeling configurations in two and three dimensions. The manipulated material may be entirely self-generated, but it may also be derived from extraneous sources, intentionally, accidentally, or even unconsciously.

Research proves that architects and industrial designers are able to successfully manipulate visual configurations in imagery in lengthy design tasks they performed blind-folded, in which no stimuli were presented [16], [17]. Finke and his associates demonstrated cogently that people can manipulate given shapes in imagery (participants were blind-folded) and combine them into meaningful and even new and useful "preinventions", some of which were assessed as creative, in just two minutes [18], [19]. These experiments opened up a line of inquiry known as 'Mental Synthesis' in which other researchers explored whether sketching during the search enhances creative results; whether the type and amount of design experience is relevant to the results, and so on. It was found that experienced designers achieve better results while sketching than without sketching in certain types of operations [20], whereas for non-designers sketching is of no particular advantage (see also [21]). Furthermore, the type of design experience of participants (graphic or industrial design) is positively correlated with their scores in tasks which require the manipulation of two or three dimensional forms, respectively, in mental synthesis tasks [22].

Now that we are assured of people's and especially designers' ability to manipulate visual material while working to solve a design or design-like problem (such as mental synthesis), we are ready to turn our attention to cases in which visual stimuli are presented to designers, such that these stimuli may serve as a trigger, or jumping board, for design ideas or concepts. Casakin (e.g., [8]) ran a series of experiments in which individual architects and architecture students were asked to solve a number of design problems at a conceptual level; half the problems were ill-defined and the other half well-

defined. Regarding stimuli, there were three conditions under which participants worked: no stimuli; a picture board in the work environment without any instructions; and the same picture board with instructions to identify and use images on the board that could serve as sources for a solution, using analogy. The resultant sketch-designs were assessed for quality and creativity by independent judges. Scores were averaged for four groups: ill and well defined problems solved by experts (architects), and ill and well defined problems solved by novices (students). In the picture board without instructions condition all groups except the well defined/novices group achieved higher scores compared to work with no stimuli at all. In the picture board with instructions to use analogy all groups except the well defined/experts group attained even higher scores. These results show that on the whole the provision of visual stimuli has a positive influence on the level of creativity of design concepts, and explicit instructions to make use of the stimuli accentuates this influence further. However, the amount of experience designers have and the type of problem at hand are of importance and may qualify the improvement curve.

In another study Goldschmidt and Smolkov [12] showed that the type of problem is of crucial importance to the impact that visual stimuli have on the rated creativity of conceptual designs. Individual designers (graduate industrial design and advanced undergraduate architecture students) solved two ill defined design problems each, half of them while sketching and the other half with imagery only. The resultant conceptual designs were assessed for originality and practicality by independent judges; the additive originality and practicality scores served as a creativity rating (as in Finke, see [18]). There were three conditions of the work environment: no stimuli; rich stimuli in the form of pictures and three dimensional objects; and sketches by other participants. The findings indicate that originality was more affected than practicality by the presence of stimuli. It was also shown that one of the problems was significantly more sensitive than the other to the presence of stimuli. Another finding was that stimuli may in fact affect designing negatively: solutions to one of the problems received lower mean practicality scores when stimuli were presented. There were also differences between the types of stimuli in the influence they had, with rich stimuli having a greater positive impact on compiled creativity scores in most cases.

We see that although the pattern of influence of visual stimuli is not entirely straightforward, on the whole such stimuli are good sources of inspiration for designers who seek to attain new and creative design concepts within a short time. It is logical to interpret this body of research findings as proof of cognitive efficiency, whereby stimuli act as readily available cues, or opportunities to identify, with little effort, a starting point in a process that is rather opportunistic in nature. Designers transfer from a source to the target problem, and when the representation modality at both ends is visual, this saves the need to invest additionally in a translation from another modality to the visual one.

However, visual stimuli are not always available, nor does it make sense to ignore other stimuli, even if the need to switch modalities may have a cognitive cost. This is why we set out to investigate the effect that textual stimuli may have on designing.

3 CAN TEXTUAL STIMULI SUPPORT THE FORMATION OF DESIGN CONCEPTS?

Creative ideas are new and unexpected combinations of existing knowledge ‘items’ in memory and new information ‘superimposed’ on them. We store in memory ideas, shapes, colors, materials and understanding about the behavior and connections among different abstract and tangible elements; the expertise of a designer is to use those pieces of knowledge in order to create new entities. Many researches (e.g., [18], [21], [23]) agreed that combinations based on previous knowledge are meaningful in the process of creation. Perttula [13] explained that new ideas originate in a new combination of ideas found in previously existing knowledge: in his experiments designers had to find solutions based on examples given at the outset of the design process, as well as knowledge retrieved from memory. The main stages in this process are the interpretation of the problem, the search in memory and the adoption of relevant knowledge.

In this research we examined the phase of concept generation in the design process. At this phase ideas are generated that serve to gel a leading concept, which in turn influences design decisions from that point on. The leading concept is usually unknown at the beginning of process. Exposure to different kinds of stimuli can help in generating concepts and in particular a leading concept. As mentioned in section 2 most of the research to date was about the influence of visual stimuli on the generation and integration of a leading design concept. The current research asks whether exposure to texts that

include ideas can help generate a creative concept, expressed in the form of a design sketch. Exposure to ideas via text is different from visual stimuli. First, because many ideas that can be expressed in words cannot be represented via visual images. Second, whereas exposure to visual images might restrict one's search for new images (to the point of fixation; see e.g., [3]), the contemplation of words leaves a wider manipulation space in the process of translation into visual images.

While we believe that stimuli can take many forms and be effective in various modalities, texts are of particular interest to us as they are very versatile 'vessels' of ideas and concepts, and can be read in many ways. Iser [20] argues that readers construct stories in response to texts they read, and this construction is in fact an act of interpretation of the original text, which may be considerably transformed in the act. Stories have long been known to serve as sources of inspiration in design although the evidence is mostly anecdotal. For example, Alon-Mozes [21] used stories to guide students' concept generation in landscape architecture studios. She developed a successful method of getting students started based on stories.

In this research we used two different kinds of text. The first text included ideas that are closely related to the subject of the design assignment. The second text included ideas that are farther removed from, or unrelated to, the field of the design task. Our goal was to understand whether texts of both kinds can serve as useful stimuli (i.e., that enhance creativity) in design idea generation. We formulated two hypotheses (1, 2) and one further research question (3):

1. Reading text that includes ideas from fields that are closely related to the design problem field improves design problem solving.
2. Reading text that includes ideas from fields that are farther removed from the design problem field improves design problem solving.
3. Which kind of stimuli (texts with ideas related or unrelated to the problem) contributes more to the quality/creativity of the design concept?

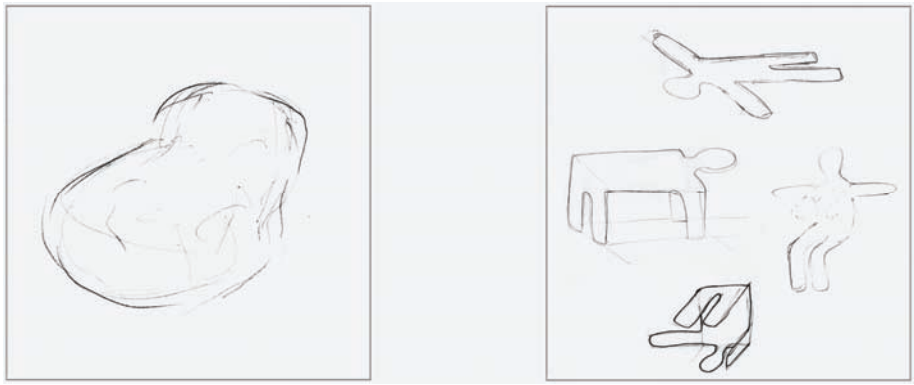
In order to test the hypotheses and question we conducted empirical work. The experiment we carried out is described in section 4.

4 EXPERIMENT

In order to test the hypotheses and answer the research question an experiment was set up in which participants were asked to solve two design problems (tasks). The participants were 35 industrial design students (19 females and 16 males, mean age 26). The students were in their second or third year of undergraduate studies. They were asked to design two products: a chair for children and a desk clock. The time allotted to each task was 40 minutes. The participants designed each of these products three times, under different conditions. In condition 1 the tasks were carried out without any external stimuli. In condition 2 the students received stimuli in the form of four texts containing ideas related to the objects they were asked to design. In condition 3 the stimuli given were four texts containing ideas unrelated to the objects to be designed. All texts were under one page long. In half the cases condition 3 followed condition 2; in the other half condition 2 followed condition 3. The participants produced sketches and added a written explanation pertaining to their designs. Later the designs were graded by three judges who are experts in the field of design. The grades were given for originality and practicality on a scale of 1-5 (as in [18] and [12]). Each judge graded one third of the sketch-solutions, i.e. 70 designs (35 students * 3 conditions * 2 tasks divided by 3 judges). The distribution of designs among the three judges was random but balanced in terms of tasks, sequence of conditions, student standing (2nd or 3rd year) and gender. The judges were blind to the goals of the study.

4.1 Examples from the chair design task

Figure 1 shows two solutions by participants in the chair design task. The design in figure 1a, by participant 27, was executed under condition 1, i.e. without any stimuli. The design shown in Figure 1b, by participant 5, was carried out under condition 2, that is, after reading texts closely related to the problem.



a b

Figure 1. a) Participant 27. Sketch, chair design without stimuli. Grades: originality 1, practicality 1. b) Participant 5. Sketches, chair design with texts closely related to the subject of the task. Grades: originality 5, practicality 4.

The text that participant 5 read prior to designing the chair shown in Figure 1b dwelt on the importance of movement as influencing a child's ability to be focused, thereby raising his or her self confidence while also leveraging the awareness of a connection between body and soul. In this design the student created a chair which is an abstraction of a child. The chair "asks" the child to put it in motion and by doing so the child explores the different positions of the chair. The design is clearly influenced by the concepts included in the text this participant read. Participant 27, whose design is portrayed in Figure 1a, got the same task but without any textual stimuli. As an explanation to his design he wrote: "the chair is comfortable, gets the shape of the child's back; when the child is comfortable he can focus well." In both cases the participants wanted to create a dynamic and comfortable chair, but as the grades awarded to their designs by the judges show, participant 5's design was much more appreciated in terms of both originality and practicality (scores of 5 and 4 respectively, vs. scores of 1 on both counts for participant 27's design).

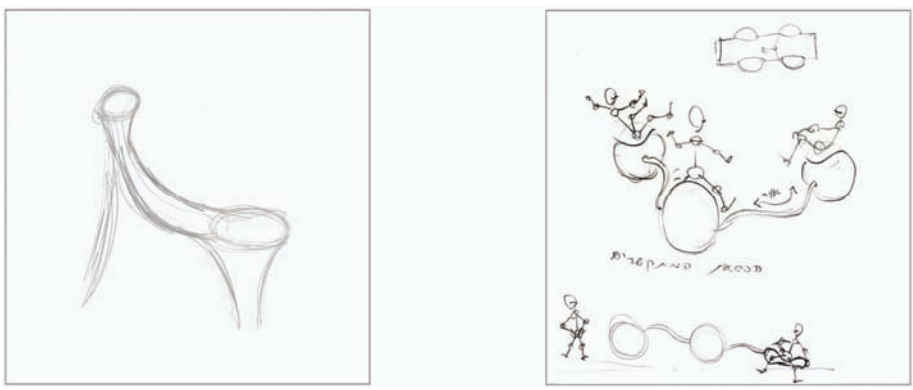


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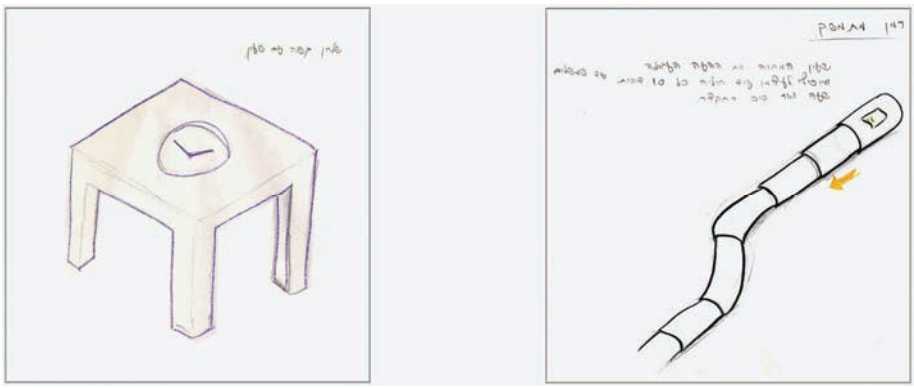
Figure 2. a) Participant 31. Sketch, chair design without stimuli. Grades: originality 1, practicality 1. b) Participant 11. Sketches, chair design with texts unrelated to the subject of the task. Grades: originality 5, practicality 5.

Figure 2 shows two other solutions by participants in the chair design task. The design in Figure 2a, by participant 31, was executed under condition 1, i.e. without any stimuli. The design shown in Figure 1b, by participant 11, was carried out under condition 3, that is, after reading texts containing ideas unrelated to the problem.
The text that participant 11 read prior to designing the chair shown in Figure 2b dwelt on fireflies, who practice twinkling in order to strengthen social connections among themselves and encourage contacts between males and females. In the explanation to his design the participant described a transformation of the idea presented in the text into the idea of the chair as encouraging social connections among three children. The chair is created from three large balloons and pipes that connect them, containing air. Every movement of one of the children influences the other children, as changing the amount of air in one balloon, through movement, inflates or deflates the other two. The system works only when three children 'ride' the balloons; otherwise a single balloon 'collapses' when sat on. Participant 31 got the same task but without any textual stimuli. As an explanation to his design this participant wrote: "A comfortable chair that combines the language of the shape of the body". This chair does not conform to good ergonomic principles and was much less appreciated in terms of both originality and practicality. It is reasonable to attribute the more successful design by participant 11 in Figure 2b to the positive impact the stimulus had on the result. The chair, which does not only provide the possibility to sit but also encourages social connections among three children in a play mode, was inspired by the text. The judges clearly preferred the design by participant 11 (score of 5 for both originality and practicality, vs. a score of 1 for both originality and practicality awarded to the design by participant 31).

4.2 Examples from the desk clock task

Figure 3 shows two solutions by participants in the clock design task. The design in Figure 3a, by participant 4, was executed under condition 1, i.e. without any stimuli. The design shown in Figure 3b, by the same participant, was carried out under condition 2, that is, after reading texts closely related to the problem.



a **b**

Figure 3. a) Participant 4. Sketch, clock design without stimulus. Grades: originality 1, practicality 3. b) Participant 4. Sketches, chair design with texts closely related to the subject of the task. Grades: originality 5, practicality 4.

The text the participant read before coming up with the design shown in Figure 3b consisted of phrases about time, one of which read "continuous time." This inspired participant 4 who created a clock made of six telescopic elements. At a full hour all elements are retracted in a telescopic manner into the largest element and every 10 minutes one element completes its emergence from the next- size element. As time goes by the clock is "getting longer" until it reaches its full length within an hour, after which all elements retract into the biggest element again. This way we can 'feel' the continuity of time in a tangible way. By contrast, the clock shown in Figure 3a, by the same designer but without stimuli, is a much simpler concept: a conventional clock which is embedded in a desk. As we can see

the judges favored the dynamic clock shown in Figure 3b, and gave it much higher originality and practicality grades (5 and 4 respectively, vs. 1 and 3 in the no-stimuli design). Here too it is reasonable to attribute the more successful design in Figure 3b to the positive impact the stimulus had on the designer while developing the design solution.
Figure 4 shows two other solutions by participants in the clock design task. The design in Figure 4a, by participant 30, was executed under condition 1, i.e. without any stimuli. The design shown in Figure 4b, by participant 11, was carried out under condition 3, that is, after reading texts containing ideas unrelated to the problem.

a b

Figure 4. a) Participant 30. Sketches, clock design without stimuli. Grades: originality 2, practicality 4. b) Participant 11. Sketches, clock design with texts unrelated to the subject of the task. Grades: originality 5, practicality 4.

The text that participant 11 read prior to designing the clock shown in Figure 4b consists of transformations the Chinese dragon undergoes during its long life. One year after its birth it is the size of a typical dragon. After one thousand years it reaches its full length. After fifty thousand years another transformation occurs. Participant 11 chose to indicate changes in a plant during its growth by creating a clock that starts ticking when the seedling is planted. Consequently one can track the plant's development and see how long every phase of its growth took. We can point here to the ability of the participant to understand the idea expressed in the text, abstract it and translate it into a design idea. Vygotsky [26] explained that an adult can understand words as concepts and extract their essence, or wider meaning, compared with a child who associates words only in a factual mode. Understanding a general concept requires the ability to abstract, and making use of the concept in a specific case necessitates the ability to transform the context of the source to that of a target idea. Participant 30 who got the same task but without any textual stimuli, described his design as a "clock in the shape of a wave." This participation did not create an abstraction in his design but adopted a (largely arbitrary) figurative shape of a wave as a leading concept. Participant 30's design was less appreciated by the judges in terms of both originality and practicality (scores of 2 for originality and 4 for practicality, vs. scores of 5 for originality and 4 for practicality awarded to participant 11's design).

5 RESULTS

The judges assigned two grades to each design: one for originality and one for practicality. In order to check the independence of grades of the two types, we computed the correlation between them for all conditions, using the Pearson Coefficient test. The negative or low correlation in all cases (between -0.25 and 0.35) assures the independence of grading for originality and practicality. Likewise, we tested for possible dependencies between grades in the two tasks, for all conditions. Correlations were very low if not negative (between -0.18 and 0.12), thereby asserting that success in one task does not predict success in the other task.

In order to examine our hypotheses (1 and 2) we implemented the Repeated Measures ANOVA test to compare the mean grades of originality and practicality for the three stimuli-exposure conditions. Then we implemented Pairwise comparisons to determine in which couples the difference between the mean grades is significant. To answer question 3 we used Finke's methodology [8] in order to check for creative results among the ensuing designs by participants, under the different conditions.

5.1 Effect of stimuli (hypotheses 1 and 2)

We hypothesized that texts related and unrelated to the subject matter of design tasks would, in both cases, improve design problem solving. We checked the mean grades for originality and practicality separately for the two design tasks.

Figure 5 shows the mean originality and practically grades for the three conditions in the chair design task. The originality grades for the conditions in which the participants received stimuli of texts that were related, and unrelated, to the subject of the task, are significantly higher than the mean grades in the condition in which the participants received no texts at all. There is no significant difference between the average grades for practicality in the three conditions.

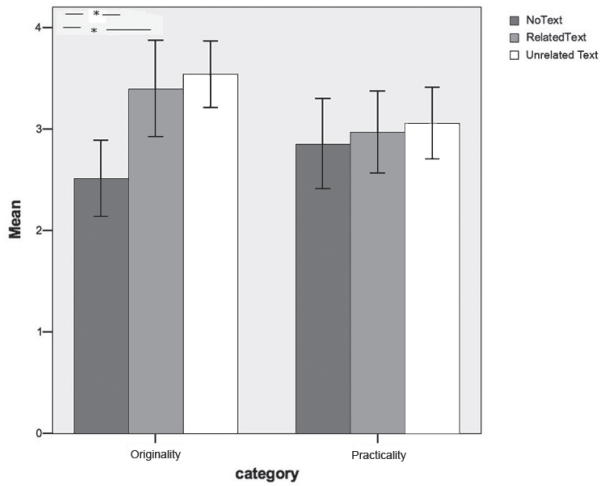


Figure 5. Mean originality and practicality grades – chair design
p<0.05 in Bonferroni multiple comparison test

Figure 6 shows the mean originality and practically grades for the three conditions in the clock design task. The originality grades for the conditions in which the participants received stimuli of texts that were related, and unrelated, to the subject of the task, are significantly higher than the mean grades in the condition in which the participants received no texts at all. There is no significant difference between the average grades for practicality in the three conditions.

We may thus conclude that hypotheses 1 and 2 have been partially confirmed: Exposure to both types of text lead to higher originality grades, compared to no exposure to text. However, practicality scores are not affected by exposure to either stimulus type.

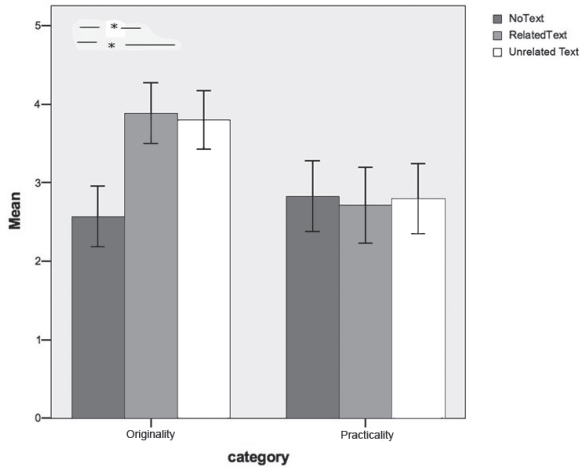


Figure 6 Mean originality and practicality grades – clock design
p<0.05 in Bonferroni multiple comparison test

5.2 Which type of stimulus is more effective (research question 3)?

In order to find out whether one of the stimulus types was more effective than the other, we decided to compare the number of creative designs that were produced in each task. We used Finke's method [8] which establishes a combined creativity score by adding the two separate originality and practicality grades. Beyond a pre-established threshold the accumulative grade is indicative of a creative solution. We set the threshold at 10 – the maximum grade for both originality and practicality. Seven designs ahieved this combined grade; the distribution is reported in Table 1.

Table 1. Number of creative designs (combined originality and practicality; combined grade = 10)

	Chair	Clock
Design without text	0	0
Design with texts closely related to the problem	1	3
Design with texts unrelated to the problem	1	2

We used the Fisher Exact test to compare the three stimuli conditions. The number of creative designs generated with texts related to the task is 4. The number of creative designs generated with texts unrelated to the task is 3. The test indicates that the difference between these values are statistically insignificant (p=0.12). We therefore conclude that the two types of text are equally effective in enhancing design creativity, as compared to design without any text. We note that no creative designs were produced without stimuli, and in accordance to the findings reported in section 5.1, this condition is inferior to the use of text of either type as stimulus for the purpose of increasing design creativity.

In summary, our results show that:

1. There is a significant difference in the grades for originality between the work carried out when the subjects had not been exposed to any stimuli in the form of texts and the work done when such stimuli had been given by texts, regardless of whether the texts were closely related to the assignment or were quite unrelated to it. The grades for originality of the designs that were generated with textual stimuli being present were significantly higher, both for the design of the chair and of the clock.

2. There is no discernible difference between the grades of the designs, produced when the textual stimuli had been closely related to the work to be carried out and when the stimuli had been unrelated to it.
3. No differences are discernible in the grades pertaining to practicality.

5.3 Experience and gender

We looked at two more parameters: experience and gender. We compared the grades achieved by second and third year students using a t-test, and found no significant differences between the two groups ($p>0.5$). In another t-test we compared the grades of male and female participants. No significant differences were found ($p>0.5$).

6 DISCUSSION AND CONCLUSIONS

In essence, what we have found is not surprising: the reading of different types of text containing ideas can be inspiring and enhances originality and creativity of designs produced by students in short-term design exercises. We knew that image stimuli have such an effect, and an 'open' formulation of design assignments has a similar effect. Now we know that texts do, too (note that as in other studies, practicality was little or not at all affected by stimuli – only originality was affected). One might claim that in fact what the judges considered to be original is not original at all since it was influenced by an external stimulus without the judges being aware of this fact. Our view is that quite on the contrary: a designer manifests creativity if he or she demonstrates the ability of integrating external ideas into a work of design. It is almost never possible to transfer ideas from elsewhere 'as is' into a new design; in the process transformations and adaptations occur, subject to a specific understanding and interpretation of the task as well as the stimulus. The ability to recognize a useful idea in a stimulus requires creativity; sometimes priming is helpful (as in [11]), and at other times a good idea need only be retrieved from memory, where it had been stored earlier in anticipation of a proper opportunity to use it, as in the case of Le Corbusier [7]. Some of the greatest artists and designers where hailed for 'stealing' ideas from elsewhere; a case in point is the architect James Stirling, about whom it was said: "Like Picasso, Stirling operated a magpie avidity to steal whatever he liked while yet turning it into his own…" ([27], p. 20).

It is often the hallmark of well known designers that they 'collect' sources of inspiration as a matter of routine, storing them in an ever-growing stock of potential design sources. Artists and writers appear to do the same. Naturally, a mature designer with considerable experience would have a larger active 'archive' of this sort than a novice who has not yet had the opportunity to build up a sizable collection of sources of inspiration. Needless to say, regardless of experience an eye for appropriate items to add to one's collection is also a necessary prerequisite, and such an eye is only partially acquired through experience; an innate propensity may be needed, too. Where, then, do stimuli in real-time fit into the picture? We posit that stimuli can serve as cues and resources when it is difficult to secure helpful cues in another way. The need for 'imported' cues may happen due to more than one reason. First, when the problem is very new and unusual it may be the case that no corresponding sources in memory are available for retrieval, even when the designer is experienced. Second, when the problem is to be solved very quickly and there is no time for a thorough search in memory or another repository of sources. Third, when the designer is a novice whose stock of available sources of inspiration is still quite limited. In all these cases a designer could potentially benefit from exposure to stimuli that can provide a starting point and make the search for a leading idea more efficient and probably shorter.

In the study reported in this paper and in other studies the participants were students, and therefore definitely novices. Hence they fall into the category of those who could benefit from the availability of stimuli at the outset of the task. As we have shown, they have indeed taken advantage of the textual stimuli offered to them. Would they have been better off with other stimuli, notably visual images? We do not know, of course, as in this study no such comparison was attempted. In an experiment conducted by Malaga [28] he showed that picture stimuli were more effective than word stimuli or combined word-image stimuli, in the design of ice cream flavors. Based on his finding we speculate that visual stimuli may have been more effective than our textual stimuli in a similar task, but this speculation requires confirmation. We must also qualify our findings from the methodological point of view: since participants worked with texts only after solving the problem without them, there may have been a learning effect that biased the result, which got better as participants acquired experience with the particular problems they were given. However, since there were no significant differences

between the mean grades achieved using the two types of text, one of which was contemplated when more experience had been gained, we cannot be sure whether the procedure we have implemented had an effect on the results.

We believe that this study, along with other studies on sources of inspiration, could be useful to designers and particularly in the context of design education. In the studio we teach design methods and the use of design aids of all sorts, but we cannot teach students how to come upon strong leading ideas. Exposing them to stimuli and raising the awareness of their utility may help them in acquiring work habits that strengthen the search for a leading concept and prevent fixation. This may also encourage novices to start building up their own stocks of sources that may someday come in handy in advancing creative design ideas.

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