



Emotional design in multimedia learning: Differentiation on relevant design features and their effects on emotions and learning



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ABSTRACT

Previous research into multimedia learning has mainly focused on cognitive factors to investigate different instructional conditions and design principles. Emotional factors have so far been widely neglected. However, recent studies showed that the emotional design of multimedia learning material can evoke positive emotions in learners that in turn facilitate the learning process. Following this lead, our study aims to further explore the potential of an emotional design. We seek to differentiate the current findings by systematically deducing emotionally relevant design features and also taking into account negative emotional states. In order to deduce relevant design features, we adopt concepts from web design. German college students ($N = 334$) were assigned to one of nine conditions, created by two design factors (classical vs. expressive aesthetics), each with two levels (high vs. low) and a usability factor (high vs. low usability) as well as a control group (no color/gray scale). Unexpectedly, objective differences in aesthetics or usability did not affect learners' emotional states. However, the perceived aesthetics and usability positively affected the emotional states of the learners. Learners' emotional states had a minor impact on learning outcomes but a larger impact on learners' intrinsic motivation, including the motivation to continue working with the material.

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Instructional conditions to enhance computer-based multimedia learning have been tested primarily with respect to cognitive factors (e.g., Mayer, 2009; Mayer & Moreno, 2003; Plass, Moreno, & Brünken, 2010). Emotional factors have widely been neglected in multimedia learning research so far, despite the existence of several unanswered questions (e.g., Leutner, 2014; Park, Plass, & Brünken, 2014). How can we design multimedia learning materials that are appealing while still being effective for learning? Are design appeal and learning effectiveness in conflict with each other? Or is the opposite true, and a felicitous design can be advantageous for learning? The integration of appealing but interesting design elements that are superfluous to learning has been rather critically discussed in multimedia learning research. Although these additional elements are assumed to positively affect learners' emotions and motivation, they are believed to induce an extraneous cognitive load and therefore harm learning (seductive details: e.g., Garner, Gillingham, & White, 1989; Harp & Mayer, 1997; Lehman, Shraw, McCrudden, & Hartley, 2007; Lenzner, 2009; Mayer, Heiser, & Lonn, 2001; Rey, 2012; coherence principle: e.g., Mayer, 2009). Recently, an *emotional design* for multimedia

learning materials has been proposed (Plass, Heidig, Hayward, Homer, & Um, 2014; Um, Plass, Hayward, & Homer, 2012). Emotional design is the use of visual design elements in multimedia learning that can evoke positive emotions and therefore facilitate learning. An emotional design for multimedia learning materials does not necessarily require additional elements, but may instead change intrinsic design elements such as color, layout or round vs. square shapes. In line with this assumption, Um et al. (2012) and Plass et al. (2014) showed that warm colors and round shapes may evoke positive emotions in learners that in turn facilitate motivation and learning outcomes. However, we are only beginning to understand the role emotions may play in multimedia learning. The current study ties in with this new line of research and aims to further explore the potentials of an emotional design in multimedia learning. To this end, this study examines (1) whether intrinsic design features of multimedia learning material affect learners' emotional states and (2) how emotional states that are experienced during learning may affect the learning process. Whereas previous studies (Plass et al., 2014; Um et al., 2012) provided initial insights into the role of selected design features (warm colors, round shapes) and positive emotions, we seek to broaden the picture by systematically deducing which design features to manipulate, by investigating the effect of negative

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emotional states on learning rather than looking at positive emotional states alone. In order to deduce emotionally relevant design features, we take a multidisciplinary view by adopting concepts from web design.

1. Deducing emotional design features

As with developments in the field of multimedia learning, the main focus in the field of human–computer interaction in general and web design in particular has primarily been on cognitive and pragmatic issues, namely system usability (e.g., Hassenzahl & Tractinsky, 2006; Moshagen, Musch, & Göritz, 2009; Tuch, Bargas-Avila, & Opwis, 2010). Utility and usability aspects such as an efficient task accomplishment have been emphasized. Nevertheless, the past decade has seen the emergence of a discussion of nonutilitarian aspects such as beauty, aesthetics, enjoyment, and fun (e.g., Blythe & Wright, 2003; Hassenzahl, 2004; Lavie & Tractinsky, 2004; Norman, 2004; Tractinsky, Shoval-Katz, & Ikar, 2000; van der Heijden, 2003). Under the umbrella term “user experience”, the task-related view of system usability is extended through non-instrumental, affective and experiential aspects (Hassenzahl & Tractinsky, 2006; van Schaik & Ling, 2009). “Joy of use” as a concept of user experience explicitly addresses the role of affective design elements and the corresponding emotional reactions of the users (e.g., Hassenzahl, Burmester, & Beu, 2001; Reeps, 2006). It is assumed that objective system qualities such as layout, content, structure, or website design lead to a subjective perception of these qualities (e.g., appealing, usable), an emotional response in the user (e.g. pleasure, satisfaction) and to behavioral responses (e.g., approach, avoidance) (Hassenzahl, 2004). The focus of this line of research is on positive emotions.

1.1. Evoking positive emotions

But how can we design a website that can evoke positive emotions in learners? Even though the discussion surrounding emotional design factors has a longer tradition in web design than in multimedia learning, there is a lack of concrete, empirically validated design factors. However, *visual aesthetics* (as a more holistic design factor) has been shown to be a strong determinant of the subjective perception of a website and of the emotional responses for the users such as pleasure and enjoyment (e.g., Lavie & Tractinsky, 2004; Moshagen & Thielsch, 2010; Schenkman & Jönsson, 2000; Tuch et al., 2010; van der Heijden, 2003). Lavie and Tractinsky (2004) identified two dimensions to the perception of website aesthetics: classical and expressive aesthetics. The classical aesthetics dimension refers to a clear, orderly alignment that appears clean, pleasant and symmetrical. It is therefore related to traditional notions of aesthetics as well as to design rules in the usability literature. The expressive aesthetics dimension refers to the novelty and unconventionality of a website. It depends on the designer’s creativity and is associated with originality, fascination, and the use of special effects.

As visual aesthetics of websites are a rather holistic design feature, we still need to deduce more concrete design features that may evoke classical or expressive aesthetic impressions in users and according emotional responses. The visual aesthetics of websites has been shown to be affected by the *color* and *color combinations* used (e.g., Coursaris, Swierenga, & Watrall, 2008; Hartmann, Sutcliffe, & De Angeli, 2007; Thielsch, 2008). Moshagen and Thielsch (2010) identified color as one of four core dimensions of website visual aesthetics (alongside with simplicity, diversity and craftsmanship). Treating color as a concrete aesthetic design feature has the advantages that (a) color is an intrinsic design feature that does not require the incorporation of additional – potentially

distracting – design elements (seductive details as mentioned above), (b) color has been shown to affect emotions and behavior in a wide variety of contexts (e.g., Elliot, Maier, Binser, Friedman, & Pekrun, 2009; Kaya & Epps, 2004; Valdez & Mehrabian, 1994; Weller & Livingston, 1988), (c) colors – in contrast to many other design features – can be completely characterized in terms of hue (chromatic tonality, e.g., blue, red), lightness and chroma (saturation) (cf. Valdez & Mehrabian, 1994), and (d) colors for webpages can be systematically varied by manipulating the proportion of red, green and blue in the RGB color model. Liedl (1994) suggests three techniques for achieving an aesthetically pleasing color harmony that is independent from individual preferences: (1) choosing complementary colors (opposing color pairs on the color wheel such as red/cyan, blue/yellow or green/magenta), (2) maximizing contrasts (by manipulating lightness and chroma, the complementary colors are made as unequal as possible – one very light/slightly saturated and the other one very dark/fully saturated), and (3) choosing similar colors (variations of one color by manipulating lightness and chroma). In a recent study, Müller, Heidig, & Reichelt (subm.) showed that systematic color designs based on these techniques (see Fig. 1 for examples) significantly differed in their perceived classical and expressive aesthetics as rated by the participants. They further affected the emotional states of the participants as their presentation resulted in significantly different ratings for valence and arousal, as measured using the “Self-Assessment Manikin” (SAM, Bradley & Lang, 1994).

1.2. Evoking negative emotions

Because this study aims to investigate both positive and negative emotions, we also need to deduce design features that may evoke negative emotional reactions. Naturally the web design literature does not explicitly contain considerations how to evoke negative emotions, instead providing suggestions on how to avoid them. Interestingly, the user experience literature dealing with affective issues of web design is almost exclusively focused on positive emotions. However, preventing negative emotional reactions such as dissatisfaction or frustration is a core aim of the usability literature (Hassenzahl & Tractinsky, 2006). Usability is defined as the extent to which a product such as a website can be used to reach a certain goal effectively, efficiently and satisfyingly (cf. ISO 9241–11). Negative emotions may occur when an inhibiting condition interferes with this goal (Lazar, Jones, Hackley, & Shneiderman, 2006). Inhibiting conditions and therefore causes of negative affects as named by users include interruptions due to bugs, system crashes, error messages and pop-ups, as well as hard-to-find features, auto formatting and long loading times (Ceaparu, Lazar, Bessiere, Robinson, & Shneiderman, 2002; Mentis & Gay, 2003). Out of these, long loading times seem to be the design feature most relevant to inducing negative emotions in multimedia learning, as they are (a) intrinsic in the sense that their manipulation does not require changes in the learning content itself, (b) easy to manipulate and (c) allow for a systematic variation. Previous studies showed that time delays lead to negative affect such as frustration and impatience, especially if no information about the length of the loading time is provided (Ceaparu et al., 2002; Dellaert & Kahn, 1999).

In the literature, suggested thresholds for intolerable loading times differ greatly and range from approximately 2–41 s (e.g. Bouch, Bhatti, & Kuchinsky, 2000; Nah, 2004; Ramsay, Barbese, & Preece, 1998; Selvidge, Chaparro, & Bender, 2000). The most frequent citations is Nielsen’s (1997) suggestion that users may lose interest or believe an error has occurred if loading times exceed 10 s. Galletta, Henry, McCoy, and Polak (2002) found decreases in behavioral intentions and performance when time delays exceeded 4 s, and decreases in attitudes for delays exceeding 8 s (cf. Nah,

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