

# Visual attention and association: An electroencephalography study in expert designers



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*Extant research on the visual attention and association of designers is limited, and scientific evidence differentiating among the effects of diverse visual stimuli on design thinking is insufficient. The current study invited 12 healthy expert designers and analysed their experiences of visual attention and association in addition to exploring the differences caused by three types of pictorial representation. The results of this electroencephalography (EEG) experiment indicated that the frontoparietal region was particularly activated when the designers engaged in visual attention tasks, whereas the brainwaves were particularly activated in the distributed prefrontal, frontocentral, and parietooccipital regions during the visual association tasks. In addition, there were no significant differences in the brainwave energy resulting from the three types of pictorial representation applied in this study. The research outcomes linking design studies to cognitive neuroscience establish a concrete foundation for developing future applied research and diverse educational practices.*

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*Keywords: design cognition, design research, human factors, psychology of design, research methods*

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Designers are typically sensitive to visual stimuli, and they usually search for a diverse range of visual references when creating a design (Cila, Hekkert, & Visch, 2014). Such stimuli enhance their

[www.elsevier.com/locate/destud](http://www.elsevier.com/locate/destud)  
0142-694X *Design Studies* 48 (2017) 76–95  
<http://dx.doi.org/10.1016/j.destud.2016.11.002>  
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creativity, and they are subsequently analogised, applied, combined, or transformed into design resolutions during the design process, particularly at the early stages of concept formulation (Casakin & Goldschmidt, 2000; Lin, Hsu, & Liang, 2014). Regarding the influence of visual stimuli, Malaga (2000) revealed that designers' ideas are stimulated more by pictures than either text alone or combinations of pictures and text. Zahner, Nickerson, Tversky, Corter, and Ma (2010) further indicated that abstract and representative objects are beneficial for generating original ideas and breaking design fixations. However, scientific evidence differentiating between the stimulating effects of abstract and realistic (even surrealistic) pictures on designer creativity is limited.

Visual attention and association are critical for creativity (Andreasen, 2011; Wegbreit, Suzuki, Grabowecy, Kounios, & Beeman, 2012), particularly for designer creativity. Attention is a means of flexibly selecting competing environmental information and enhancing a range of sensory inputs for further processing on the basis of current goals while ignoring the rest (Clark, Squire, Merrikhi, & Noudoost, 2015). Visual attention can bias selection of information about objects, such as particular features (feature-based attention) or locations (spatial attention) (Amso & Scerif, 2015). Association is the construction of mappings between source and target objects (Grace, Saunders, & Gero, 2011). Visual association is significantly associated with creativity among visual artists (Afsaneh, Parisa, Karim, & Saleh, 2015). Specifically, visual attention determines what information is selected for subsequent perception and action, whereas visual association determines what target objects are related to previous memory and successive creation.

Both visual attention and association impose crucial processing bottlenecks for designers, but extant research on visual attention and association in designers is scant. Overlooking the scientific evidence of cognitive reactions can engender erroneous conclusions regarding the relationships between visual activities and design creativity, which suggests that further research on the visual attention and association of designers is warranted. Numerous studies have identified visual attention and association in the brain (e.g., Bunge, Burrows, & Wagner, 2004; Carrasco, 2011; Clark et al., 2015; Gazzaley et al., 2007), and experimenters are currently seeking to determine which areas of the brain are causally related to behavioural benefits in designers.

By applying electroencephalography (EEG), the present study aimed to analyse the brainwave patterns of visual attention and association in expert designers and explore the differences resulting from several types of pictorial representation. The research questions as follows: (i) Which brain regions are particularly activated when expert designers engage in tasks of visual attention and association? (ii) What are the differences among the brain activities

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