The Role of Imagery and Emotion in the Translation of Concepts into Product Form

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ABSTRACT This paper represents a portion of a comprehensive design cognition study focused on the embodiment of concepts with varying emotional content (i.e. concrete, abstract and emotional) into product form. It is aimed at identifying differences in terms of cognitive processing among these three states during the initial part of the design process and during the creation of a new product by professional designers via the use of design briefs. A mixed-methods approach was used including both qualitative and quantitative approaches, and retrospective protocol analysis was used as a primary source of data analysis. Results
showed that imageability and context availability ratings for abstract, concrete and emotion concepts are highly related. Findings are discussed with reference to models of cognition and design.

KEYWORDS: design cognition, design process, embodiment of concepts, protocol analysis

Introduction

Suh (1990) defines design as ‘an evolving process that can be considered as a transition from abstract concepts to concrete descriptions’. As the transition of abstract concepts into concrete forms is a difficult task to achieve for designers, it is also a challenging issue for researchers to analyse and later describe. Visualization and embodiment of emotional and abstract concepts in the mind is an important area of investigation (Damasio, 1994; Niedenthal, 2007, 2008; Niedenthal et al, 2009). In design research, Van Rompay and Hekkert (2001) interpreted this challenge as lacking the ability to bridge a gap between the verbal, conceptual domain and the visual, material domain. Research questions in the current study focused on ‘how abstract and emotional concepts were embodied as product form’ give rise to another, more interesting question, that is, ‘what are the cognitive differences between transforming an abstract, concrete or emotional concept into product form?’ The present work will identify the differences related to cognitive activity in design processes across these varying concepts. Comparisons will allow quantitative, as well as qualitative, analyses of the data. Thus, the purpose of the current work is threefold: (1) to gain a better understanding as to how designers translate concepts that are emotional and non-emotional into product form from a cognitive perspective; (2) to compare the ways in which emotional and non-emotional concepts drive the design process specifically via the use of design briefs, oral protocols and sketches so as to determine the similarities and differences in the ways in which designers mentally represent those concepts and translate them into form; and (3) to explore these cognitive hypotheses (imageability and context availability) in a simulated real life task, through an interdisciplinary collaboration, in addition to stimulating future research questions regarding cognition, emotion, and design. It is important to note that all of the methods, findings and interpretations reflect the conceptual design phase, and therefore, cannot be generalized to the whole design process.

Context Availability and Imageability Ratings for Abstract, Concrete and Emotion Words

The current research is based on the previous work of Altarriba, Bauer and Benvenuto et al (Altarriba and Bauer, 2004; Altarriba et al,
They examined the nature of emotion words in memory by comparing the ratings of the three word types (abstract, concrete and emotion) on concreteness, imageability and context availability scales. Their research has supplied strong evidence of the distinctiveness in the cognitive processing of concrete (e.g. table, apple, car), abstract (e.g. freedom, soul, time) and emotional words (e.g. upset, surprised, fear). According to dual coding theory (Paivio, 1971, 1986), there are two functionally independent yet interconnected representational systems: verbal and imaginal. The verbal system processes verbal information, whereas the imaginal system processes non-verbal information, typically in the form of a picture or image. These representations are differentially available in memory contingent upon the concreteness of the words. Both concrete and abstract words are represented in the verbal system, but only concrete words are connected to the imaginal system. Since the image provides an additional means through which concrete words can be stored and retrieved, concrete words are more likely to be recalled better than abstract words that lack representation in the imaginal system (Altarriba et al., 1999).

The context availability hypothesis emphasizes the ease with which a context or circumstance can be recalled for a particular word (Kieras, 1978; Schwanenflugel et al., 1988, 1992). The explanation states that it is easier to retrieve a context in which a concrete word appears than to retrieve a context in which an abstract word appears. For example, the context availability hypothesis would say that it is easier to think of a context for the word chestnut (concrete) but much more difficult to retrieve a context for the word loyalty (abstract) or aggrieved (emotion). Context availability ratings are measured with a context availability scale (Figure 1). Participants are asked to rate words on whether or not they can be associated with a context or circumstance in which the word would appear. If the word

![Figure 1](image)

**Figure 1**
Context availability scale and rating instructions (Altarriba et al., 1999).
can easily be associated with a certain context or circumstance, it would get a high rating. If it takes longer and is more difficult to think of a context, it would get a low rating (Altarriba et al., 1999).

Imageability can be defined as the facility to evoke a mental image by a referent. With the aid of imageability rating scales (Figure 2), words are rated on how difficult or easy it is to form a mental image of those words (Altarriba and Bauer, 2004; Altarriba et al., 1999; Kousta et al., 2011). Measures of imageability have been used to evaluate the influence of images on memory performance and ease of word recognition (Paivio, 1971; Balota et al., 2004). Imageability is closely related to concreteness; for most words, the two measures are quite similar, although there are some exceptions. The sample word ‘armadillo’ was given by Bird et al. (2001), which generates high concreteness but low imageability ratings, apparently reflecting a lack of personal exposure to armadillos.

Altarriba et al.’s (1999) work indicates that there is a difference between all three word types on each of these scales. For both the context availability scale and the imageability scale, concrete words received the highest ratings, followed by emotion and then by abstract words. As hypothesized, emotion words were rated as being easier to image and as being easier to access an appropriate context for than abstract words. Emotion words were rated lower than concrete words on the imageability and context availability scales. Although emotion words have often been included in the abstract stimuli in the literature, when rated on concreteness, imageability and context availability they are different from abstract and concrete words. The results across studies indicate that concepts represented by emotion words are more imageable and are easier to think of a context for than abstract words.

**Experiment Overview**

Design processes of varying emotional, abstract and concrete concepts were examined using a design-and-report-task which was
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held in six sessions of 15 minutes each. The design of the experiment was formulated considering the characteristics of the research question and protocol analysis methodology. Of all the empirical research methods used for the study and analysis of design activity, protocol analysis is regarded as the most applicable and prevalent method to reveal the cognitive abilities of designers (Cross, 2007; Cross et al., 1996). The sessions were recorded by video cameras, capturing the sketching and drawing behaviour of each designer. Upon starting the sessions, the participants were presented with an informed consent form followed by a design brief. Each participant received three design briefs, in total – one for each of the three concepts mentioned above (i.e. concrete, abstract, emotion). Ten minutes of intervening tasks including demographic questionnaires were administered in between the design tasks. The procedure was identical for every participant.

**Method**

**Participants**

Twelve designers who are professionally active and contributing to the field of industrial design were randomly selected. The decision to select expert industrial designers as the sample population was based on their homogeneity of design expertise and shared terminology. Their areas of specialization included furniture, jewellery, glassware, yachts, footwear, packaging and household appliances. Their duration of practice averaged 12 years (ranging from 2 years to 37 years). Five participants were male and seven were female with a mean age of 35 years (ranging from 25 years to 56 years). They completed the experiment individually and in their natural designing environment, in various design offices, design agencies and companies located in Istanbul. The participants used their own hand designing tools. They were asked to sign an informed consent form to be videotaped and recorded during the task.

**Materials**

Each of the 12 participants was given an experimental session package that contained consent forms, demographic questionnaires and three design task/report task briefs. The design task brief developed for this research was created to be appropriate for the research problem – a basic product design project focusing on the concept and appearance of the product, not too large, and feasible to complete in the available time.

Design briefs instructed the participant to design a perfume container with three different given concepts of an emotional-‘aggrieved’, abstract-‘loyalty’ and concrete-‘chestnut’ nature. The perfume container was chosen especially for its potentially minimal complexity in terms of overall form and form dominant structure. Thus, the designer could work towards constructing the form without being distracted by complex aspects of product design.
In order to select the three specific concepts stated above, various lists of words were constructed. Words whose meaning denoted a material object were classified as concrete words. Multi-dimensional scaling and factor analytic studies suggest that emotional experiences consist of both a valence (pleasant or unpleasant) and an arousal (low, medium or high) component (Russell, 1980, 1991; Russell and Bullock, 1985). Therefore, words whose meanings were affective and had pleasantness or unpleasantness and arousal components were classified as emotion words. Words whose meanings referred to something independent from a material object that were not classified as an emotion word were designated as abstract words (Altarriba and Bauer, 2004). Overall, a list of abstract, concrete and emotion words, matched in terms of word frequency and word length, was generated and classified for further selection from the Turkish Word Frequency Dictionary database (Göz, 2003). Ultimately, the criteria for choosing the final three words were:

- Concrete and abstract words should not contain any emotion components (i.e. neutral in terms of valence and arousal).
- Emotion words should be negatively valenced. Negative stimuli tend to capture attention and affect cognitive processing more than neutral or positive stimuli. In many situations, results for positive stimuli are equivalent to those for neutral stimuli (Pratto and John, 1991; McKenna and Sharma, 1995; Montalan et al, 2011).
- The three words should be matched on word frequency and word length – variables that have been known to affect overall cognitive processing of word stimuli (Altarriba and Basnight-Brown, 2011).

The design briefs were formulated as shown in Figure 3. As each participant was presented with a total of three identical design briefs, one for an emotion concept, one for a concrete concept and one for an abstract concept, the order of these briefs was counterbalanced across participants using a Latin Square Design. In psychological

**Figure 3**
Design task brief for emotion concept.

**DESIGN BRIEF- EMOTION**

Design a perfume container with the given concept “AGGRIEVED”.

This is a form oriented design task. So it is important not to focus on design and product features (such as brand identity, intended market, dimension limitations, manufacturing processes, etc.) but to focus on the overall concept.

You will have 15 minutes for completing your design sketches.

You will be given one sheet A3 drawing paper and may use any of your own hand drawing tools, whatever you typically use.
experiments, when every participant is run under all experimental conditions, those conditions are typically counterbalanced to minimize order effects (Bradley, 1958). In the design of such experiments, Latin Squares (row-column design) are used in which each condition is preceded by a different condition in every row and in every column. For more detailed discussion of the general use of Latin Squares to eliminate unwanted experimental effects, see Grant (1948).

Procedure
After consenting to participate voluntarily, the participants were given a general brief. Participants were instructed that once the study began, they would not be permitted to ask any questions of the experimenter. Before starting the design tasks, a practice task for understanding the ‘think aloud protocol’ was held (Ericsson and Simon, 1993). It was important to make sure that participants understood the method and what they would be doing prior to the start of the experimental tasks. Next, each participant received his/her first design brief. After reading it, this first design task was started. It was important that all the participants were given an equal amount of time, so the experimenter reminded participants that they had 15 minutes for each activity. The participants were given one A3 sheet per task. The camera was set to record starting with the first design task. After completing this task, the experimenter turned the camera off and transferred the recording to a computer. The camera was set on again to record the corresponding report task that participants engaged in, as they viewed their performance on this particular design task. The report task began simultaneously with the screening of the participant’s own designing session. In retrospective verbal reports, the participants were asked to recall the thinking process immediately after finishing the task. It is important that there is no delay between the task completion and reporting, so as to fully access working memory (Ericsson and Simon, 1993). In the current study, we adopted Suwa and Tversky’s (1997) experimental procedure in order to minimize selective recall effects and simultaneously showed the participants the videotapes of their own design sessions. The report tasks took approximately 15 minutes depending on the reporting detail of the participant. The experimenter encouraged the participant to ‘tell more’ if needed. However, the experimenter provided an equal amount of time for each task across participants in order to maintain consistency throughout the study. Portions of demographic questionnaires were given as intervening tasks in between the three design and report tasks. At the end of the experiment, each participant was given a debriefing form, thanked and dismissed from the session.

Results and Discussion
In this paper, each participant’s protocol dataset was processed and time coded in order to draw comparisons with the theoretical
motivation of attempting to understand cognitive processing differences across our three word types, as per previous findings (Altarriba, and Bauer, 2004; Altarriba et al, 1999).

Protocols consisted of two kinds of data – video recordings of the tasks, and the drawings. To interpret and analyse the data, both sketches and verbal protocols (verbal and visual data) were analysed in tandem. This procedure followed the dual mode process by Akin (1986). Both verbal and visual data were time coded, and we examined the following topics:

- Amount of time spent to represent the first image to be drawn (i.e. the time during which the participant generates the first external representation as a pictorial image, after receiving the design brief).
- Amount of time spent for the first representation either visual or verbal (i.e. the time during which the participant generates the first external representation whether it is a meaningful visual representation (a pictorial image) or a meaningful verbal representation (a written explanation/text/word) after receiving the design brief).
- Total amount spent for each design task.
- Number of product alternatives produced in each design task.

Time coding was accomplished via the use of the video recordings. All sketches were numbered in the order of their appearance, identifying the first image presented up to the point when the final image was formed, including the total time spent on each phase of the task as shown in the sample drawing from a participant in Figure 4.

Figure 4
Sample analyses of visual material.
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Mean Amount of Time to Produce a First Representation as a Drawing
As can be seen in Table 1, individuals were fastest to begin sketching concrete concepts, followed by emotion concepts and finally abstract concepts.

Table 1  The mean amount of time (in seconds) to produce the first drawing.

<table>
<thead>
<tr>
<th>Descriptive statistics</th>
<th>Mean</th>
<th>Std deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>38.25</td>
<td>43.15</td>
<td>12</td>
</tr>
<tr>
<td>Emotional</td>
<td>71.41</td>
<td>87.66</td>
<td>12</td>
</tr>
<tr>
<td>Abstract</td>
<td>98.25</td>
<td>89.83</td>
<td>12</td>
</tr>
</tbody>
</table>

The results of an analysis of variance (ANOVA) indicated that there was a difference between concrete, abstract and emotion concepts in terms of the mean amount of time taken to produce a first pictorial representation as a drawing, though this difference failed to reach significance ($p > 0.05$). However, the difference between abstract concepts ($M = 98.3$) and concrete concepts ($M = 38.3$) was statistically significant, $t(11) = 2.10, p < 0.05$. No other comparisons yielded significant differences. In line with the work of Altarriba et al (1999) and Altarriba and Bauer (2004), it is quite clear that concrete words, because they naturally refer to objects that are highly imageable and can readily be placed into contexts, incite a designer to transfer concept to form much more quickly than was the case for the other two concept types. As one might expect, abstract words – words that are not typically easily associated to an actual object and quite often do not easily bring to mind an associated context, prompt the designer to take more time in deciding how to execute a first sketch or actual representation. While numerically, emotion concepts fall somewhere in between these two word types, they actually lie closer to abstract words, indicating that while they are often pictureable as, say, the expression of emotion on a human face (Barrett et al, 2007; Ekman, 1992), these emotion concepts, when attempting to be translated to form, bear a closer resemblance to abstract words, in the mental representations of these word types.

Mean Amount of Time to Produce a First Representation
Table 2 shows the mean amount of time taken to produce a first representation (i.e. first verbal recall or drawing). When a verbal description appears as a first representation, both the emotional concept task and the concrete concept task are first processed much more quickly than the abstract task, as each of the first two
tasks more easily call to mind some form of representation (picture or verbal description), as compared to the latter task (i.e. a sad human face image was recalled and announced just as fast as the chestnut image, as shown in Figures 5 and 6). These data also suggest that verbal representations generated by an associative recall of an emotion word (i.e. grief, sadness) were expressed just as fast as the pictorial representations of the word *chestnut* (see e.g. Figure 7).

Table 2 The mean amount of time (in seconds) to produce the first representation.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>62.25</td>
<td>66.49</td>
<td>12</td>
</tr>
<tr>
<td>Concrete</td>
<td>27.92</td>
<td>37.09</td>
<td>12</td>
</tr>
<tr>
<td>Emotional</td>
<td>25.08</td>
<td>26.96</td>
<td>12</td>
</tr>
</tbody>
</table>

The results of an ANOVA indicated that there was a significant difference between concrete, abstract and emotion concepts in terms of the mean amount of time taken to produce a first representation, $F(2, 33) = 4.51, p < 0.05$. Planned comparisons revealed that there was a significant difference between the mean time spent producing an initial response for the concrete concepts ($M = 27.92$ seconds),
Figure 6
Sample sketches of the ‘chestnut concept’ container.

Figure 7
Sample sketches of the ‘aggrieved concept’ container.
as compared to the abstract concepts ($M = 62.25$ seconds), $t(11) = 2.06, p < 0.05$. Likewise, there was a significant difference between the mean time spent producing an initial response for the emotion concepts ($M = 25.08$ seconds) as compared to the abstract concepts $t(11) = 2.40, p < 0.05$. As noted earlier, concrete concepts and emotion concepts tended to take about an equal amount of time to initiate response, likely due to the similarities that have been reported in the literature regarding the ease with which these concepts appear to lead to the formation of mental images (see e.g. Altarriba et al., 1999). Thus, the current work is the first, to our knowledge, to examine the representation of the concept types – concrete, abstract and emotion – in the context of product design.

**Mean Amount of Time Spent on Each Task**

As can be seen in Table 3, participants finalized the concrete concept task fastest, followed by the emotion concept task and finally the abstract concept task (see Table 3). As it was easier to form an image for the concrete concept (i.e. they already had the form of a chestnut in memory), the participants finalized the product faster in that particular task.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>833.00</td>
<td>104.50</td>
<td>12</td>
</tr>
<tr>
<td>Concrete</td>
<td>738.58</td>
<td>175.14</td>
<td>12</td>
</tr>
<tr>
<td>Emotional</td>
<td>810.25</td>
<td>139.13</td>
<td>12</td>
</tr>
</tbody>
</table>

The results of an analysis of variance (ANOVA) indicate that there was a significant difference between concrete, abstract, and emotion concepts in terms of the mean amount of time spent in each of the three design tasks, in total, $F(2, 33) = 3.14, p < 0.05$. Planned comparisons revealed that there was a significant difference between the overall time spent on working with the concrete concepts ($M = 738.58$ seconds) as compared to the abstract concepts ($M = 833$ seconds), $t(11) = 2.57, p < 0.05$. While there was a trend towards finding a difference between the concrete concepts and the emotion concepts ($M = 810.25$ seconds), the effect was only marginally significant, $t(11) = 1.63, p < .10$. Overall, it appears that concrete concepts are somewhat easier to work with in terms of overall time to completion, followed by emotion concepts and then abstract concepts, respectively. Clearly, the ability to construct an image and context for concrete items leads to their ease of access and in the ability to translate that concept into form, followed by emotion concepts which, in turn, have been rated higher in imageability as compared to abstract concepts (see e.g. Altarriba et al., 1999).
Thus, theoretical predictions one might make about the cognitive processing of these three concepts as they are translated into form are borne out by the current set of data.

**Additional Findings**

The primary findings resulting from observations of the tasks, qualitative analysis and further quantitative comparisons on the data set are as follows (with quotations from designers included):

- While working on the *chestnut* concept, designers tended to draw the chestnut image right away. However, while developing the form, he/she tries to ‘deny’ the chestnut image to create something unique. Additionally, in general, the designers were not satisfied with the final form they developed, thinking that they lacked the ability to come up with a creative form.

  I want to move my mind away from the real chestnut image in my mind, I start taking notes of what chestnut reminds me of; winter, fire, thorns, inner–outer, cold, paper bags … …along the way I’m telling myself that I do not want to use the image of chestnut directly …

- While working on the *chestnut* concept, designers tended to consider tactile properties much more readily, such as texture, colour, smell, etc., particularly as compared to the other two types of concepts:

  I thought of the shape and I drew. I drew something half-opened like a cross-sectional view because we always see it as it is divided and broken. These things that I drew here is to tell myself that it is a cavity … Because of its texture, it is something that we do not want to touch; but on the other hand, I think that it is the shell of the chestnut.

  …I can give both the colour and texture of a chestnut to the first bottle …

  …in order to give rise to a chestnut smell, I remember that the chestnut has to be processed …

- As the designers tried to embody a form, they tried to capture every single concrete visual representation of the given concept that could be transferred or transformed into a three-dimensional form. Through this transformation process, the object concept ‘container’ as described in the design brief, acted as a priming concept directing the recall process. As a result, when the concept and retrieved context was not associated with the ‘container’, it took more time generating a representative image to be embodied as a form.

  I again imagine a sphere … as there is a container concept here; spontaneously I think of voluminous forms, I mean I
imagine three-dimensional forms. It is something that you can put things into, the natural structure of the chestnut also has this…

…I imagined a weeping willow, I felt it’s an unhappy tree… I started drawing from the trunk because this is going to be a perfume container… [for the emotion concept aggrieved]

…loyalty reminds me of two pieces, two bodies… Now I drew the two spheres here, these symbolize the two individuals for me… [for the abstract concept loyalty]

• When the concept was abstract or emotional, to access a mental image, designers tended to create metaphors, associations and context. Thus, they became more involved with the process, creating scenarios and stories. They were more satisfied with the final product in terms of creativity.

The abstract concepts that I named as difficult was easier at this stage, supposing that it fed me more.

• For the loyalty concept, the most common association was ‘two people, man and woman, two pieces’. Thus, the final product was a two-pieced container in eight out of 12 participants (67 per cent).

There appear two characters in front of my eyes. I cannot think of loyalty as singular. I cannot think of it as a single-sided thing either. If there is one, there should be the other one, as well.

• For the aggrieved concept, the most common first representation is an unhappy face and a person with his head lowered which led designers to try tilting the neck of their form at some point in the design process.

In the beginning, an aggrieved, unhappy person. Afterwards he/she is not really unhappy but more hesitant. Little like hopeless. Depressed. That’s why first I thought about a sulky face, down faced, down necked…

• For the emotion concept, designers created a greater number of different associations, as compared to the other concepts. Thus, the final product solutions were more creative and showed considerable diversity as compared to the abstract and concrete concepts.

• As the emotion concept grief is often associated with pain, a tactile property was often used as a design measure, similar to the chestnut concept.

Grief hurts you inside, you ache. Then I thought of something and started to draw. Grief may have a bitter smell, but I can also create the bitter form. I saw the form
and started to draw … I drew that and created a texture with small sharp triangles. It is a texture such that when I hold, it hurts …

**Conclusions**

This paper is derived from a comprehensive design cognition study that was aimed at exploring the cognitive processes of designers while embodying abstract, emotional and concrete verbal concepts into product form. Transforming a set of verbal data into form through conceptual design activities, in the early design stages, is largely a memory-based activity involving distinct cognitive operations and processes. As observed in the current experiment, these processes include, (i) search of memory contents, recall and retrieval of the acquired knowledge/information; (ii) deriving analogies, mapping information retrieved with stored representations in memory; (iii) contextual associative processing, activating associations by these representations in the relevant context; and finally, (iv) generating new information and providing new ideas.

Understanding these cognitive processes through the complex nature of design activity is crucial for contributing to design knowledge, developing methods and theories to support design activity and providing significant insights to design cognition (Gross, 2007; Gero and Purcell, 1998; Hasirci and Demirkan, 2007; Liikkanen and Perttula, 2006, 2010; Shah et al, 2000). Furthermore, the current paper may help to inform teaching practices used in design classrooms, particularly those related to instruction on rapid drawing and sketching (see e.g. Have and van den Toorn, 2012, for related arguments on the importance of these notions particularly at the beginning stages of the design process).

The data set was analysed in light of recent cognitive literature that outlines the theoretical and processing differences across the three types of concepts under study. Interestingly, the ways in which the concreteness or emotionality of a concept is processed in the verbal domain, is directly related in the ways in which designers move from their conceptual understandings to actual forms derived from those concepts. The correspondences are many and typically statistically reliable (see above). Thus, one might conclude that designers first translate a verbal label into a possible pictorial image or form after considering their mental representations of those concepts, and then, with an image in mind, they begin their sketches and/or verbalizations regarding those images. Clearly, the use of contextual memory – memory for the circumstances and settings in which those concepts were learned and/or experienced – plays a role in the development of those ideas that are then transposed into actual drawings. This transitional process is cyclic, until a designer reaches a satisfying solution. The findings are also consistent with the idea generation model that Liikkanen and Perttula (2006) suggested in their recent work. In their model, idea generation is treated
as a cue, and this cue, in turn, stimulates a context-dependent memory search process. After receiving the verbal concept (as a keyword) participants started retrieving internal information in order to generate a first representation. This process was fastest for the chestnut concept, not only because the image of a chestnut can be most quickly recalled, but also because the concept cued the container itself – another, concrete entity. Context availability of concepts leads designers through an associative process, generating new ideas and imagining the product form precisely in specific, realistic and meaningful contexts. These activities, therefore, greatly increase the likelihood that a designer will come upon a satisfactory, final product form.

Emphasizing the crucial importance of internal (mental) representations, Visser (2009, 2010) proposed that design activity is the construction of external and internal representations that designers then ultimately produce. Knowledge learned and gained through experience, as the basis of these representations, is a key element in design creativity (Visser, 2006). The majority of the participants in the current study evaluated their aggrieved concept final design as creative. The images recalled and represented in the emotional concept task were also shown to produce the greatest diversity. The participants’ predictions that their emotional experiences should be unique, made participants think that their design must also be novel and unique.

Knowledge generated by the current work may contribute to future research focused on generalizing these results to other types of design tasks, as well as towards the development of tools and instructional methods that might capitalize on what we know about the various characteristics of abstract, concrete and emotional concepts in order to facilitate their embodiment or transformation into form. Likewise, measures of creativity and related skills could also be examined in terms of their impact on the ease with which images are accessed and converted into object forms leading to greater creativity in design solutions. Furthermore, modelling such a transformation process from abstract concepts to form will contribute to our knowledge of the developmental aspects of design training and skill development. Finally, another interesting avenue for future research would be exploring gender differences using the current paradigm.

In 1998, Gero and Purcell (1998: 430) argued that ‘There are a number of theoretically developed areas of cognitive psychology which are used to facilitate the theoretical enterprise in the design problem solving area… Conversely, it would also appear that research in the area of design problem solving, because of the particular characteristics of design problems, could make a significant contribution to expanding our understanding of working memory, imagery and creative synthesis.’ The current work represents a strong step towards making just such a contribution, as designers clearly performed their tasks differently depending on
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the concreteness, imageability and emotional nature of the concepts they were attempting to translate into form.

References


**Biographies**

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second language acquisition, and emotion, attention and cognition. Currently, she focuses on how monolingual and bilingual speakers represent emotion-related words through the use of both implicit and explicit measures. Her work has appeared in numerous scientific journals including the Journal of Memory and Language; Memory & Cognition; and Perception and Psychophysics. She is co-editor of the recent volume, An Introduction to Bilingualism: Principles and Processes, as well as two other books in the areas of cognition and culture, and bilingual sentence processing.

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