# *The effect of subliminal suggestions on Sudden Moments of Inspiration (SMI) in the design process*

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*The purpose of the study is to identify Sudden Moments of Inspiration (SMI) in the architectural design process to examine the effect of subliminal suggestions on SMI. In the study, two experienced designers were selected and were provided with a design task. While one designer was subjected to subliminal suggestions through a slide show presentation and a video clip, the other designer was not. The design sessions of both designers were recorded, coded and analyzed, using concurrent and retrospective protocol methods. Comparison of the two design protocols provided convincing evidence of the occurrence of SMI influenced by subliminal suggestions.*


*Keywords: architectural design, design cognition, protocol analysis, creativity, Sudden Moments of Inspiration*

The Sudden Moment of Inspiration (SMI) in a design problem is the moment where the designer gets an insight into the design solution and/or the problem frame. These moments of inspiration are what drive the design process, redirecting them into innovative solutions. There have been very few attempts to identify how these SMI occur and their nature or role within the design process. In this study, we analyze the architectural design process to explain the nature of these SMI.

Architectural designing is a complex process of problem solving, problem framing (Gao & Kvan, 2004) or even problem stating (Bijl, 1985). The method of protocol analysis has been used extensively to examine the design process. Suwa and Tversky (1997) discuss how the designer's attention changes from one aspect of the design to another in what they refer to as a *focus shift segment*. This study attempts to identify these focus shifts, specifically to identify the focus shifts that dramatically affect the design, or what we term as the Sudden Moments of Inspiration (SMI). These focus shift segments can also be considered as the turning points of a design, which mould the design. The SMI is also referred to as the "aha" moment (Akin & Akin, 1996), eureka moment (Knoblich & Oellinger, 2006) or as sudden mental insight (Cross, 2001).

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When identifying SMI, the objective was to investigate the role of subliminal suggestions, which have been studied extensively in fields such as marketing. A subliminal suggestion may be a sign or message embedded within a context, which is designed to pass through normal perception without clear detection. Even though not directly detectable, these messages are received by the subconscious mind. Studies suggest that subliminal cues may mould the way that a person reacts, which is termed as subliminal persuasion (Ap Dijksterhuis & Smith, 2005).

The main hypothesis of the study is that since subliminal suggestions have the capacity to alter the cognitive process, they might manifest in the form of SMI and affect the design process. Specifically, the study examines whether subliminal suggestions affect the frequency and the nature of the occurrence of SMI in the design process.

# 1 Sudden Moments of Inspiration (SMI)

The literature on Sudden Moments of Inspiration (SMI) in design is dispersed within studies of design protocols. Some studies address SMI in relation to design *stuckness* and mental blocks. The phenomenon of not being able to move forward in a problem is termed *stuckness* (Sachs, 1999). Here, stuckness is referred to as the culmination of an involuntary, unintentional process that begins with a breakdown in the design student's capacity to respond to the studio requirements (pp. 208–209). *Mental block* is a broader term, i.e. "A barrier in our minds preventing us from producing desired information" (Kozak, Weylin Sternglanz, Viswanathan, & Wegner, 2008, p. 1123). The study of *mental block* has been addressed in design in terms of design fixation (Murty & Purcell, 2003; Purcell & John, 1996). Gestalt psychologists have extensively studied fixation as a phenomenon interchangeable with mental block found in design studies (Murty & Purcell, 2003). Design fixation too deals with the idea that designers, regardless of discipline, will at times find it difficult to move away from an idea in order to resolve a problem (Jansson & Smith, 1991)

There are two theories which attempts to provide solutions for fixation. Forgetting fixation theory of incubation (Smith, 2003) explains that an incubation interval can overcome fixation. Opportunistic assimilation theory (Seifert, Meyer, Davidson, Patalano, &Yaniv, 1995) suggests that insightful ideas are triggered by stimuli that are serendipitously encountered sometime after repeated failures have sensitized one to an unsolved problem (Smith, Linsey, & Kerne, 2010). The incubation effects depend on the ability to problem solve and these may occur suddenly and unexpectedly in an unrelated activity or when returning to the problem after a pause. This swift answer to the problem is called illumination or an insight.

Insight that eliminates fixation can be activated by accidentally encountered cues. According to Smith et al. (2010) insight means a deep understanding of the innermost workings of a problem which may include critical ideas that can solve difficult problems. When such an understanding springs into mind in a sudden realization it is referred to as an insight experiences, an "aha" experience or an eureka moment.

The idea of *insight* in problem solving was first suggested by Gestalt psychologists. They suggested that this process occurred due to two things-prior experience and restructuring of the problem (Köhler, 1969; Wertheimer, 1961). When more seasoned designers experience the SMI, they might be drawing from their prior experiences and then restructuring the problem to look at it in a different way.

Kounios and Beeman (2009) state that a sudden comprehension that solves a problem, reinterprets a situation, explains a joke, or resolves an ambiguous percept is called an insight or an *"Aha" moment*. This Sudden Moment of Inspiration (SMI) in a design problem is the moment where the designer gets an insight into the design solution and/or the problem frame. Kounios and Beeman (2009) further state that although the experience of insight is sudden and can seem disconnected from the immediately preceding thought, studies conducted using ectroencephalography (EEG) and functional magnetic resonance imaging (fMRI) show that the SMI is the culmination of a series of brain states and processes operating at different time scales.

Wallace (1926) identifies four major phases in information processing that would lead to innovative problem solving and creativity: *1. Mental preparation, 2. Incubation, 3. Illumination and 4. Verification*. He states that the incubation phase consists of putting the problem aside and thinking instead about other matters, where at some point during this phase there is an abrupt shift to the illumination phase, when the SMI occurs. Seifert, Meyer, Davidson, Patalano, and Yaniv (1995) state that people who achieve creative insights go through intense mental preparation; subsequent long-term subconscious incubation; and abrupt, unanticipated illumination prior to achieving SMI.

Some studies have examined overcoming fixation through inducing insight. Most of these studies directly induce insight providing conscious visual stimuli (Goldschmidt, 2010; Goldschmidt & Smolkov, 2006; Keller, 2005). However, studies which have examined the effects of subliminal visual stimulation on design are almost nonexistent. Jansson and Smith (1991) demonstrate that exposing designers to an image of potential design solution to a problem prior to a design session results in fixation. The effect of Visual stimuli on design have been studied extensively focusing on user sketches (Verstijnen, Hennessey, Leeuwen, Hamel, & Goldshmidt, 1998) and rich displays (Casakin & Goldschmidt, 2000) as well as visual stimuli. Furthermore, Goldschmidt & Smolkov, 2006 demonstrates that visual stimuli, and their nature, have an effect on qualities of the solutions the designers arrive at. Smith et al. (2010) state that people are susceptible to design fixation, blocks or impasses caused by a variety of subconscious cognitive processes.

## 1.1 Subliminal suggestions

The effect of subliminal suggestions has been studied extensively in fields such as marketing (Broyles, 2006; Hawkins, 1970; Theus, 1994; Trappey, 1996) and education (Boucouvalas, 1993; Russell, 1991). Designers often incorporate these images consciously into the design process (Eckert & Stacey, 2000; Mougenot, Watanabe, Bouchard, & Aoussat, 2009). However, there has been very little or no research done in terms of the effect of subliminal suggestion in architectural design. Subliminal suggestions in the design context can be referred to as visual stimuli incorporated in the design process subconsciously. This study attempts to identify if subliminal suggestions can play a part in forming generators of architecture while creating corresponding SMI.

The concept of subliminal perception is defined as a behavior that may be affected by stimuli of which the individual is unaware (Byrne, 1959). Hawkins (1970) referred to this phenomenon as the registration of a stimulus below the threshold of perception. Hawkins also noticed that regarding the threshold of perception, the three following concepts have been used interchangeably: *registration threshold, absolute threshold, and recognition threshold,* with the last one being the most popular in recent research. Unconscious activation in which subliminal influences take root is known to be short lived and without memory trace (Greenwald, Draine, & Abrams, 1996). Repeated exposure to subliminal representations can be considered classical conditioning (Kihlstrom, 1987) and would lead to subliminal persuasion (Ap Dijksterhuis & Smith, 2005).

*Supraliminal* perception, on the other hand, is manifested above the threshold of cognition or at conscious awareness (Bernat, Bunce, & Shevrin, 2001). The process in which psychological material crossing between subliminal perception and supraliminal perception is called *transliminality* (Thalbourne & Delin, 1994), and researchers have reported a correlation between *transliminality* and creative personality (Thalbourne, 2000).

More specifically, Thalbourne and Delin (1994) define creativity as a process in which pre-existing elements are put into an unexpected relationship that is considered contextually appealing and useful. In the *'transliminal zone'* described by (Ference & Houran, 2006) a person was found to vividly connect unrelated objects, thoughts, feelings etc., leading to the birth of creativity.

## 1.2 The design process

The process of designing is a complex problem-solving exercise. Some authors suggest that design is more a process of problem framing (Gao & Kvan, 2004) than of problem solving. Archea (1987) refers to the design process as puzzle making, and it is also often described as a wicked problem (Buchanan, 1992; Rittel & Webber, 1984) or an ill-defined/structured problem (Simon, 1973). However, design can also be seen as a method of problem management, where the required function is fulfilled, even though an optimal solution is not derived. Attempts at quantitatively examining this process have been made through the practice of protocol analysis (Heylighen & Martin, 2004; Neiman, Do, & Gross, 1999; Suwa, Purcell, & Gero, 1998; Suwa & Tversky, 1997).

In these quantitative studies, how a design evolves is often discussed through a step-by-step process, but the steps prior to sketching have not been discussed at length. How does an architect begin to design? Do they start off with arbitrary sketching? Lawson (1972) provides two contrasting styles of operation—the problem focused and the solution focused. In solving design problems, science students used a problem-focused approach describing the structure of the problem, while architecture students used a solution-focused approach, in which they tried out different solutions and tested them later. Hillier, Musgrove, and O'Sullivan (1972), who provides a conjecture-analysis model for the design process, state that in order to make a problem tractable, it should be pre-structured, either explicitly or implicitly. They further state that design is essentially a matter of pre-structuring problems and argue that this is the reason that design is resistant to empirical rationality, where even with a complete account of the designer's operations there will still be gaps as to where the solution originated.

Darke (1979) modified Hillier's model as generator-conjecture-analysis. She rationalized this model by stating that the idea of a primary generator precedes the conjecture stage. She defined the primary generator as the concept or objective that generates a solution. Even though she states that the primary generator can be rationally justified at the point where it enters the design process, it is usually more of an article of faith on the part of the architect, *"a designer-imposed constraint not necessarily explicit" (p. 181)*. In a design process, this primary generator can be the *user*, the *context*, the *activity pattern* or some *higher purpose*. In designing a personalized house, the primary generator may be the end *"user"* of the house. In projects where the site is to be given a large amount of consideration, and the site itself defines the form of the design (such as in the case of a sloping site); the *"context"* becomes the primary generator. In designs where the activity patterns should be given prominence, as in a hospital setting, the *"activity pattern"* becomes the primary generator. In situations where emphasis is more concentrated on the non-physical, cognitive aspects such as in museums, the primary generator becomes the *"higher purpose."* The *"higher purpose"* generator can be defined as influences by extraneous factors outside of the immediate physical, social or functional context. Each of these generators is capable of becoming a secondary or a tertiary generator as well. For example, if a house is to be designed on a sloping site, the primary generator could be the *user,* and the secondary generator could become the site or *context*. The *higher purpose* generator can be considered present in every form of the design, either as a secondary or even tertiary. While the first three generators relate to the physical characteristics of the design, *higher purpose* demands a different explanation. This fourth generator deals with the normative facet of design. It is important to understand how this particular generator functions, and the inferences that make this generator function. The ways that generators of architecture and inspiration work in the design process are two different things.

Heylighen and Martin (2004) proposes that the ideas underlying architectural designs can be mentioned by many names, such as image, primary generator, organizing principle, concept, etc. She further states that these ideas do not necessarily require the addition of an extra ingredient, and that every aspect is already present in the design situation. But how can one explain an abstract imagery for John Utzon's Bagsværd Church, where the architect has drawn inspiration from regular, trade-wind driven clouds he saw while lying on a beach in Hawaii? Might this show that imagery and primary generator lie in two different planes? In this context, it is important to investigate the occurrence of SMI and its translations into primary generators of architecture, more specifically to the *higher purpose* generator of architecture. If inspiration can be induced from an external source, would it affect the formation of the primary generator, and would the nature of SMI provide turning points for a design?

## 2 Method

In this study two designers were provided with a design task. One designer was subjected to subliminal suggestions through a slide show presentation and a video clip, which were provided under the guise of information required for the design. The other designer was not subjected to subliminal suggestions but was given instructions regarding the design verbally. The design protocols of both designers were documented through video and audio recording through a think aloud process. Verbal protocol analysis was used to record the design process. In verbal protocols, participants are asked to verbalize their thoughts either during the design process (*concurrent* protocol) or after the design process (*retrospective* protocol). In distinguishing between the two types of protocols, Kuusela and Paul (2000) found that concurrent data provided more information about decision making, while the retrospective method provided more insight about the final choice. In order to identify the SMI and their frequency in the design process, a protocol focusing on decision making (concurrent protocol) was found to be a better choice. In the study a retrospective analysis was also included to gain insight into the final design to see how subliminal stimuli influenced the final product. After completing the design, both designers were asked questions regarding their design process, and the protocols were coded and analyzed by two separate coders.

## 2.1 Segmentation

In order to study recorded verbal protocols, the segmentation structure introduced by Suwa and Tversky (1997) was adopted, in which a segment is one coherent statement about a single item/space/topic. However, this definition was not sufficient to analyze the larger shifts in the design process where SMI occurred. Hence, the unit of segmentation used was similar to a design *move* proposed by Goldschmidt (1995), in which a *move* is defined as an act that transforms a design from one state to another. Linkages between different segments helped to identify how segments with SMI relate to the surrounding segments. The emphasis was on the macroscopic scale of the protocol and not on the finer details, which enabled to clearly frame the task of identifying SMI within the protocol.

The dependencies among subsequent segments, referred to as dependency chunks (Suwa & Tversky, 1997), were identified and were grouped accordingly. Segments that did not lead to dependency chunks were defined as *isolated segments*. Segments that set-off a dependency chunk were defined as a *focus-shift segment*.

To address the macro-level phenomenon, sequences of dependency chunks that formed a distinct phase in the design process were identified and defined as *phase chunks*. A design process may have several phase chunks categorized according to the specific phase of the design. For example, a portion of the protocol where the design idea emerged as distinct physical form was identified as the *form* phase. The *form* phase consisted of several dependency chunks, which described activities related to the form (Figure 1).

## 2.2 Action categories

Adopting the same action categories proposed by Suwa et al. (1998), the cognitive action of the designers were coded into four categories: *physical, perceptual, functional and conceptual*. In the physical action category, depictions made on paper, looking at previous depictions, and other physical gestures were recorded. In the perceptual category, the visual-spatial features of a design were recorded. In the functional category, the designer's attention to

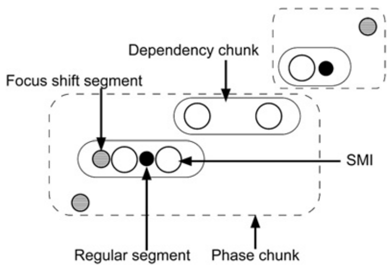


*Figure 1 Excerpt from the coded protocol showing the different elements*

functional aspects of the design was recorded, and in the conceptual category, anything that was not recorded by the previous categories was recorded, especially dealing with the conceptual aspect of the design Table 1.

## 2.3 Identifying SMI

The sudden moment of insight occurs quickly, unexpectedly and without any clear general rules. This makes it difficult for verbal protocol to capture them (Lloyd, Lawson, & Scott, 1995). However, Lloyd et al. (1995) indicates the occurrence of a change of voice, tone or conversation style in some participants after the SMI incubation period. To identify the SMI, Jonson (2005) employed the combination of verbal identification, sketches and computing. Specifically in Jonson's study, half of the SMI were captured by verbalization. Sketching and computing identified the other half.

In our study, SMI was identified through analysis of the concurrent protocol.

The retrospective protocol was used to verify the existence of a new idea in each SMI, and the participants were asked for confirmation of ideas that emerged. Retrospective protocol was also used to confirm and supplement the identification of SMI that relate to the subliminal stimuli. It was reasonable to assume that a single phase chunk would consist of at least one key event/decision. Due to this, every major decision of the design process was initially considered a potential SMI, and was re-analyzed to verify if they were in fact SMI. For this, the coders observed voice modulation of the designer, content of the segments, word density of the segments, incubation periods for the segment and the information from retrospective protocol to confirm the SMI.

## 2.4 Design experiment

Two architects with similar backgrounds and experience were chosen for the study. The study was conducted on each of them separately. One designer (who will be identified as John) was exposed to the subliminal suggestion, and the other designer (who will be identified as Jane) was considered the control.

**Table 1 Action categorization**

| *Category* | *Names* | *Description* | *Examples* |
|---|---|---|---|
| Physical | D-Action | Make depictions | Sketching of any type |
| | L-Action | Look at previous depictions | Turning page to look at previous depictions |
| | M-Action | Other physical actions | Hand gestures, facial gestures |
| Perceptual | P-Action | Attend to visual features of elements | Geometric formations |
| | | Attend to spatial relations among elements | Proximity, alignment, intersection |
| | | Organize or compare elements | Arrangement of spaces, grouping |
| Functional | F-Action | Interaction between people and space | Circulation issues, entrances |
| Conceptual | E-Action | Aesthetic evaluation on preference | Like-dislike |
| | K-Action | Retrieve knowledge | According to previous experiences |

The chosen subliminal suggestion for this study was the imagery of an arch. Before introducing the design experiment, John was provided with a slide show of images which contained nine slides. He was given 5 s to view each slide and 30 s to answer a question related to the image. Each of these images had a figure of an arch either hidden in the image or prominently displayed (Figure 3). The questions were not related to the hidden image of the arch. For example, as shown in Figure 2, one image showed a boat; in the background was a bridge that had arches. The question was, *"How many buckets are there on the boat?"* (Figure 2).

The test was devised according to the definition provided by DeVaul, Pentland, and Corey (2003), who state that subliminal suggestions can be identified as stimuli that fall beyond the subject's awareness and are presented for a very short duration at low intensities, hidden behind a "mask" of other stimuli.

At the end of the slide show, John was required to write down the names of the objects seen in the slide show. The purpose of this activity was to ensure that the designers were not verbally conscious of the subliminal stimuli, as suggested by Byrne (1959), and to identify if the stimuli is truly subliminal or not. It was interesting to note that John did not mention "arch" as an object in his list. This is evidence that John wasn't consciously aware of the subliminal stimuli. Then he was provided with a short introductory video to *Secondlife* which lasted 2 min and 15 s, where images of arches were used in the background scenery. *Secondlife* is a 3D virtual online environment where people socialize, learn, and do business using a personalized avatar. After showing this video, John was asked to write down all the objects he could remember that were shown in the video. He did not mention the *"arch"*. The main rationale in providing the slide show and the short video introduction was that the images would be etched into his subconscious and would later inspire him in

*Figure 2 How many buckets are there on the boat?*

the design task. Jane was not provided with a slide show or the introductory video. Instead, she was provided with the same information through a verbal transcript.

The research employed both concurrent and retrospective protocols. The entire design task was video and audio recorded using two cameras, one focusing on the sketching and the other focusing on facial expressions and the context where the design task took place. During the design process, the designers were instructed to think aloud. If they paused for more than 20 s, they were probed to think aloud. All pauses shorter than 20 s were recorded. Allowing designers to have small periods of silent moments (incubation periods) affects the generation of SMI (Lloyd et al., 1995).

In the retrospective analysis, the designers were questioned about these periods of silence. The process of sketching can be thought of as a method that combines cognitive as well as physical components. The cognitive component in sketching is the cognitive process, which continues while sketching, and the physical aspect is putting the pencil/pen to the paper in order to create a physical impression of that cognitive process. Studies have shown that the human brain can only effectively handle two tasks at a time (Rosen, 2008), so while sketching (both the cognitive and physical components), it would not be


*Figure 3 Images with arches in the background*

effective to provide verbal transcript of what the designer is doing, and by using retrospective analysis such effects were minimized.

## 2.5 The design task

The design task was to create a large monument on the *Secondlife* island to function as a landmark. The designers were informed that the island belonged to *WritingWorld*, a private company that provides writing services for the public. The company offers tutoring, writing courses, editing and proofreading services. Because *Secondlife* users have the ability towalk or fly around the island, the main objective was to make the figure large enough to be noticed from any location on the island, irrespective of whether they were on the sky or on land.

There were several reasons that contributed to selecting such a project. One of the main reasons was the selection of the design generator. The effects of *user, context and activity pattern* generators were intended to be minimized so that the design outcome would not be bound by any biases of the platform (Secondlife). Since the higher purpose generators by definition are influenced by elements outside of the immediate context, it was believed that they might be more prone to the effect of Sudden Moments of Inspiration, and since they are not affected by other constraints, they might be affected by subliminal suggestions. But the primary generator selected by John was the *context* instead of *higher purpose*. However, Jane selected a *higher-purpose* primary generator for her design. Another reason was that the design process needed to be simple and very short in order to be completely coded and analyzed for SMI occurring throughout the design process.

Since both designers were familiar with the *Secondlife* platform, it made the project more interesting to them as well. The subjects were given approximately 30 min to design the monument/landmark, but both designers completed the design in 14–15 min.

# 3 Analysis and discussion

In order to test the validity of the coding scheme, the Cohen's kappa value (Cohen, 1960) was calculated for the protocols using Cohen's kappa formula.

$$k = (Po - Pc)/(1 - Pc)$$

Po is the proportion of observed agreement, and Pc is the proportion of agreement predicted by chance. Some researchers define poor reliability as a kappa of less than 0.4, fair reliability as 0.4 to 0.6, good reliability as 0.6 to 0.8, and excellent as greater than 0.8 (Trickett & Trafton, 2007). In the study, the initial IRR was calculated at 0.60. After negotiations between the coders, it was increase up to 0.95.

Protocols of John and Jane were both encoded using the coding method previously explained. Facial expression was not coded due to not being able to identify significant changes in facial expressions. In the analysis, focus was placed on the concurrent protocol, which was later corroborated using data obtained through the retrospective protocol and the sketches that the designers made.

## 3.1 John's protocol (treatment)

First, John's protocol was divided into segments and then combined segments to form dependency chunks, as defined by Suwa and Tversky (1997). Then these dependency chunks were combined into phase chunks that identified a single phase of the design. For example, all the dependency chunks that describe the form of the design were placed in a single phase chunk, and all of the dependency chunks that describe the concept were placed in a single phase chunk (Figure 4).

In some instances, after working within one phase chunk, the designer would work on a different aspect of the design and then go back to the previous phase chunk. These were counted as separate phase chunks.

It was reasonable to assume that there should be at least one key event/decision that took place in a single phase chunk, and these would manifest as SMI for that phase chunk. As the timeline vs. segments graph in Figure 5 depicts, several SMI were identified in certain phase chunks. Two types of SMI were identified, regular SMI that were not directly related to the subliminal stimuli (which was denoted as nSMI) and SMI that were directly related to the subliminal stimuli (which was denoted as sSMI).

In John's protocol, 27 segments, 8 dependency chunks, 5 phase chunks, and 9 SMI were identified. The five phase chunks consisted of *1. site identification, 2. form, 3. material, 4. programming,* and *5. details.*

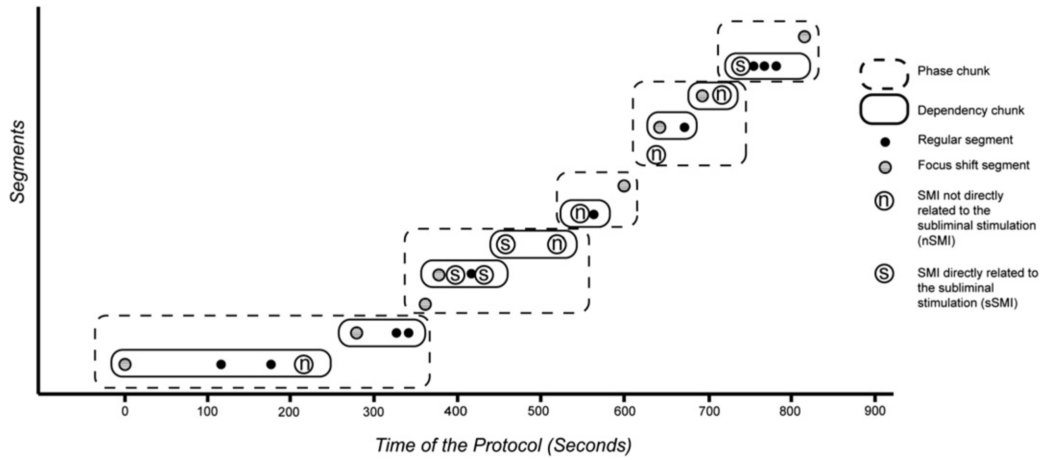


*Figure 4 Timeline and chunking of John's protocol*

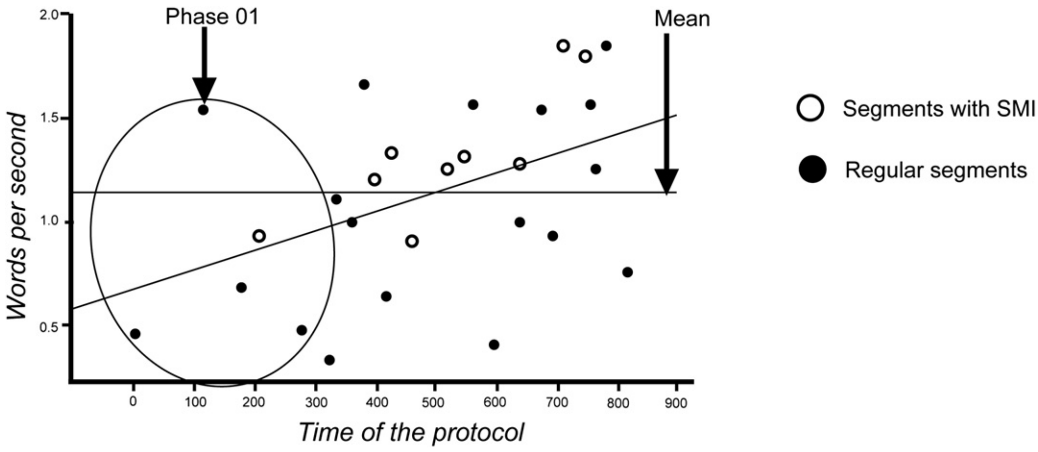


*Figure 5 Words per second vs. timeline (John)*

The first phase took more time and is represented with only one SMI which was not related to the subliminal stimuli. This phase was considered to be the incubation period for the complete design process. In this period, the subliminal suggestions began to affect the design process. The main characteristic of this phase is that since the time period was comparatively longer, the words-per-second rate was very low, which might have occurred due to incubation period of SMI.

Phase 2/*form phase* chunk contained 4 SMI out of the 9. These SMI were directly related to the subliminal stimuli. The relationship to the subliminal stimuli was identified under three conditions (agreed upon by the researchers before the experiment).

1) The sketching pattern within the segment being considered should depict similar traits to the subliminal stimuli,
2) The verbal protocol should indicate indirect references to the subliminal stimuli, and
3) The designer should directly reference elements in the subliminal stimuli.

Lloyd et al. (1995) states that when insight occurs, the tone of the voice will change from commentary to signaling recognition. The same method of identifying the difference in voice modulation of the subject was adopted. Lloyd et al. (1995) also state that in the minutes or seconds before insight occurs, concurrent verbalization may or may not be able to capture the designer's thoughts. This was one reason that a retrospective protocol method was used (Figure 6).

In phase 5, the designer completed his sketches with a corresponding sSMI, which significantly resembled the subliminal stimuli presented. (In this case, one can see an arch of the design of the landmark) (Figure 7).

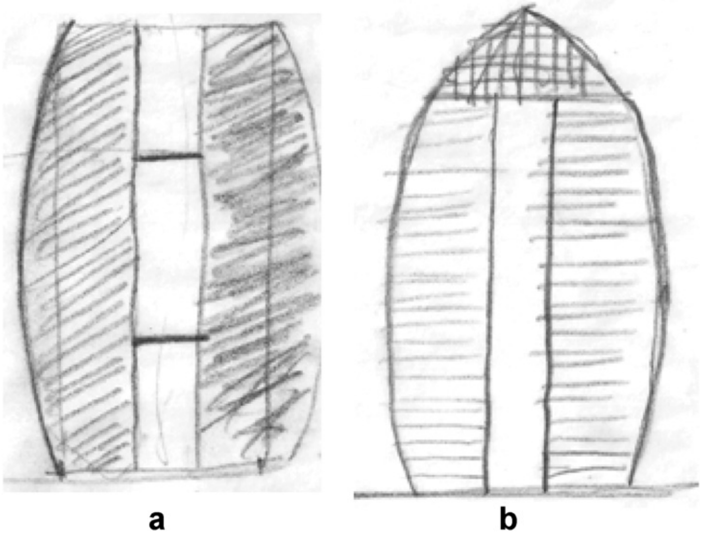


*Figure 6 (a) Part of the sketch completed in phase 2 and (b) Part of the sketch completed in phase 5 both containing sSMI (John)*

In order to identify the correlation between the change of rate of words per second as time progressed, regression analysis was conducted between words per second and timeline progression. The result of the regression between words per second and timeline progression indicated the two predictors explained 21% of the variance ($R^2 = 0.21$, $F(1, 26) = 6.6$, $p < 0.05$). It was found that as time progressed, the number of words per second increased

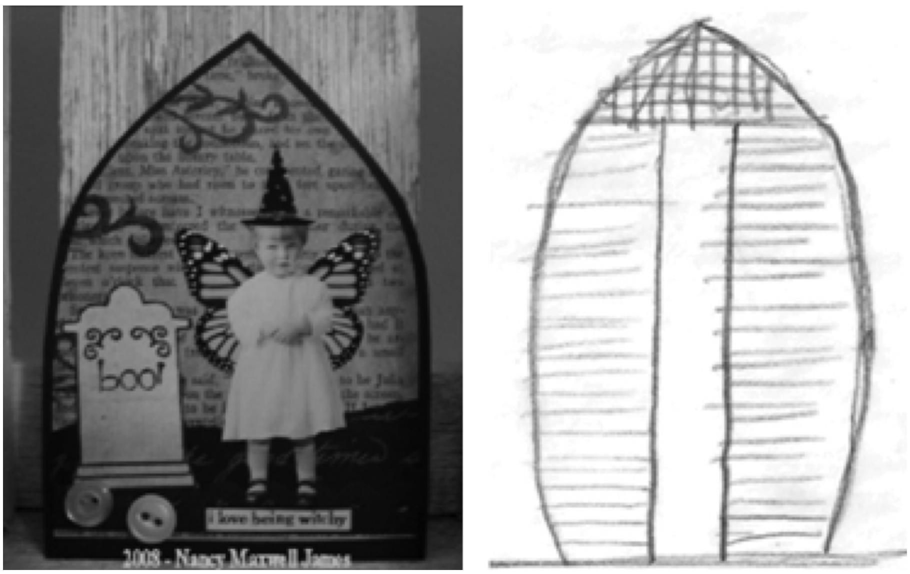


*Figure 7 Side-by-side comparison of one of the images shown to John and his final design sketch*

($\beta = +0.0009323+(26) = 2.57, p < 0.05$). In John's design process, as time progressed within the design process, the words per second increased. It can also be observed that in the majority of the segments where SMI occurs, words per second are centered on the mean value for words per second.

Similarly, regression analysis was conducted between number of pauses and timeline progression in order to identify the correlation between the number of pauses and timeline progression. The result of the regression between number of pauses and timeline progression indicated that the two predictors explained 37% of the variance ($R^2 = 0.37$, $F(1, 26) = 14.56$, $p < 0.05$). It was found that as time progressed, the number of pauses decreased ($\beta$ - 0.0021+ (26) = -3.82, $p < 0.05$). This indicates that as time progressed within the design process, the incubation periods were reduced Table 2.

Table 3 provides total calculated actions that took place within the whole design process (Phase 1−5), which are categorized according to phases. Phase 1 has the lowest actions per second rate (0.075), and in the second phase, the number of actions per second had doubled (0.150). This is a dramatic change in the actions per second rate, which is not repeated afterward (0.16, 0.21 and 0.2 respectively). Even though there are increases in the actions per second rate thereafter, the increase is comparatively low. It was assumed that this sudden increase is due to the subliminal suggestion acting upon the design process, based on the retrospective protocol and subjects sketches (Figure 8).

A comparison of the three graphs, timeline vs. segments, timeline vs. words per second and timeline vs. action density of John's protocol (Figure 13), shows that after initiation of the second phase, there is an increase in density and an increase in words per second. The SMI influenced by the subliminal stimuli may have increased the actions within this period.

## 3.2 Jane's protocol (control)

Jane's protocol was used as a control to John since Jane was not subjected to subliminal suggestions. Jane's protocol was divided into segments, similar to John's and then segments were combined to form dependency chunks. These dependency chunks were then combined into phase chunks to identify a single phase of the design. Because of the difference in design style, the phase chunks formed differently in Jane's protocol. Jane selected a *higher purpose* primary generator, and so her design was more concept-oriented than John's.

**Table 2 Regression analysis**

| *Regression* | $R^2$ | df | $\beta$ | $F$ |
|---|---|---|---|---|
| Change of rate of words per second Vs. Time | 0.21 | 26 | 0.0009 | 2.52 |
| Number of pauses Vs. Time | 0.37 | 26 | −0.002 | 3.82 |

**Table 3 Actions categorized according to phase chunks (John)**

| Phase Chunk | | Action type | | | | | | | Total Actions | Time | Actions per second |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | D | M | L | P | F | E | K | | | |
| 1 N=7 | Mean | 1 | 0.71 | 0.57 | 0.86 | 0.29 | 0 | 0.14 | 25 | 335 | 0.075 |
| | SD | 0 | 0.49 | 0.53 | 0.38 | 0.49 | 0 | 0.38 | | | |
| | Median | 1 | 1 | 1 | 1 | 0 | 0 | 0 | | | |
| 2 N=7 | Mean | 1 | 0.71 | 0.14 | 1 | 0.29 | 0.57 | 0.14 | 27 | 181 | 0.15 |
| | SD | 0 | 0.49 | 0.38 | 0 | 0.49 | 0.53 | 0.38 | | | |
| | Median | 1 | 1 | 0 | 1 | 0 | 1 | 0 | | | |
| 3 N=3 | Mean | 1 | 1 | 0 | 1 | 0.67 | 0.07 | 0 | 13 | 80 | 0.16 |
| | SD | 0 | 0 | 0 | 0 | 0.58 | 0.58 | 0 | | | |
| | Median | 1 | 1 | 0 | 1 | 1 | 1 | 0 | | | |
| 4 N=5 | Mean | 1 | 0.8 | 0.6 | 0.8 | 0.8 | 0 | 0.8 | 24 | 114 | 0.21 |
| | SD | 0 | 0.45 | 0.55 | 0.45 | 0.45 | 0 | 0.45 | | | |
| | Median | 1 | 1 | 1 | 1 | 1 | 0 | 1 | | | |
| 5 N=5 | Mean | 1 | 0.2 | 1 | 1 | 0.8 | 0.2 | 0 | 21 | 102 | 0.2 |
| | SD | 0 | 0.45 | 0 | 0 | 0.48 | 0.48 | 0 | | | |
| | Median | 1 | 0 | 1 | 1 | 1 | 0 | 0 | | | |

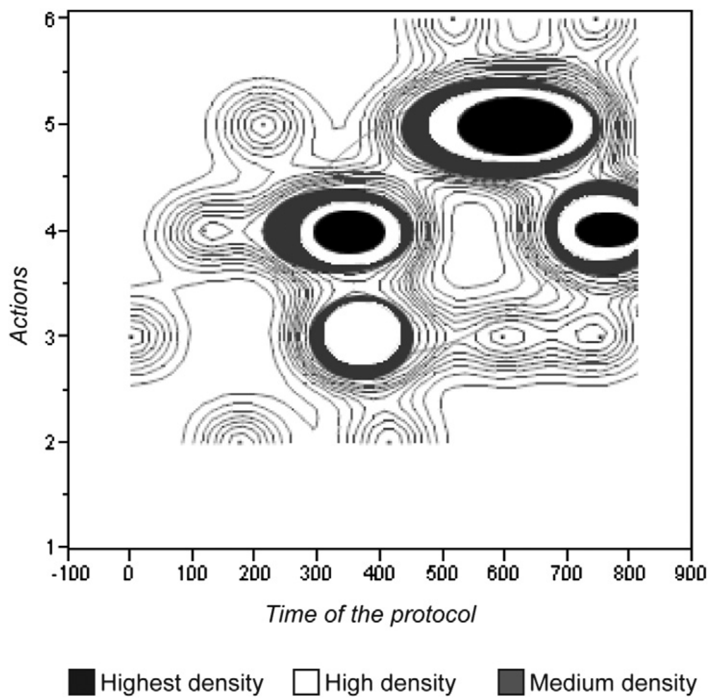


*Figure 8 Action density by timeline (John)*

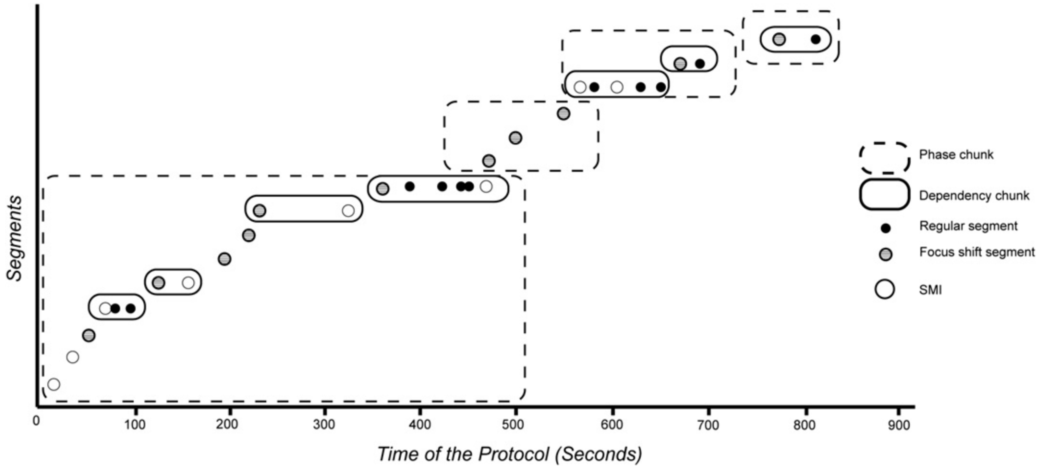


*Figure 9 Timeline and chunking of Jane's protocol*

The phases for Jane's protocol were: 1. *Conceptual-(I), 2. Material, 3. Conceptual-(II), and 4. Functional* (Figure 9). Even though the design process is divided into four phases, for identification purposes, it was observed that each of the conceptual phases molded the subsequent phases (Phase 2 and Phase 4), and hence the SMI occur in the conceptual phases. It may be the case that in situations where the generator becomes higher purpose, SMI occur in conceptual phases rather than functional phases, since these phases dominate the rest of the design protocol.

One of the main characteristics of Jane's protocol is that a number of consequent SMI seem to be occurring in the first few segments of the first phase.

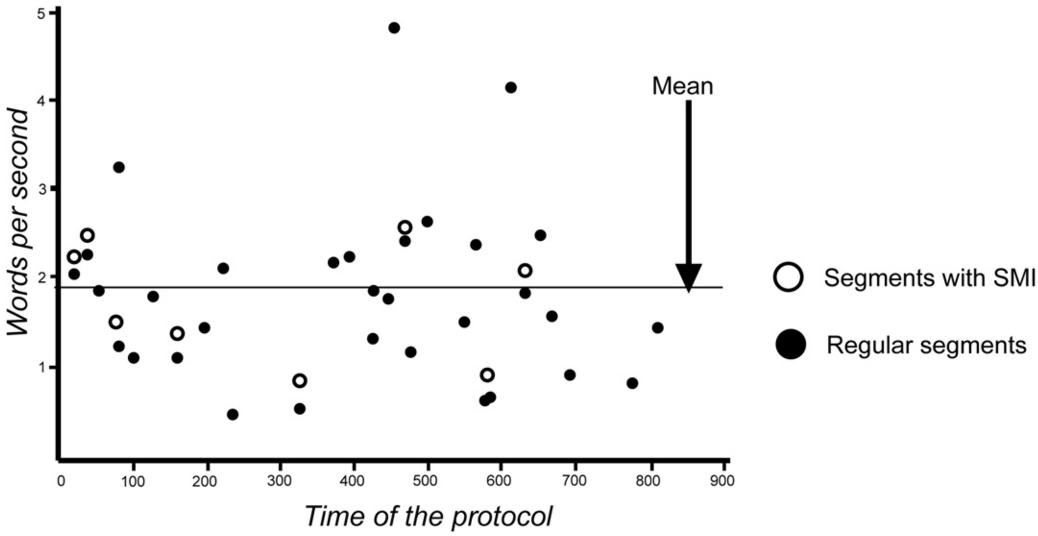


*Figure 10 Words per second vs. timeline (Jane)*

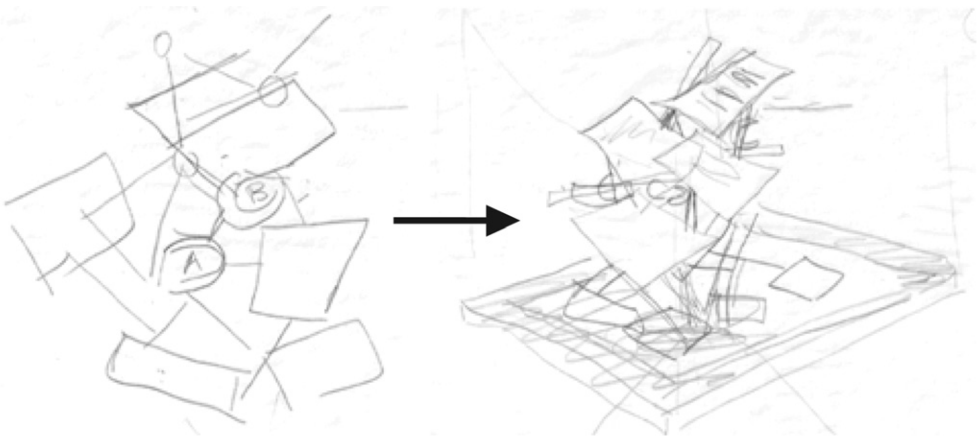


*Figure 11 Jane's sketch of concept to finished design*

The phase chunks other than *conceptual (I)* and *conceptual (II)* have only five segments combined (Figure 10).

Regression between words per second and timeline did not provide any significant results. Almost 50% of the segments are below the mean words per second rate, which was similar to John's protocol. But the difference here is that even though the words per second rate increased with time in John's protocol, Jane's protocol does not show a similar trend (Figures 11 and 12).

Comparisons of the action density in the two protocols show how John's actions are more centered around the time of the sSMI occurrence, while Jane's

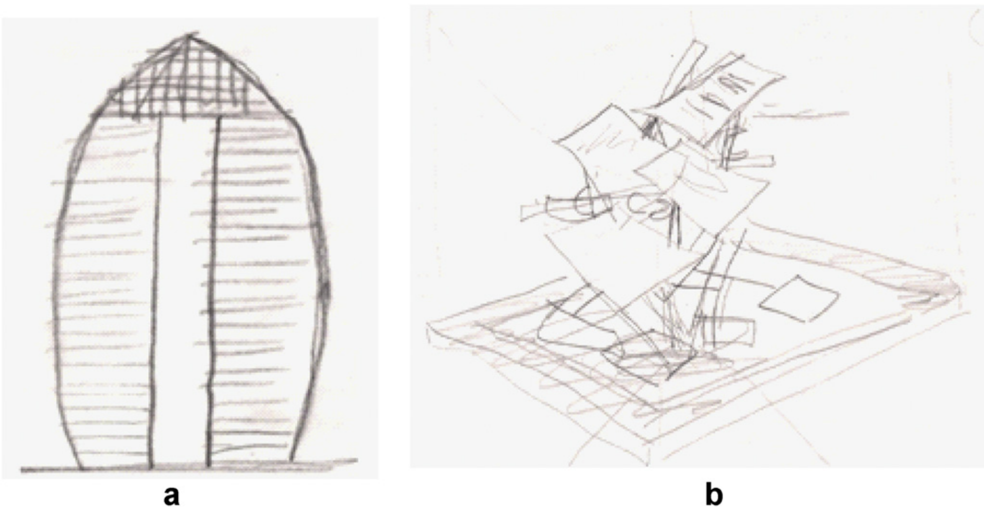


*Figure 12 Comparison between sketches by John (a) and Jane (b)*

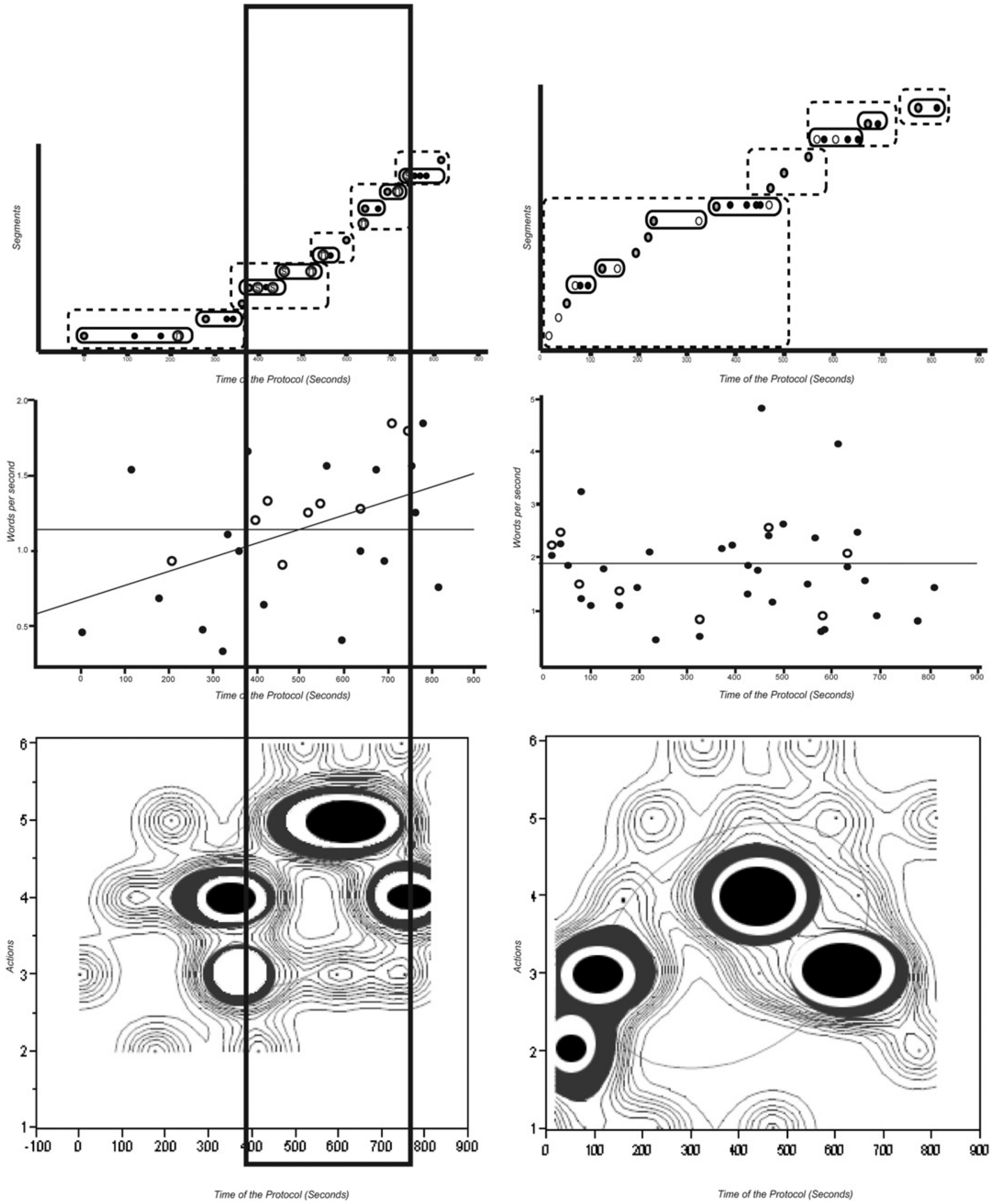


*Figure 13 Comparison between John and Jane's protocols of timeline vs. segments, timeline vs. words per second and timeline vs. action density graphs*

actions are more scattered without any particular concentration areas. With regard to this finding, the authors believe that it is necessary to document processes that lead to SMI and the activity that occurred concurrently with the SMI, since it would give a much more composite understanding of the nature of SMI. Figure 8 provides action densities against time in John's protocol (using data provided in Table 3). Action categories provide the amount of actions the subjects performed in that particular period. Using Figure 13, we can see that in John's protocol during the time period where SMI occur (due to subliminal stimulation) action is higher and word density is higher.

## 4 Limitations and concluding remarks

The major limitation in the study is the number of subjects. However, as a pilot study for future research, the findings of the study provide a better understanding of SMI and provide evidence of how subliminal suggestions may influence SMI in the design process. John and Jane's design protocols provide clear differences in the effect of SMI with and without the influence of subliminal suggestions. Both protocols concluded that SMI are major components in the design process. These moments are often signified when the designer maintains a period of silence or pauses. SMI are preceded by this incubation period. The study showed that there is a possibility of inducing SMI using external stimuli, through subliminal suggestions. It was also shown that design actions mainly revolve around particular time periods when these subliminal stimuli activate SMI. Hence, the main hypothesis of the study, that subliminal suggestions influence SMI and play a major part in the design process was supported within the limitations of the study.

Even though the effect of subliminal stimuli has been studied extensively with regard to fields such as marketing, there are very few empirical studies to identify its effect on design, especially architectural design. The evidence of the effect of subliminal stimuli in this study has implications not only to architectural design but appeal to different fields of design. The ability to induce SMI provides the capability of redirecting or shifting the design process in the necessary direction. In design education, it should be noted that inducing such SMI consciously or unconsciously may hinder the originality of students. These techniques might be used by clients in inducing design traits of their preference, as well. The findings suggest subliminal suggestions affecting the design processes through design management, as well as co-design raise interesting opportunities for future directions.

## References


Akin, Ö., & Akin, C. (1996). Frames of reference in architectural design: analysing the hyperacclamation (Aha-!). *Design Studies, 17*(4), 341–361.

Ap Dijksterhuis, H. A., & Smith, P. K. (2005). The power of the subliminal: on subliminal persuasion and other potential applications. *The New Unconscious, 77*.

Archea, J. (1987). *Puzzle-making: What architects do when no one is looking*.

Bijl, A. (1985). An approach to design theory. *Design Theory for CAD* 3–31.

Boucouvalas, M. (1993). Consciousness and learning: new and renewed approaches. *New Directions for Adult and Continuing Education, 1993*(57), 57–69.

Broyles, S. J. (2006). Misplaced paranoia over subliminal advertising: what's the big uproar this time? *Journal of Consumer Marketing, 23*(Iss: 6), 312–313.
Bernat, E., Bunce, S., & Shevrin, H. (2001). Event-related brain potentials differentiate positive and negative mood adjectives during both supraliminal and subliminal visual processing. *International Journal of Psychophysiology, 42*(1), 11–34.
Buchanan, R. (1992). Wicked problems in design thinking. *Design Issues, 8*(2), 5–21.
Byrne, D. (1959). The effect of a subliminal food stimulus on verbal responses. *Journal of Applied Psychology, 43*(4), 249.
Casakin, H. P., & Goldschmidt, G. (2000). Reasoning by visual analogy in design problem-solving: the role of guidance. *Environment and Planning: B Planning and Design, 27*, 105–119.
Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement, 20*, 37–46.
Cross, N. (2001). Design cognition: results from protocol and other empirical studies of design activity. *Design Knowing and Learning: Cognition in Design Education* 79–103.
Darke, J. (1979). The primary generator and the design process. *Design Studies, 1*(1), 36–44.
DeVaul, R. W., Pentland, A., & Corey, V. R. (2003). *The memory glasses: Subliminal vs. overt memory support with imperfect information.*
Eckert, C., & Stacey, M. (2000). Sources of inspiration: a language of design. *Design Studies, 21*(5), 523–538.
Ference, G. A., & Houran, J. (2006). *Nurturing employee creativity*. New York: HVS International.
Gao, S., & Kvan, T. (2004). An analysis of problem framing in multiple settings. *Design Computing and Cognition, 4*, 117–134.
Goldschmidt, G. (1995). The designer as a team of one. *Design Studies, 16*(2), 189–209.
Goldschmidt, G., & Smolkov, M. (2006). Variances in the impact of visual stimuli on design problem solving performance. *Design Studies, 27*(5), 549–569.
Goldschmidt, G. (2010). Ubiquitous serendipity: potential visual design stimuli are Everywhere. Paper Presented at the NSF International Workshop on Studying Visual and Spatial Reasoning for Design Creativity SDC'10. Aix-en-Provence, France
Greenwald, A. G., Draine, S. C., & Abrams, R. L. (1996). Three cognitive markers of unconscious semantic activation. *Science, 273*(5282), 1699.
Hawkins, D. (1970). The effects of subliminal stimulation on drive level and brand preference. *Journal of Marketing Research, 7*(3), 322–326.
Heylighen, A., & Martin, G. (2004). That elusive concept of concept in architecture. In *Design Computing and Cognition '04* (pp. 57–76).
Hillier, B., Musgrove, J., & O'Sullivan, P. (1972). Knowledge and design. *Environmental Design: Research and Practice, 2*, 3–1.
Jansson, D. G., & Smith, S. M. (1991). Design fixation. *Design Studies, 12*(1), 3–11.
Jonson, B. (2005). Design ideation: the conceptual sketch in the digital age. *Design Studies, 26*(6), 613–624.
Keller, I. (2005). *For inspiration only: Designer interaction with informal collections of visual material.* PhD thesis, DelftUniversity of Technology.
Kihlstrom, J. F. (1987). The cognitive unconscious. *Science, 237*(4821), 1445.
Knoblich, G., & Oellinger, M. (2006). The eureka moment. *Scientific American Mind, 17*(5), 38–43.

Köhler, W. (1969). *The task of Gestalt psychology*. Princeton, NJ: Princeton University Press.

Kounios, J., & Beeman, M. (2009). The Aha! moment: the cognitive neuroscience of insight. *Current Directions in Psychological Science, 18*(4), 210–216.

Kozak, M., Weylin Sternglanz, R., Viswanathan, U., & Wegner, D. (2008). The role of thought suppression in building mental blocks. *Consciousness and Cognition, 17*(4), 1123–1130.

Kuusela, H., & Paul, P. (2000). A comparison of concurrent and retrospective verbal protocol analysis. *The American Journal of Psychology, 113*(3), 387–404.

Lawson, B. R. (1972). *Problem solving in architectural design*. University of Aston in Birmingham.

Lloyd, P., Lawson, B., & Scott, P. (1995). Can concurrent verbalization reveal design cognition? *Design Studies, 16*(2), 237–259.

Mougenot, C., Watanabe, K., Bouchard, C., & Aoussat, A. (2009). *Visual materials and designers' cognitive activity: Towards in-depth investigations of design cognition*. Seoul, Korea: International Association of Societies of Design Research.

Murty, P., & Purcell, T. (2003). Discovery methods of designers. In *Proceedings of the 5th European Academy of Design Conference, Barcelona, Spain*.

Neiman, B., Do, E. Y. L., & Gross, M. D. (1999). Sketches and their functions in early design: a retrospective analysis of two houses. In *Design Thinking Research Symposium '99*.

Purcell, T. G., & John. (1996). Design and other types of fixation. *Design Studies, 17*(4), 363–383.

Rittel, H. W. J., & Webber, M. M. (1984). Planning problems are wicked problems. *Developments in Design Methodology* 135–144.

Rosen, C. (2008). The myth of multitasking. *The New Atlantis, 5*, 105–110.

Russell, T. (1991). Subliminal self-help tapes and academic achievement: an evaluation. *Journal of Counseling and Development, 69*(4), 359–362.

Sachs, A. (1999). Stuckness' in the design studio. *Design Studies, 20*(2), 195–209.

Seifert, C. M., Meyer, D. E., Davidson, N., Patalano, A. L., & Yaniv, I. (1995). Demystification of cognitive insight: opportunistic assimilation and the prepared-mind perspective. *The Nature of Insight, 124*.

Simon, H. A. (1973). The structure of ill structured problems* 1. *Artificial Intelligence, 4*(3–4), 181–201.

Smith, S. M. (2003). The constraining effects of initial ideas. In P. B. Paulus, & B. A. Nijstad (Eds.), *Group creativity* (pp. 15–31). New York: Oxford University Press.

Smith, S. M., Linsey, J. S., & Kerne, A. (2010). Using evolved analogies to overcome creative design fixation. *Design Creativity, 35*.

Suwa, M., Purcell, T., & Gero, J. (1998). Macroscopic analysis of design processes based on a scheme for coding designers' cognitive actions. *Design Studies, 19*(4), 455–483.

Suwa, M., & Tversky, B. (1997). What do architects and students perceive in their design sketches? A protocol analysis. *Design Studies, 18*(4), 385–403.

Thalbourne, M. A. (2000). Transliminality and creativity. *The Journal of Creative Behavior, 34*(3), 193–202.

Thalbourne, M. A., & Delin, P. S. (1994). A common thread underlying belief in the paranormal, creative personality, mystical experience and psychopathology. *The Journal of Parapsychology, 58*(1).

Theus, K. (1994). Subliminal advertising and the psychology of processing unconscious stimuli: a review of research. *Psychology and Marketing, 11*(3), 271–290.

Trickett, S., & Trafton, J. (2007). *A primer on verbal protocol analysis. Handbook of virtual environment training*. Westport, CT: Praeger Security International.
Trappey, C. (1996). A meta-analysis of consumer choice and subliminal advertising. *Psychology and Marketing, 13*(5), 517−530.
Verstijnen, I. M., Van Leeuwen, C., Goldschmidt, G., Hamel, R., & Hennessey, J. (1998). Creative discovery in imagery and perception: combining is relatively easy, restructuring takes a sketch. *Acta Psychologica, 99*(2), 177−200.
Wallace, G. (1926). *The art of thought*. New York: Harcourt, Brace.
Wertheimer, M. (1961). *Productive thinking* (rev. ed.). London: Tavistock. (Original work published 1945).