Beyond the effect size: Can visualizations from emotional design really be compared?

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Abstract

In this qualitative analysis we reviewed six experimental studies comparing different emotional designs, all including cellular visualizations. Our analyses revealed inconsistencies between conceptions both within and between studies. Materials designed do not seem to follow the theory on which they are based. Results raise the question of the relevance and generalizability of conclusions drawn in previous studies, particularly meta-analyses.

Context

To make multimedia document visually more attractive, one can integrate cartoon-like elements in their design. This characteristic of multimedia is the focus of research on emotional design. Emotional design is a multimedia principle on how to enhance learning by inducing positive emotions (Mayer & Estrella, 2014). Within the emotional design principle, different parameters can be distinguished (presence of anthropomorphism, warm colors and rounded shape), which induce distinct effects on learning outcomes (see Plass et al., 2014). Although research in this area reports contradictory results, meta-analyses from Bom et al. (2018) and Wong and Adescope (2021) found an overall positive effect of positive emotional design on learning outcomes. Nevertheless, both meta-analyses focused on anthropomorphism and color, while rounded shape and other parameters such as dimensionality can induce positive affect in the learner (Plass & Kaplan, 2016, Plass et al., 2020). Nonetheless, there is a need to identify the intrinsic features of emotional design successfully inducing positive emotional states in learners (Heidig et al., 2015). In this perspective, we conducted a qualitative analysis to identify differences and commonalities in the implementation of emotional design in previous studies.

Method

The original sample criteria from the meta-analyses of Brom and colleagues (2018) and of Wong and Adesope (2021) was for experimental material to have a common domain. Six publications investigated emotional design applied to cellular visualizations. Experimental materials were then analyzed to gather data on original source, topic, multimedia format, and emotional design manipulations (see Table 1), as well as manipulations definitions. Material samples provided in the publications were used as a basis for comparison and are presented in Figure 1.

Results and Discussion

Design comparison yielded four parameters of emotional design: anthropomorphism, color, rounded shape and dimensionality (Figure 1). However, analyses reveal inconsistencies within studies (materials based on Um et al., 2012), such as between manipulation description and actual implementation of the parameters, which seems to be derived from visual design choices more than from theoretical accounts. As an example, we noticed that the strength of the manipulation can be unstable: anthropomorphism sometimes includes a mouth but not always. We also noticed a lack of homogeneity induced by the details implemented with eyes and

mouths that vary from schematic to elaborate. As another example, while in theory it is recommended to use warm colors (shades between yellow and red), we observed the use of blue shades without justification. Finally, angular shapes such as rectangle are sometimes used when rounded shapes are recommended (Um et al., 2012)
Such inconsistencies were also present between studies. The manipulations of anthropomorphism were not homogeneous between the different images, in some hair and limbs are included (Schneider et al., 2019), in others it is completely absent (Um et al., 2012). This lack of stability also applies to the details integrated such as the use of shadow, which gives a spherical aspect to the cell (Brom et al., 2016), or no shadow, which result in a flat perspective (Um et al., 2012). Further, the adequacy with the theory was not always consistent for rounded shapes: some cells are round (Brom et al., 2016), but others pointy (Mayer & Estrella, 2014). The same issue is found for warm colors: cells are sometimes blue (Mayer & Estrella, 2014), and other times orange (Brom et al., 2016).
More results will be presented at the meeting.

Thus, as the parameters of emotional design seem to induce distinct effects (Plass et al. 2014), it there is a need for common design definitions, to foster consistent implementation across future studies.

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The asterisk indicates studies included in this qualitative analysis.

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Table 1. Comparative table of studies on emotional design with cellular visualizations

Authors (year)	n	Topic	Multimedia format	Design manipulation
Brom et al. (2016)°	Study 1= 23	How a virus causes a cold	Written text and pictures	Anthropomorphism with colours, Anthropomorphism in B&W, Schematic
Mayer & Estrella (2014)	Study 1= 64 Study 2 = 47	How a virus causes a cold	Written text and pictures	Enhanced (personification and visual appeal)
Park et al. (2015)*	101	Immunization	Narrative text and animations	Anthropomorphism (2)
Plass et al. (2014)*	Study 1 = 121 Study 2 = 103	Immunization	Narrative text and animations	S1: External induction of emotion (positive, neutral) x Internal induction of emotion (positive, neutral) S2: Colour (warm, neutral) x Shape (round, neutral)
Schneider et al. (2019)	Study 1 = 87 Study 2 = 148 Study 3 = 162	Blood platelets	Written text and pictures	Anthropomorphism (3)
Tien et al. (2013)*	Study 1 = 121 Study 2 = 103	Immunization	Narrative text and animations	S1: Neutral, Positive S2: Shape (2) x Colour (2)
Um et al. (2011)	118	Immunization	Narrative text and animations	Neutral, Positive

** Material based on Um et al. (2011); ° Material based on Mayer & Estrella (2014)*

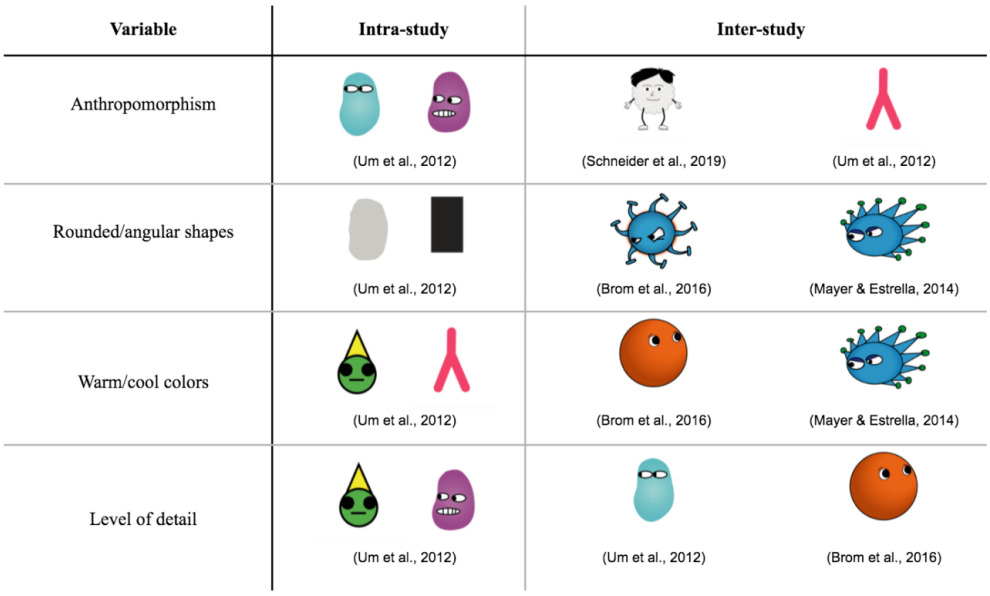

Figure 1. Material samples of studies on emotional design with cellular visualizations