Effects of Angry Birds-like Live Streaming on Working Memory

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***Abstract*—This paper investigates whether and to which degree watching Angry Birds-like live streaming could affect the spectator's working memory (WM). We prepared Angry Birds-like gameplay on the Twitch streaming platform in which a domino effect based on Rube Goldberg Machine (RGM) mechanism is featured in each generated game level. The spectators' working memory are measured using the N-back task, and our results show a possibility that watching the proposed live streaming can increase the WM performance.**

***Index Terms*—Angry Birds, working memory, spectator, Rube Goldberg Machine**

I. Introduction

Working memory (WM) refers to the system involving the temporary storage of information that maintains the process of specific cognitive tasks [1]. The performance of WM corresponds with higher cognitive tasks such as complex learning or reasoning and WM capacity related to the capability of using attention to maintain information or avoid distraction [2]. Previous studies revealed that specific emotional states [3] or acute stress [4] induced by watching videos of showing parts of movies could affect spectator's WM performance. Based on the aforementioned work, we are curious to know if watching videos of other kinds, such as gameplay, could also affect spectator's WM performance.

In this study, we investigate whether watching videos of interesting gameplay could lead to positive effects on performance in WM tasks. We note that, in our prior study, showing an interesting explosion in Angry Birds-like game was found to statistically significantly decrease the negative affect and promote better emotion of spectators [5]. In the current study, we hypothesize that watching interesting Angry Birds-like live streaming would increase the spectator's WM performance.

II. Methodology

A. The Stanford Sleepiness Scale

The Stanford Sleepiness Scale (SSS), developed by Hoddes et al. in 1972, is a one-item self-report questionnaire measuring levels of sleepiness throughout the day [6]. The SSS is presented in a seven-point Likert scale ranging from 1 (feeling active, vital, alert, or wide awake) to 7 (no longer fighting sleep, sleep onset soon).

The SSS was used in Jiménez et al.'s study [7] to screen their participants before performing mental demanding tasks: 3-back or oddball task. The participants were required to score ≤ 3 on the SSS upon their arrival at the experiment place.

B. N-back Task

The N-back task is a WM-related task that had been used to measure the WM performance [3] [4]. A study by Gray et al. strengthened the evidence that participants' unpleasant emotional state improves the spatial N-back performance and decrease the verbal N-back performance, while the pleasant one works in the opposite way. Another study by Qin et al. [4] found that an acute stress induced by watching movie clips with aversive content could significantly reduce participants' N-back performance.

C. Science Birds Live Streaming

This study is conducted using an extended version of Science Birds from our prior study [5]. Science Birds is a clone version of Angry Bird widely employed for academic research [8]. We presented our Science Birds gameplay via the Twitch online streaming platform. Our previous study found that proper placement of a TNT (in-game explosive object) contributes to in increase in the interestingness of an Angry Birds video and helps the participants reduce their negative affect [5]. Based on this finding, this study features a procedurally generated level with a *domino effect* based on Rube Goldberg Machine (RGM) mechanisms (Fig 1). We calculate projectile motions for bird-shooting based on in-game gravity, the bird starting position, and the target position.

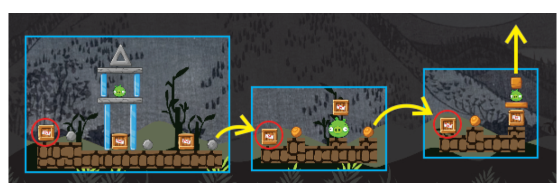

Fig. 1. An example of an RGM level. There are three segments in this level, those surrounded by blue rectangles. A segment contains a trigger object (red circle) that when it is destroyed it will make a particular object to fly (yellow arrow) and destroy the next segment's trigger object. The process will be chained until all available segments are destroyed.

III. Experiment

A. Participants

Participants were 14 healthy university students at our university. All participants provided their informed consent

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prior to their participation in this study. Upon their arrival at the experiment place, they were given time for practicing and getting familiar with the system to do a 3-back task. A practice session lasted for 90 seconds, and each participant was allowed to take the session twice. After the participant completed their practice session, they were required to fill the SSS presented in English [6] and Japanese [9] to assess their sleepiness. The participants were screened with the same scale of SSS according to Jiménez et al.'s study [7], in which all of the participants with the sleepiness scale above 3 will be excluded from the analysis.

B. Experimental Protocol

Each participant was required to complete two experimental sequences (presented counter-measuredly to each participant). Each sequence was lasted for around 5 minutes. Before measuring the participant's WM performance using a 3-back task, all participants were required to complete a particular task on each sequence with the same duration of 2 minutes.

We used two types of tasks assigned to the participant: REST (control task) and STREAM. During REST, the participants were asked to close their eyes and rest. For STREAM, the participants were required to watch Science Birds gameplay with generated RGM levels from the Twitch streaming platform. After finishing each task, the participant was then assigned to do a 3-back task (Fig 2).

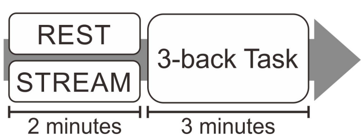

Fig. 2. The experimental protocol

This study adopted a 3-back task variant showing a series of letters on the screen, WM_REST (after doing REST) and WM_STREAM (after doing STREAM). Letters were presented 45 times (one letter each) in a white colored font with a dark background. They were randomly presented one at a time with the interval of 1000 ms and the interstimulus interval of 2000 ms. The participants were told to press the "L" key on the keyboard if they thought the same letter appeared 3 steps before (Fig 3). Otherwise, they should to press "A." A green (right answer) or red (wrong or no answer) interface was then displayed for 1000 ms as feedback to the participant.

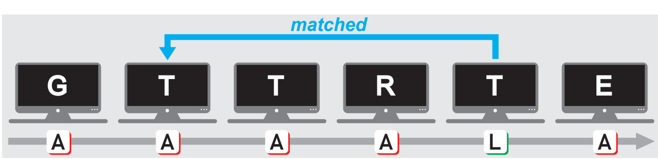

Fig. 3. An illustrative concept of 3-back task

IV. Results

Three sleepy participants, whose score was higher than 3 on the SSS, were excluded from our experiment. From the Cronbach's α [10], our data has a good reliability for both WM_REST and WM_STREAM ($\alpha \geq 0.8$). We compared the accuracy (the number of getting correct responses) and the reaction time (the time taken to get responses) in WM_REST and WM_STREAM. Our results showed that WM_REST has a lower accuracy (mean = 69.49%; median = 71.11%) than WM_STREAM (mean = 72.32%; median = 71.11%). For the reaction time, WM_REST showed higher figures (mean = 708 ms; median = 719 ms) than WM_STREAM (mean = 688 ms; median = 709 ms).

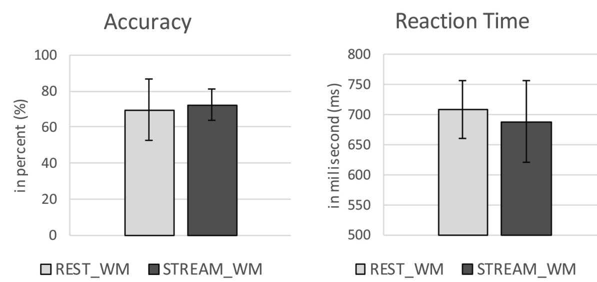

Fig. 4. The average results of accuracy and reaction time

V. Discussion and Future Work

From our results, WM_STREAM performs better than WM_REST in both accuracy and reaction time. These results support our research hypothesis that there is a possibility that watching Angry Birds-like live streaming could positively affect the spectator's WM performance. In a future study, an AI approach to generate more interesting levels or playing (shooting) styles will be conducted to create better gameplay content and increase the effect of watching live streaming to spectators' WM performance.

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