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A Trial Study on Restraint of Mind-Wandering while Viewing Educational Videos by Adjusting Biofeedback Operations

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Abstract: In this study, we conducted an experimental examination regarding the impact of biofeedback to restrain mind wandering (MW) that occurs while watching educational videos. In the experiment that was conducted with ten participants, we introduced a beep (biofeedback) while they watched educational videos when MW was detected over time. This was done by using a pre-prepared machine learning estimation model based on electroencephalograms. The results of the experiment suggest that it is possible that the beeps were introduced when the participants were thinking of something unrelated to the task, when they were daydreaming, and when they felt sleepy while watching educational videos.

Keywords: Human interface, audio-visual education, multimedia, artificial intelligence

1. Introduction

Mind Wandering (MW) is the phenomenon of the occurrence and unconscious development of a thought that is irrelevant to the task at hand (daydreaming) (Smallwood & Schooler, 2006). There have been cases that report a negative correlation between the number of occurrences of MW during learning and the level of understanding, and it has been noted that it is possible that MW may hinder learning (Szpunar et al., 2013). Kawashima and Kumano (2017) developed a method to quantify the intensity of MW at any point in a task using electroencephalograms and artificial intelligence (machine learning). In addition to restraining MW, these are effective in introducing an external stimulus, such as an alarm, so that the learner can notice the MW (Hattori and Ikeda, 2016). In this study, we have conducted an experimental examination of the effect of the method of detecting MW through the electroencephalograms of learners and introducing a beep (biofeedback) to restrain MW that occurred while they watched educational videos.

2. Method

The participants in the experiment are ten university students (average age 22.9 years, *SD* = 1.30; five men and five women) who have the experience of studying by using educational videos. In the experiment, we made them watch multiple educational videos related to research ethics for twenty minutes with two presentation conditions, which are, experiment and control conditions. By doing so, we took a counterbalance to offset the order effect. This was followed by a questionnaire and an interview to subjectively evaluate each of the conditions.

With respect to the presentation conditions, for the experiment conditions, we used the method proposed by Kawashima and Kumano (2017) to introduce a beep when MW is detected by applying a machine learning estimation model prepared in advance based on the electroencephalogram of each participant while they watched the educational videos. In the control conditions, we introduced a beep

at random times while the participants watched the educational videos. The participants were instructed, in advance, to concentrate on the educational videos when they heard the beep.

The questionnaire consisted of seven questions on a six-point scale (1: Strongly disagree-6: Strongly agree) and included items such as drowsiness, concentration, and attention. In our analysis, the number of positive responses (Slightly agree, Agree, Strongly agree) and negative responses (Slightly disagree, Disagree, and Strongly disagree) were tallied for each question for each participant, and the direct probability (two-sided testing) was calculated for the bias in the number of participants.

In the interview, we asked about the timing of the beeps introduced in both the experiment and control conditions. For the analysis, we classified all the responses into positive and negative impressions and tabulated the results.

3. Results

Table 1 shows the results of the questionnaire including the number of positive and negative respondents for each question. First, in the experiment conditions, there was significant bias in the number of respondents with respect to the questions, “I became sleepy while watching the educational videos” and “I was daydreaming while watching the educational videos.” On the other hand, there was no significant bias in the number of respondents in the control conditions. Also, there was significant bias in the number of respondents for the questions, “I felt tired while watching the educational videos,” “I felt bored while watching the educational videos,” and “The beep caught my attention.” Furthermore, there was no significant bias in the number of respondents for the questions, “I heard the beep when I was daydreaming” and “I realized I was daydreaming when I heard the beep,” in both the experiment and control conditions.

Table 1. *Number of Positive and Negative Respondents for Each Question*

Questions	Experiment			Control		
	Positive	Negative	Assay	Positive	Negative	Assay
I became sleepy while watching the educational videos	7	3	*ns*	9	1	*
I felt tired while watching the educational videos	9	1	*	9	1	*
I was daydreaming while watching the educational videos	8	2	*ns*	9	1	*
I felt bored while watching the educational videos	10	0	**	9	1	*
The beep caught my attention	10	0	**	10	0	**
I heard the beep when I was daydreaming	7	3	*ns*	6	4	*ns*
I realized I was daydreaming when I heard the beep	6	4	*ns*	6	4	*ns*

Table 2 shows the results of the interviews. We obtained a total of twenty-nine responses. We obtained a positive impression for, “I heard the beep when I was thinking of something different,” “I heard the beep when I was daydreaming,” “I heard the beep when I was sleepy,” and “I did not hear the beep when I was concentrating.” On the other hand, we obtained negative impressions for, “I heard the beep even when I was concentrating,” “I heard the beep when I was (concentrating) reading the text,” and “I regularly heard the beep.”

Table 2. *Interview Results*

	Impression	Respondent
Positive impressions	I heard the beep when I was thinking of something different	a, e, i, j
	I heard the beep when I was daydreaming	a, c, i, j
	I heard the beep when I was sleepy	b, d, f
	I heard the beep when I was tired	e
	I heard the beep when my mind was elsewhere	d
	I did not hear the beep when I was concentrating	a, c, d, g, i
	I heard the beep when I was not concentrating	c
	I heard the beep when my eyes were closed	b, e
	The beep appropriately sounded under conditions of the experiment	a, b, d
Negative impressions	I heard the beep even when I was concentrating	f, j, g
	I heard the beep when I was reading the text	j
	I regularly heard the beep	h

4. Observations

The results of the interviews suggest that it was possible that the beeps were introduced when the participants were thinking about something unrelated to the task, when they were daydreaming, or when they felt sleepy while watching the educational videos. From this, it may be possible to accurately detect MW, to some extent, based on the electroencephalograms of learners while watching educational videos under experimental conditions. However, there is no significant bias in the number of respondents in both the experiment and control conditions for the question, "I realized I was daydreaming when I heard the beep." Based on this, the extent to which the biofeedback method under the experiment conditions led to restraining MW, cannot be judged. In addition, we obtained impressions such as, "I heard the beep even when I was concentrating." Moving forward, based on these observations, we will need to improve the accuracy of biofeedback and conduct additional experiments on the relationship between the beeps and the restraint of MW under more comprehensive experimental conditions.

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