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HOW MOOD FOSTERS CREATIVITY IN PRODUCT DESIGN? EXPERIMENTAL EVIDENCES ON HUMOUR IMPACT DURING A CONCEPTUAL DESIGN SESSION IN A MASTER DEGREE CLASS

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ABSTRACT
Humour may improve performance in creative problem solving as demonstrated in various studies, although the mechanisms underlying this phenomenon are still unclear. In this work the mechanisms of how humour facilitates creative problem solving during the conceptual phase of product design will be investigated. From the educational point of view all the activities that tend to reduce fixation during conceptual design are welcome, because students without specific experiences in work group and in generating original ideas reproduce always what is already known.
In order to study the impact of humorous visual stimuli on creativity an experiment was performed. A sample of students of a MSc class in Management Engineering was divided into two sets and engaged to generate ideas concerning benches and shoe racks by Brainwriting (635 method) in two different ways: without stimulus and with stimulus. Three experts evaluated the concepts proposed in the generation phase and the Torrance Test of Creative Thinking (TTCT) was used to measure creativity.
A correlation analysis among the different assessments made by evaluators was performed. The interquartile distance method was used to identify and delete the extreme and abnormal values. Finally, a sensitivity analysis was used in order to demonstrate that even changing the TTCT criteria weights the experiment outcome does not vary.
The results obtained in this study shows that the concepts obtained using Brainwriting combined with humorous visual stimulation reach better creativity scores than those obtained without stimulation.
Lastly, some hypotheses are suggested in order to explain some seemingly contradictory outcomes.

Keywords: Creativity, Brainwriting, Humour, Torrance Test of Creative Thinking, Creative Thinking

1 INTRODUCTION

Creativity behaviour has been defined as one of the most important forms of human capital. Its role in innovation, invention, design and advance in a wide range of domains is now largely accepted.
Many times creativity is considered a prerogative of a few people and is associated with something abstract, far away and impossible to influence activities, but today more than ever through numerous studies it is proving that, subjected to an appropriate stimulus, all people can conceive creative ideas. This is increasingly attracting the attention of many companies who see the possibility of influencing creativity an opportunity to create new products or solve problems in a more effective and efficient way, and this is vital in a market like today's that is in constant evolution and requires the ability to adapt continuously to changes.
The early design phases represent the moment when a team of designers can have a greater impact on the innovativeness of an existing product or a new product. Many researchers have studied how to foster and stimulate creativity in the conceptual phase of product design and many techniques have been proposed to make the design team express better ideas [1 - 2].
Resources for the creative process are a combination of specific aspects of intelligence, knowledge, cognitive styles, personality, motivation, affect, and physical and socio-cultural environmental contexts [3]. Many researchers in recent decades have studied the mechanisms related to the creative process and some have studied the influence of the mood [4].

Humour and the subsequent physiological expression of laughter is a psychological phenomenon used by humans to relate each others. Intentional humour created by people involves three elements: a communicator, a listener, and a message. The study of humour can be divided into three branches [5 - 6]: Superiority theory, Relief theory, and Incongruity theory.
Regardless of the mechanism of humour, some researchers have studied the influence of humour on creativity in various contexts [7] [8] [9]. Many methods for evaluating creativity have been proposed and investigated [10] [11]. The educational environment is frequently used to test and compare different approaches. In the present paper a class of master level has been involved in the study, basically as a try to overcome fixation during conceptual phase and allow students to attend that without anxiety.
In any case, the choice of the method employed in the survey is not trivial and this depends highly on the environment in which the creative process is expressed [12]. The most used methods in the industrial context are the Consensual Assessment Technique (CAT) [13] and the Torrance Test of Creative Thinking (TTCT) [14].
The experiment we are discussing in this paper was conducted in the context of a product design course at master level, which, as already shown by other researchers [15], represents a suitable environment in which to test the choice of concept generation methods [16], of validity valuation and creativity scoring methods for design alternatives [17] and to assess the use of fostering agents [18].

2 EXPERIMENT

Many studies have been done in the past in order to understand how an external stimulus containing humour can influence individual's creativity. In some cases it has been shown that the cognitive process involved in the ideas' generation have an element of "playfulness" that can have, if adequately stimulated, an influence on the quality and quantity of ideas. In order to study the correlation between creativity and humour, an experiment was conducted engaging first-year students attending the Sustainable Products Design course of the MSc programme in Management Engineering at the University of Calabria, Italy. The experiment was performed during the very first phase of conceptual design of an industrial product when, once decided the design task and the mission statement, a design team generates the first conceptual solutions.

2.1 Concept generation

Among the many techniques of concept generation, Brainwriting (635 method) [19] has been chosen to conduct this experiment. The main reasons to use this method are [20]: (a) the possibility of creating groups without a facilitator, considering that an overzealous facilitator can limit the participants creativity; (b) the exchange of ideas without interactions, since in those methods where it is allowed to interact, it happens that some participants tend to impose themselves; (c) the active participation of all group members; (d) the possibility of carrying on and developing all ideas. These advantages can well compensate for the unavoidable disadvantages, such as the short time available, which can limit the flow of ideas, or even the lack of discussion that in some cases can affect the quality of ideas.
Among the varieties of the method, in the present experiment the following structure was adopted: the number of participants is not six but four or three for each team; during the session each participant makes three improvements to the drawing in front of him; each participant has 10 minutes to design the initial concept and 5 minutes for each following improvement phase; the total duration of a session is 40-45 minutes; the role of the mediator is not covered and the participants cannot discuss each other.
Once defined the structure of the experiment, this was performed in two different ways: the first consists of the methodology described above without making any changes, for simplicity this method has been called Normal Brainwriting, the second way is called Video-enhanced Brainwriting.
Video-enhanced Brainwriting is like a normal 635 method in which a humorous video is shown at the beginning of the session. The video is the external stimulus used to influence creativity.
The choice of video is an important phase of the experiment and must have specific characteristics in order to improve the impact on the "public". The video must be composed of different sketches quite short and not connected to each other, there must be no dialogue in it therefore must present a so-called visual humour, must support the three theories of humour (Incongruity, Relief and Superiority) and finally must present an absurd humorous style, so that it can be understood by everyone and does not discriminate anyone. In order to respect these constraints, it was decided to use a video containing various sketches of the English TV series Mr. Bean, played by British actor Rowan Atkinson.

A set of 38 first-year students of the Master's Degree in Management Engineering has been divided into 10 groups, 8 of which were composed by 4 elements and the remaining 2 groups by 3 elements.
All ten groups of participants were divided into two rooms, five groups in each one.
The case studies proposed to the students concern the design of novel (a) benches and (b) shoe racks.
In each classroom two sessions were done, one using Normal Brainwriting and the other using the Video-enhanced Brainwriting. In Figure 1 some outcomes of concepts generation session are shown.

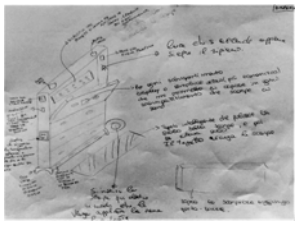
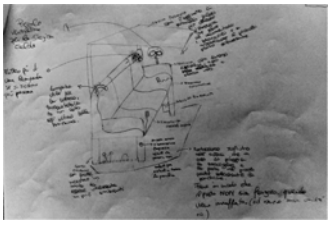
a)  b) 

Figure 1. Example of sketch of a) a shoe rack and b) a bench

Once completed in each classroom the two concepts generation sessions, all the drawings have been collected and then moved in to the creativity evaluation phase.

3 RESULTS

To evaluate creativity the Torrance Test of Creative Thinking (TTCT) is used [14]. TTCT is a method based on the theory of divergent thinking, it measures creativity by breaking it into different measurable criteria and associating a weight to each criterion, so the weighted sum of the criteria will give a measure of creativity. The TTCT standard decomposes creativity into four criteria: *fluency* (the total number of ideas), *flexibility* (the number of the different categories of relevant answers), *originality* (the statistical rarity of the answers) and *elaboration* (the amount of details in the answers).
Using the Brainwriting method the number of concepts generated per group is always the same and it is equal to the number of members present in the group, so in this case the fluency criterion is not useful for the measurement of creativity. Therefore, it was decided to replace the fluency criterion with a new, called “validity of the mechanical solution” (VMS), which indicates how much a mechanical solution is useful for that type of concept. By "mechanical solution" we mean the solution found to a problem, such as the material used, a particular shape that makes functional the product.
So, in summary, the criteria used to evaluate creativity have been reordered as: **(1) Elaboration** - the amount of details in the design alternative, evaluated using a scale ranging from 1 to 5, where 1 indicates that there are few details and 5 indicates the presence of many details; **(2) Originality** - the statistical rarity of an answer. In order to measure the originality we count for each category (material, accessories, etc.) the number of times it appears in the concepts of the same type. The reciprocal of such sum must be computed, so that a high value indicates that the answer is rare. The arithmetic mean value of the originality of the various categories belonging to the same type of concept gives a measure of the originality for that idea; **(3) Flexibility** - the number of different categories present in the concept; **(4) Validity of the mechanical solution (VMS)** - how much the mechanical solutions found in that type of concept are useful. Each solution is evaluated using a scale ranging from 1 to 5 where 1 indicates that it is not very useful and 5 indicates that it is very useful. Each solution is also associated with the weight of the category in which the mechanical solution belongs to. Five categories have been identified: *structural elements*, *design elements*, *accessories*, *functional elements* and *material*. The weighted average of the VMS gives the VMS amount of the concept.
Weights were assigned to both the criteria and the categories (see Table 1a and 1b), defined not only by the research on similar experiments, but also through "subjective" considerations in order to make the values as consistent as possible with the experiment in which they were used.

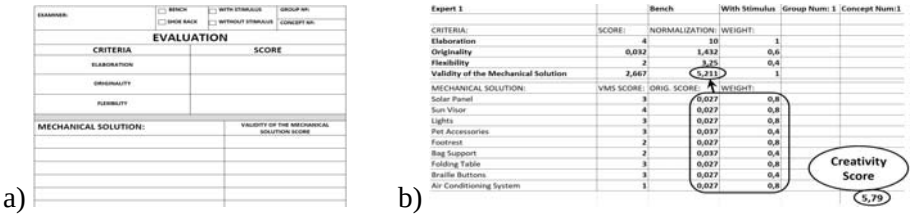
Table 1a. Weights of the TTCT criteria

TTCT CRITERION	Weight
Elaboration	1
Originality	0.6
Flexibility	0.4
VMS	1

Table 1b. Weights VMS’s categories

VMS’s CATEGORY	Weight
Structural elements	1
Design elements	0.6
Accessories	0.4
Functional elements	0.8
Material	1

Once the evaluation method has been defined three experts were involved, who independently and without influencing each other assigned a valuation for each of the four TTCT criteria for all 76 concept, filling out the form shown in the Figure 2a.



a) b)

Figure 2. Example of a) evaluation form and of b) creativity assessment form table

The collected data were first normalised. The normalisation was made on the four TTCT criteria reporting them all on a scale ranging from 1 to 10. Once normalised the data, the score of creativity, for each concept, has been obtained by Eq. (1) as the weighted arithmetic mean of the various criteria (see Figure 2b):

$$CREATIVITY = (1*Elaboration+0.6*Originality+0.4*Flexibility+1*VMS) / (1+0.6+0.4+1) \quad (1)$$

The collected data were ordered and stored in tables with the values obtained from the evaluations made by the three experts. The tables are divided by type of concept: bench with stimulus, bench without stimulus, shoe rack with stimulus, shoe rack without stimulus (see an example in Table 2).

Table 2. Example of the results of creativity assessment by one expert for one session

	Bench with stimulus (expert 1 - E1)				
	Elaboration	Originality	Flexibility	VMS	Creativity score
Group 1	6,14	1,50	3,57	5,14	4,54
Group 2	10,00	2,52	6,14	4,26	6,08
Group 3	1,00	1,40	4,86	9,69	4,49
Group 4	6,14	2,88	7,86	10,00	7,01
Group 5	2,29	8,76	10,00	7,80	6,45
AVG	5,11	3,41	6,49	7,38	5,71

Before discussing the results obtained in detail, the data collected must be further processed. First of all a correlation analysis was done using the Pearson coefficient on the assessments of the expert evaluators, in order to ensure that the scores assigned by the evaluators are sufficiently consistent. Since, as a result of this analysis, the values obtained have shown in some cases the presence of slight inconsistencies, a fourth expert has been introduced which compensated the detected.

After the correlation analysis, the values of the criteria of each concept were expressed as the arithmetic mean of the evaluations given by the experts.

Since values were much higher or much lower than the average, in order to make this study more reliable, it was decided to identify both extreme and anomalous values by means of the method of interquartile distance and eliminate them. It has been considered extreme a value with a positive variance from the third quartile greater than 1.5 times the interquartile range or, symmetrically, a value with negative deviation from the first upper quartile (in absolute value) to 1.5 times the interquartile range. On the other hand, a value with deviation (positive) from the third quartile or (negative) from the first quartile above 3 times the interquartile range is considered an anomalous value.

The final result has been calculated as the arithmetic mean of the evaluations made by all the experts.

The results have shown that, in the case of the bench the scores of the criteria elaboration, flexibility and VMS are higher in the case of the concepts generated with the Video-enhanced Brainwriting, instead the originality has a higher score in the case where Normal Brainwriting was used. However, the overall result, creativity is greater in the concepts where the visual stimulus was introduced. In the case of the shoe rack, the results are similar to those that emerged in the case of the bench except for the flexibility criterion, which appears to be higher where no stimuli have been introduced. Here, too, creativity appears to be greater in the concepts generated with Video enhanced Brainwriting.

A possible critical issue of the Torrance Test of Creative Thinking is the choice of weights associated with the criteria. In the assignment of weight values there is always a subjective component that cannot be cancelled but that has been minimise it someway. It was decided to conduct a sensitivity

analysis on the weights associated with the criteria. The analysis was made by "shuffling" the weights, i.e. all the 11 possible combinations were tested in order to understand if for some of them we can verify that the result go against the starting one. Even after the sensitivity analysis, in all cases, the concepts obtained with the Video-enhanced Brainwriting are still having a greater creativity score. Sensitivity analysis demonstrates how changing weights does not change the result, and this can be interpreted as an index of robustness of the experiment.

4 DISCUSSION

Once the final results have been obtained, the next step has been to understand why different evaluations emerged between concepts generated with Normal Brainwriting and with Video-enhanced Brainwriting. The reasons found are the result both of a study of the current literature but also of particular considerations, depending on the methodology of concept generation used.
First of all the criteria were analysed both in the case of the bench and in the shoe rack (see Figure 3).

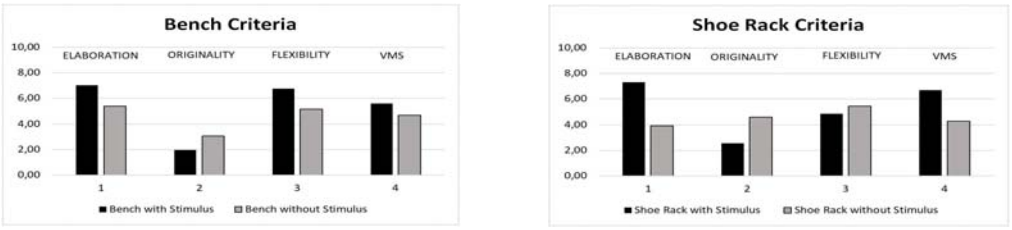


Figure 3. Graphs of the scores of the criteria in all the sessions

Both for the Elaboration criterion and for the VMS criterion, we can see how the score obtained from the ideas generated with the visual stimulus is much greater than that of the ideas generated without any stimulus. The reasons that lead to these values can be different one of the most important is certainly the "positive" atmosphere that is generated thanks to the humorous video projected at the beginning of the session. In several studies, it has been shown that creating a positive atmosphere can influence creativity in generating ideas. In particular the visual stimulus used may have generated a feeling of relief from stress, thus creating a friendly environment and eliminating the mental "blocks" caused from the fear of having to be judged, thus making the participants feel free to express their ideas. Moreover, the atmosphere created can lead to a playful approach to the problem and creativity takes advantage of it. As regards the originality criterion, however, in both cases the score obtained from the concepts created using Normal Brainwriting is greater than those created using Video-enhanced Brainwriting. The reasons are various, and once more, most likely, the atmosphere played an important role; in this case we have a "neutral" atmosphere where there are no particular stimuli. An environment of this type, without distractions, can encourage seriousness and push to solve problems in a structured way. Generally, in these cases the participants tend to make more use of the consolidated knowledge that is part of their background but give little importance to the intuitions.
The criterion of flexibility unlike the others presents different scores in the two cases; in the concepts concerning the bench, it appears to be greater where the stimulus is introduced, in the shoe rack concepts instead presents a higher value without stimulus. To argue about flexibility, further analyses will have to be carried out in order to have consistent results on which hypotheses can be made.
In brief it is possible to say that both a humorous and a neutral atmosphere can influence creative thinking. In particular, a positive atmosphere can make the expression of ideas easier, breaking those inhibitions that can lead to an expressive block. Instead, a neutral atmosphere can encourage the designer to tackle the problem in a more structured and formal way. Among the two methods it is not possible to say which the best is ever. In the experiment reported in this paper it has been shown that for the development of innovative ideas the method of generating concepts implemented with a visual stimulus of a humorous style leads to more creative solutions.

5 CONCLUSIONS

In this work an experiment was conducted to study the impact that a visual humorous stimulus can have on creativity. The results obtained from the experiment have shown that the value of creativity (assessed by means of TTCT method) for the concepts obtained using Brainwriting combined with humorous visual stimulation is higher than those obtained without stimulation.

Although the results of the experiment are positive, some changes can be introduced that could improve the quality of the ideas; for example: (a) introducing moments within the concepts generation session in which small communication exchanges take place; (b) to avoid that some participants impose themselves on the others, an external mediator could be introduced, i.e. a facilitator who does not participate actively in the session but ensure that the information circulates within the group and that nobody tries to impose their own ideas; (c) being more flexible about time, having a limited time, in fact, can make it difficult to fully express ideas and hurry can lead to find solutions that are qualitatively inferior to those that could be conceived with more time; (d) introducing, in addition to the video, other stimuli such as colours and sounds that have a further positive effect on the environment thus improving the effects of the "positive" atmosphere; (5) using more videos according to the feeling of the participants, so that the stimulus has a homogeneous effect on the entire sample.

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