The Effect of Positive Emotions on Multimedia Learning

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Abstract: The study examined whether the positive emotions experienced during multimedia learning facilitate cognitive process that leads to better learning performance and satisfaction. Positive emotions were experimentally induced before a multimedia based learning by means of self-referencing mood induction procedure (positive or neutral emotions) and during the learning by the aesthetic design of the learning materials (good or neutral design). The result of the experiment shows that there is significant effect of emotions on their transfer test, mental effort investment, as well as level of satisfaction. It also indicates that positive emotions can be generated by the instructional design that may be able to affect learners' experience and performance. The study implies that positive emotions should be considered as important factors in instructional design. Also, emotional design principles should be studied in more detail for better instructional material design.

Is it important that learners experience positive emotions during learning? If so, how can multimedia learning environments be designed to be both efficient and inducing positive emotions in learners? Research on emotions has been conducted in various academic fields. However, little empirical research on users' emotions and their effect on learning performance is available that could guide the design of learning environments.
The purpose of the research is to study whether the positive emotions experienced during multimedia learning facilitate cognitive process that leads to better learning performance and satisfaction. Furthermore, we investigate whether positive emotions induced before the learning are maintained throughout the learning process so that they affect the learners' cognitive process during the learning, and how we can generate positive emotions by instructional design focusing on the aesthetic design of learning materials.

Literature Review

Kleinginna and Kleinginna (1981) defined emotion as a complex set of interactions among subjective and objective factors, mediated by neural/hormonal systems which can a) give rise to affective experiences, b) generate cognitive processes, c) activate widespread physiological adjustments, and d) lead to behavior that is often expressive, goal directed, and adaptive.

In cognitive perspectives of emotions, emotional experience includes various cognitive components. Emotions are generated by people's judgment about the world and initiated by an individual's appraisal, and this appraisal is the output from the interaction of one's concern and stimulus (Desmet, 2003; Frijda, 1993; Lazarus, 1991; Oatley & Johnson-Laird, 1987; Ortony, Glore, & Collins, 1998). This explains that, during the learning, learners' emotions are generated by cognitive process of appraisal and interaction with the learning environment including the learning material. How these emotions affect learners' cognitive process during the learning has been the topic of speculation by various research studies on positive emotions.

In describing emotions, researchers typically categorizing them broadly into either negative or positive emotions. Positive emotions have been studied as facilitating factors of changing people's other affective experience such as attitude, motivation, creativity and problem solving skills. This is consistent with the facilitation hypothesis of emotions that positive emotions help long-term memory and retrieval, and facilitate working memory process (Erez & Isen, 2002; Isen & Patrick, 1983; Petty, Schumann, Richman, & Strathman, 1993, Weiss, Nicholas, & Daus, 1999). Especially the series of studies by Isen and her colleagues have suggested that positive emotions improve creative problem solving 1) by altering the cognitive context in which cognitive activity takes place and 2) by giving cues an extensive and varied set of material (Isen & Daubman, 1984; Isen, Daubman, & Nowicki, 1987; Isen, Jhonson, Mertz, & Robinson; 1985; Isen, Rogenzweig, & Young, 1991).

Positive emotions have also been studied as direct or indirect factors in changing people's other affective experiences such as attitude, judgment, evaluation and satisfaction (Isen, Shalker, Clark, & Karp, 1978; Isen & Patrick, 1983; Petty et al., 1993; Weiss et al., 1999). Overall, people who are in a positive emotional state make more positive judgments and give favorable feedback because they interpret situations more positively than they would at other times. The studies of Erez and Isen (2002) and Isen and Reeve (2005) also indicated that positive emotions facilitate intrinsic motivation by influencing the cognitive process involved in motivation.

However, there are studies that show the opposite effect of positive emotions, which is consistent with the suppression hypothesis that mood can take extra-task processing or task-irrelevant processing and it will have a negative effect on reasoning and performance (Ellis & Ashbook, 1987; Oaksford, Morris, Grainger, & Williams, 1996; Seibert & Ellis, 1991a). This effect of positive emotions can be explained within cognitive load theory (Paas, Renkl, & Sweller, 2003; Sweller, 1988; 1994), where emotions experienced during cognitive processing of learning materials can be viewed as imposing unnecessary load in working memory, i.e., can be interpreted as extraneous cognitive load. Even though the facilitation hypothesis is dominant in positive emotions related research, the effect of users' positive emotion in learning process is still not understood well.

In designing multimedia-based learning, various studies have implied that different aesthetic designs can induce emotions and that these emotions affect users' performance and cognitive process (Harp & Mayer, 1997; Mayer & Moreno, 1998; North & Hargreaves, 1999; Szabo & Kanuka, 1998; Tractinsky, Katz, & Ikar, 2000; Wolfson & Case, 2000). Also, users' positive perceptions about the multimedia program and learning (e.g., in Tractinsky et al. (2000) and Wolfson & Case (2000)'s studies) imply that positive emotions were produced by the different design of multimedia elements such as layout, color, and sound.

In this study we therefore examine the effect of positive emotions in a learning context, and try to identify strategies of inducing positive emotions in multimedia-based learning through the instructional design of the learning material. The research questions of this study are, 1) whether the positive emotions induced before the learning are maintained throughout the learning process so that they can affect the learners?; 2) can positive emotions be induced by the aesthetic design of the learning material?; and 3) what is the effect of positive emotions in multimedia learning on performance (retention and transfer tests), cognitive load, and learner satisfaction with regard to the learning material.

Method

Participants and Design

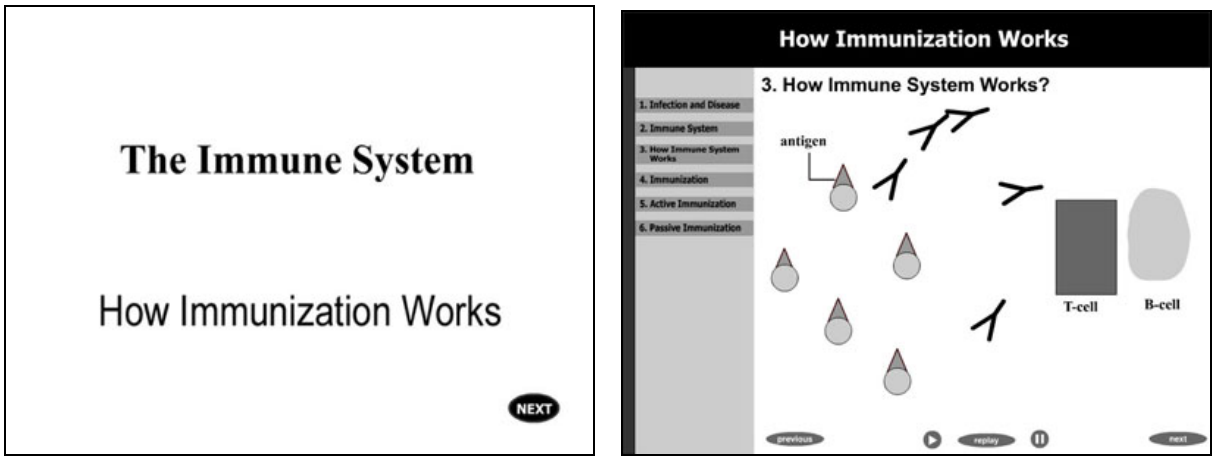
The participants were 34 college students at a large private university in the northeastern U.S. who participated in the experiment on voluntary basis. They were randomly assigned to one of four treatment conditions. These four conditions were created by two design factors, which were the manipulation of emotions by means of self-referencing mood induction procedure (positive or neutral emotions), and the manipulation of affect by means of the aesthetic design of the learning materials (good or neutral design). Therefore, controls (NEND group) received neutral mood induction procedure and neutral aesthetic design of material. The PEGD group received positive mood

induction procedure and good aesthetic design of material. The PEND group received positive mood induction procedure and neutral design material. The NEGD group received neutral mood procedure and good aesthetic design of material.

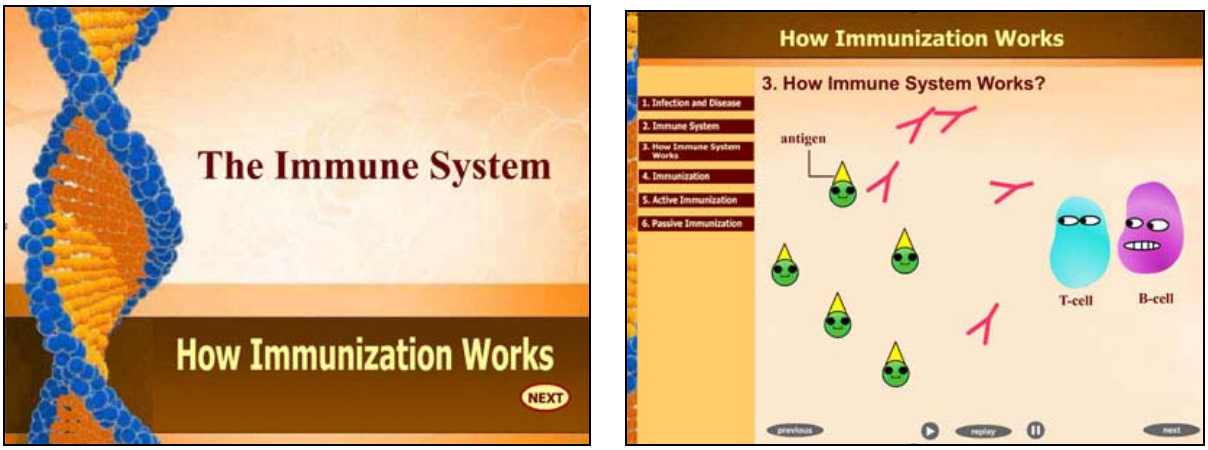
Affect Manipulation (Independent Variables)

Positive emotions induction

To induce positive emotions and neutral emotions, a self-referencing mood induction procedure developed by Seibert & Ellis (1991a) was used. The procedure was developed for inducing moods states in the laboratory that were useful in the study of cognition and emotion. Out of three mood-inducing states of happy, sad, and neutral (control) in the original instrument, this study used happy and neutral mood induction procedures.



Screen shots of Neutral Design material



Screen shots of Good Design material

Figure 1: Screen shots of multimedia based learning materials

Design of multimedia material

A computer-based lesson of 'How immunization works' was used as multimedia learning material (Figure1). This 7-minute multimedia instructional presentation was developed by the first author using Macromedia Flash™ and

HTML. Contents and instructional design of the materials were reviewed by 3 instructional design professionals. To manipulate affect, two different designs were implemented; 'neutral emotional design' aims to generate neither positive or negative emotions, and 'positive emotional design' aims to generate positive emotions. The 'positive emotional design' version was revised from the neutral one to have better quality in aesthetic design using emotional design principles (Lidwell, Holden, & Butler, 2003) such as color combination, immersion and the aesthetic-usability effect. To assure that the only design change between the two versions of the material were of aesthetic nature, both designs had the same amount of content, length and also followed the same usability and multimedia design principles (Mayer, 2001).

Procedure and Dependent Variables

Introduction

Participants were seated individually in front of computers. First, they answered the participant questionnaire soliciting information concerning participant's gender, age, and medical science/biology knowledge. Medical science/biology knowledge was accessed using a knowledge checklist and self-rating about their knowledge of immunization.

Self-referencing Mood Induction

Once they finished answering the questionnaire, 25 statements of either positive or neutral mood induction were displayed on individual computer monitors with the 10 seconds interval (Seibert & Ellis, 1991b). The participants were instructed to read each of the statement to themselves and then read the statement out loud.

1st PAS test - First Manipulation Check

To check whether the mood induction procedure affected participants' emotion, the participants answered the Positive Affect Schedule (PAS) from Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1998). The PANAS is well-validated and widely used self-report index of positive affect and negative affect mood dimensions (Crawford & Henry, 2004; Ostir, Smith, & Ottenbacher, 2005). On the PAS respondents indicated, on a scale ranging from 1 (very slightly or not at all) to 5 (very much), the degree to which they experience 10 different feelings related to positive affect ($\alpha = .84$).

Multimedia Instruction

Either the neutral or good aesthetic design of the material was displayed on each participant's computer. They were told that they had 15minutes time to study the material.

2nd PAS test - Second manipulation check

To check whether the design quality affected participants' emotion, and to also see any change of the emotions since the mood induction procedure, the participants answered the PAS questionnaire again.

Cognitive Load Measure

The participants were given the questionnaire about a learner's mental efforts (e.g. "How much of your mental efforts were invested in learning?"). Paas (1992) utilized the measure in which learners self-report how much mental effort they invested in the task. He used a 9-point Likert scale of mental effort at the task. With regard to internal reliability, Paas reported a high Cronbach's coefficient alpha of the mental effort rating scale of .90.

Recognition and Transfer Test

To check the learning outcome (performance) of the multimedia instruction, two tests of recognition and transfer tests were provided on an individual computer. The recognition test had 15 multiple choice questions (e.g. "What is the role of phagocytes?"). Participants received one point for each question they correctly answered (α= 0.69). The transfer test had 4 questions (e.g. "HIV (human immunodeficiency virus) destroys T cells in immune system. Explain the consequences of this infection by describing the role of T cells in the process of immune system"). Participants received one point for each acceptable answer on each of the four problem-solving transfer questions.

User Satisfaction about the Learning Material

A seven-scale Likert style question was used to check the satisfaction about the learning environment (e.g. "How much you did like learning using this material?").

Results

Manipulation Check

For the manipulation check of positive mood induction before the learning, an Independent Samples *t*-test with the score of 1st PAS questionnaire between the positive emotion groups (PEND, PEGD) and neutral emotion groups (NEGD, controls) was used. The mean scores and standard deviation for each treatment group on the 1st PAS test were as follows: positive emotion groups: 36.22 (6.873), neutral emotion groups: 21.06 (5.221). An Independent Samples *t*-test on the score of 1st PAS test with treatment group revealed that Positive Emotion groups rated PAS test significantly more positively than did the Neutral Emotion groups, $t(32) = 7.17$, $p = .00$. This suggested that the mood induction procedure was able to induce the intended affective state.

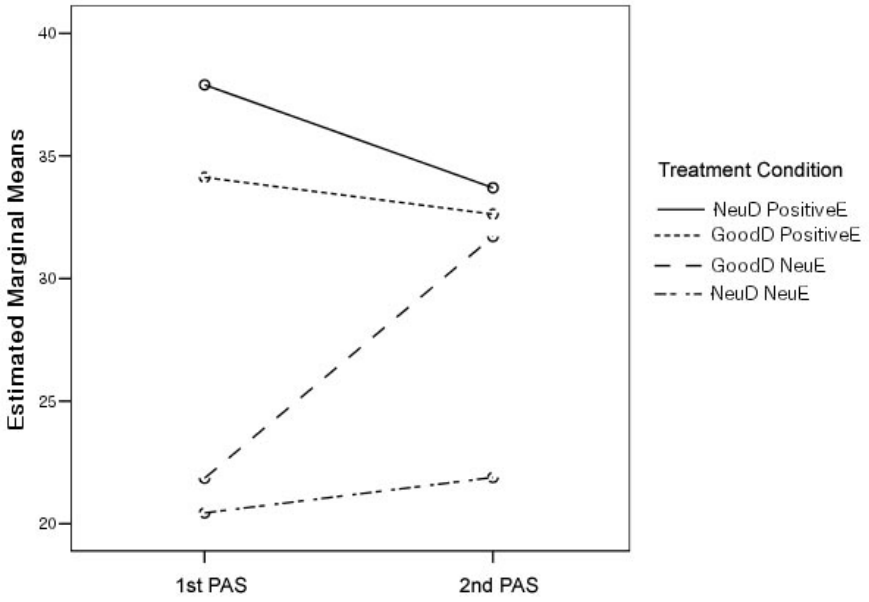


Figure 2: Changes of the mean score of PAS questionnaire - before and after the learning

Positive Emotions Before & After Learning

An analysis of variance for repeated measures on the PAS scores of the four groups on the 1st and 2nd PAS tests indicated a significant PAS trial and Group interaction, $F(3, 32) = 5.141$, $p = .005$, which indicates that the PAS scores were changed by the groups. Further analysis of variance for repeated measures on the PAS scores of each group on the 1st and 2nd PAS tests indicated that only the PAS scores of NEGD changed significantly, $F(1, 7) = 10.83$, $p = .02$, which means that their positive emotions increased significantly in group NEGD. Additional ANOVA on the 2nd PAS score with groups revealed a significant effect of group, $F(3, 30) = 3.098$, $p = .042$. Post-hoc tests revealed significant differences at the .05 level between controls and three other groups: with group PEGD ($p = .024$), with group NEGD ($p = .010$) with group PEGD ($p = .045$). Inspection of means confirmed that, at the end of the learning process, group NEGD became positive emotions group along with PEND and PEGD but that the emotional state of the Control group NEND remained neutral (Figure 2). Accordingly, the analysis of Independent Samples t-test on the score of 2nd PAS test between the controls and three other groups showed that there was a significant difference in their emotions, $t(32) = 3.106$, $p = .00$.

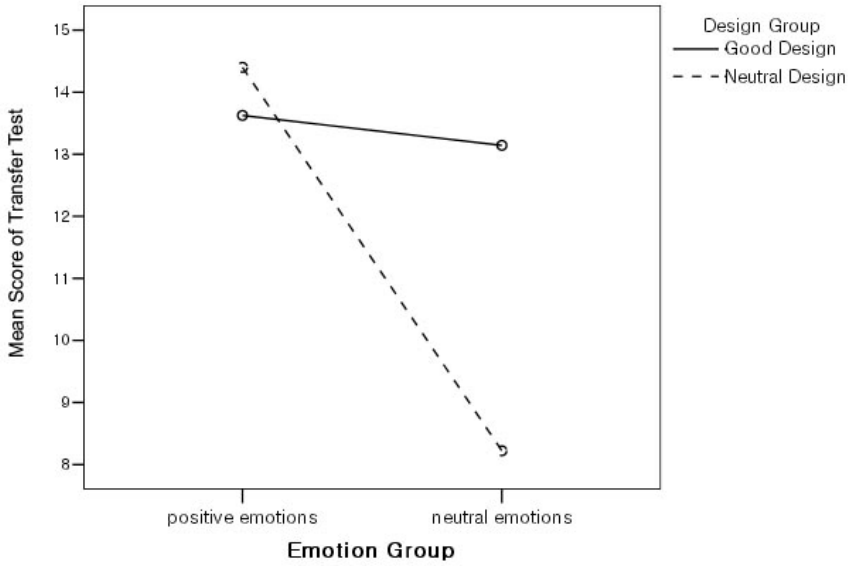


Figure 3: Interaction between design Emotions and Design Quality condition on Transfer Test

Transfer Test

The mean scores and standard deviations for each group on the transfer test scores were as follows: Control: 8.22 (4.74), PEGD: 13.63 (4.78), PEND: 13.14 (6.49), and NEGD: 14.40 (4.38). An ANOVA computed on transfer test scores with groups as between-subject factor revealed a marginal significant main effect for the level of emotions, $F(1, 30) = 3.633$, $p = .066$, which means that a learner in Positive Emotions groups showed better transfer test scores than a learner in Neutral Emotions groups. There was no main effect for the level of design. However there was a trend of interaction between the level of design and emotions, $F(1, 30) = 2.657$, $p = .114$. Post-hoc tests revealed significant differences at the .05 level between Controls and PEGD ($p = .035$), Controls and NEGD ($p = .012$). Also there was a marginal significant difference between Controls and PEND ($p = .063$). This indicates all the treatment groups scored better than Control group on the transfer test (Figure 3).

Retention test

An ANOVA computed on retention test scores with groups as between-subject factor did not show any significant difference.

Cognitive Load

The mean scores and standard deviations for each group on the scores of mental effort questionnaire were as follows: Controls: 5.11 (0.600), PEGD: 5.50 (0.637), NEGD: 6.50 (0.570), PEND: 7.00 (0.681). An ANOVA computed on mental effort scores with groups as between-subject factor revealed a significant interaction effect between the level of design quality and emotions at F (1, 30) = 5.367, p =.028 (Figure 4). There was no main effect for the level of design quality and for the level of emotions. Post-hoc tests revealed that there was no significant difference between Controls and PEND, while there was a significant difference between Controls and PEGD (p=.046), and a trend of a difference between Controls and NEGD (p=.104).

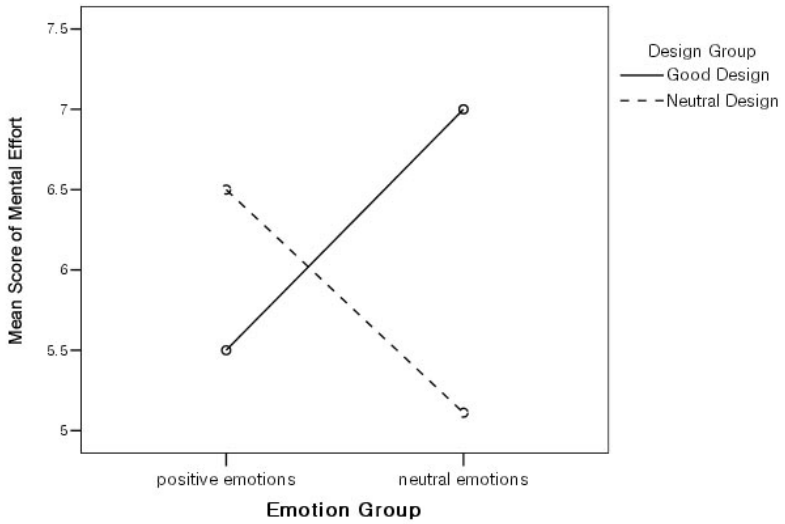


Figure 4: Interaction between design Emotions and Design Quality condition on Mental Effort

Satisfaction about Learning Material

The mean scores and standard deviations for each group on the scores of satisfaction questionnaire were as follows: Controls: 3.22 (1.394), PEGD: 4.70 (1.165), NEGD: 4.40 (1.713), and PEND: 5.29 (1.113).
An ANOVA computed on satisfaction score with the groups as between-subject factor revealed a significant main effect for design quality, F(1, 32) = 6.196, p =.019, which means that learners in Good Design groups showed more satisfaction about the learning material than the learners in Neutral Design groups. There was no main effect for the level of emotions. However there was a trend of an interaction effect on satisfaction between design quality and emotions (p =.087).
Post-hoc tests revealed that all the scores of satisfaction from Good Design groups were significantly higher than the score of Controls (with PEGD: p =.032 and NEGD: p =.007), and the score of PEND showed a trend that the score was higher than the score of Controls (p = .077). This indicates that satisfaction with the learning material from all the groups was higher than Control group.

Conclusion

First, our result implies that the positive emotions induced before the learning were mostly maintained during learning, however, the good aesthetic design of the learning material increased the positive emotions throughout the learning process for those learners whose emotional state in the beginning of the learning was neutral. This suggests that positive emotions can be induced from the learning material through the quality of the aesthetic design.

The result of the transfer test supports that positive emotions promote knowledge construction and problem solving, which is consistent with the facilitation hypothesis of emotions (Isen & Daubman, 1984; Isen et al., 1985; Isen et al., 1987).

Previous research has suggested that positive emotions would increase cognitive load in working memory, and that aesthetic design could result in increased extraneous cognitive load (Oaksford et al., 1996). We found in our research as expected that the learners in the control group showed the lowest level of mental effort. Also, learners in NEGD and PEND used more mental effort than the learners in control group. However, the learners in PEGD who had positive emotions with the good design quality material reported investing the same lower mental effort as the controls. It seems that if either positive emotions or good design quality of material is presented during the learning process, learners invested more mental effort, but if both manipulations are presented at the same time, they would not.

Also, the result shows that positive emotions lead to increased levels of satisfaction for the same learning material, indicating that people appraise more positively in learning context when they are in good mood.

In instructional design, especially in multimedia learning, emotions have been used as outcomes of instructional design as a part of affective domains, but rarely as factors that influence the learning process and cognition. Our experimental study attempted to investigate emotions and their affect on cognitive process in the context of learning. The study has important theoretical and practical implications. On a theoretical level, it shows that there is significant effect of emotions on learning and mental effort investment. It also indicates that positive emotions can be generated by the instructional design and that they may be able to affect learners' experience and performance too. On a practical level, our study implies that positive emotions should be considered as important factors that should be incorporated into instructional design. Emotional design principles should be studied in more detail to allow for the design of better instructional materials.

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