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On the use of adjustable distraction as a measure to determine sustained attention during movie clips

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Abstract

Secondary task reaction time has been applied to measure the cognitive effects of movies, but has generally not produced convincing results when utilized to measure presence. We hypothesize that mixed results could be due to factors which prolong simple reaction time. This paper seeks to investigate the stability of a time independent alternative method (the adjustable distraction method) by testing it in relation to two other methods (heart rates and subjective intensity ratings) applied for measuring presence. In a comparison study 23 subjects were exposed to the three methods, with the aim of finding common and discrete patterns in the obtained results. The study showed that both the subjective ratings and the heart rates shared a common pattern, while the adjustable distraction method showed a discrete pattern. We speculate that this pattern emerged due to the great variance found in the participants' ability to perceive vibrations. In future research of the method we recommend extending it with a screening process to create uniform vibration perception thresholds.

Keywords--- Presence, immersion, attention, secondary task reaction time, adjustable distraction, vibration, measuring method, comparative test, movie clip, viewing session.

1. Introduction

The film media has a history reaching over a hundred years back [1] and yet we still struggle to understand its ability to engage, immerse and absorb us into alternative universes presented by the movies. A milestone towards understanding this intangible concept is to figure out how to quantify or measure it. One of the classic methods for evaluating features of movies has been the use of secondary task reaction time (STRT) [2,3,4]. The STRT method assumes that attention plays a part in this "media engagement". As such it attempts to measure how persistent a media product is in sustaining a user's attention. This is done by recording how long the user is in responding to a distraction (the secondary task), while experiencing the media. Through repetitive recordings it is possible to perform systematically evaluation of temporal changes in attention of a viewer during the playback of a movie. A couple of interesting findings have been done with this methodology. For instance the reaction time has been shown to increase if the amount of pans, zooms, cuts etc. is decreased [[3]]. This could indicate that excessive use of such narrative tools (e.g. pans and cuts) might have a repulsive effect on attention. It has also been shown that reaction time to random distractions increases in the second half of a viewing session [4], which might be because the viewer tends to forget the real world the longer they are exposed to an alternative experience offered by a media.

Among several researchers, the immersive effect, which media products can have on us, is known as *presence as immersion* [5]. Due to the STRT method's prominent role in prior media research it has been suggested as a possible mean to determine temporal changes in the level of presence during a media experience [6]. However experiments testing the STRT method in relation to presence have generally returned mixed results [7,8,9]. We hypothesize that these mixed results could be due to factors, which have an impact on simple reaction time (e.g. muscular tension [10], age [11,12,13], gender [13,14], fatigue [12] and breathing cycle [15]). To rule out these factors we have previously suggested an alternative method [16], which applies adjustable distraction as a measurement for sustained attention instead of reaction time. This paper will build upon the existing research on the use of the Adjustable Distraction method [16] to investigate whether it in relation to the STRT method can provide us with consistent results in relation to presence.

1.1. The adjustable distraction method

In a prior attempt to define a method for determining presence as immersion in media (e.g. games), the adjustable distraction (AD) method was suggested [[16]]. The AD method is still used to measure a media's persistency in sustaining the attention of a user. But instead of noting the reaction time, the strength of the distraction is repeatedly

increased or decreased in search of the minimum distraction strength at which the average media user shifts his or her attention from the media towards the distraction. The minimum strength of the distracting signal thereby becomes an indication of the media's persistency in sustaining users' attention.

The mechanism for adjusting the strength of the distraction has to be independent of time (e.g. the distraction could not gradually increase over time), because if time was used this would make all the time-related factors of the STRT method part of the AD method as well. Instead we came up with the idea to adjust the strength of the distraction across test participants and thereby obtain a general indication of "sustained attention" instead of an indication from each individual. To do so a particular mechanism was developed inspired by the binary search algorithm known from e.g. computer science [17]. To clarify how the mechanism works, for testing various distraction strengths, a fictional example will be used:

First the range of distraction strengths which should be evaluated must be determined before an experiment. For simplicity the range of signal strengths will be set from 0 to 10 in this example. 15 fictional participants have "volunteered" for this fictional experiment. The participants are divided into three groups with five in each. Now the first group watches a movie in turns and at the same point during the movie a signal of "strength 5" is send to each of the participants in the first group. Each of the five participants either does or does not react to the signal strength. If the majority (over 50%) of the first group reacted upon the signal strength the strength of the signal will decrease for the next group of participants. If the majority instead did not react upon the distraction strength the strength will increase for the subsequent group.

The exact strength presented to the next participants will be determined by the remaining span for strengths currently not tested. For instance we will assume that the majority of the first group reacted on "strength 5". This would suggest that there somewhere in the lower span, [strength 0; strength 5[, probably will be a strength at which the majority does not react. The best guess we can make at this point as to what strength this might be will be to take the strength-value in the middle of the lower span and test ("strength 2.5"). Therefore the next five participants will be exposed to this strength at the same point in the movie as the first five participants. Now we will assume that the majority of the second group did not react to the signal of "strength 2.5". Then it could be expected that there might be a strength in the upper span,]strength 2.5; strength 5[, at which the majority again would react upon and therefore the strength tested on the third group would be "strength 3.75". As the number of test rounds increments toward infinity the distraction strength will become the borderline at which half of a population will not react, while the other half will react.

2. Methodology

To evaluate whether the results from AD method could be used as an indication of presence, we performed a comparative study. During the experiment a movie clip was shown to a range of participants, while three measuring methods were applied to collect information about the participants' feeling of presence. If all of these methods were measuring the same phenomenon a common pattern was expected in the collected data across the methods. If the results from any of the methods display a distinct pattern it will probably mean that the method is measuring another aspect of the experience. If this is so this study will contribute with considerations according to the authors observations on what the method might be measuring and how it might be altered to measure presence as immersion.

2.1. Test material

A seven minutes long movie clip from del Toro's "El Laberinto del Fauno" [18] was chosen as the test material for the experiment. Some of the arguments leading to this decision was the Spanish cast, which internationally was assessed as being relatively unknown. Thereby it was expected that less of the test participants would be affected by prejudices or certain views towards an actor acquired from seeing the actor performing in another movie. Another important feature of the selected clip was that its narrative structure was in accordance with the classical Hollywood model [1]. We felt this was an asset as the changing levels of suspense and action in this structure might result in a characteristic pattern of presence [19]. We hoped that this pattern would be easier to recognize across the results from all the measuring methods.

A quick description of the course of events in the movie clip is given in the following: A little girl has found a secret door leading to a room where a monster-like pale man is sleeping. While the girl is looking around the pale man wakes up and hunts her back to the door opening. The door shuts in front of her, but she manages to escape through another door in the ceiling, before the pale man reaches her. Now a cut is made to a scene where a group of people works through the woods.

During a pilot test the movie clip was shown to a couple of persons. According to their descriptions the intensity in the clip would almost constantly increase and peak at the scene where the girl attempts to escape. They also described how they suddenly perceived the pale man as appearing comical (instead of scary) at a point in the clip where it is revealed that the eyes of the pale man is located in the palms of his

hands. Due to these descriptions three events where chosen for evaluation:

Event 1: The sequence where the pale man suddenly appears comical.

Event 2: The part where the girl seeks to escape from the pale man.

Event 3: The beginning of the subsequent scene with the people walking in the woods.

It was expected that the level of presence would increase from event 1 to event 2, as the sudden comical appearance of the pale man might seem out of context with the eerie setting. Furthermore the feeling of presence was expected to decrease significantly from event 2 to event 3, because the subsequent scene will show a new location and new characters without proper introduction.

2.2. Data collection techniques

The three presence measuring methods compared were post-test paper and pencil questionnaires, Heart rate measurements and the AD method. Questionnaires were chosen as these are the common way of measuring presence [20]. Heart rates measurements were also interesting to include in the study as they measure temporal changes (like the AD method) and previously have shown convincing results when applied in tests of presence in scary [21] or violent media content [22]. Each method was to collect repeated measurements of the immersive presence felt during the three selected events in the movie clip.

The questionnaires consisted of three formulations created from the guidelines posted at the ISPR website [23]. It is here advised that presence is not directly addressed in subjective self-reports, but that descriptive synonyms should be applied instead [20]. As it was assessed to be too overwhelming and exhausting for the participants to answer a large range of similar questions containing different synonyms, it was decided to focus on finding a single descriptive term. As a result the three questions where formulated in the following way:

"How intense was the sequence where the pale man puts his hands (with his attached eyes) up in front of his face to look at the girl for the first time?"

"How intense was the sequence where the door closes in front of the girl, preventing her from escaping?"

"How intense was the sequence where the group of people is walking through the woods?"

Each of these questions where accompanied by a five optioned Likert-scale [24].

The AD method was utilized with vibration as the distracting stimulus. The vibration was created by a small pc speaker. The physical displacement of the speaker membrane (or the amplitude of the vibration) was then adjusted while the frequency of the speaker was kept constant at 250 Hz as the skin is most sensitivity to vibrations of this frequency [25].

2.5. Equipment

For the experiment a computer was set up and connected to the pc speaker (and an amplifier), through the sound card's output port. To transfer vibrations to the participants' skin a 5 x 50 mm stainless steel A4 bolt (non-magnetic material) was attached to the center of the pc speaker membrane. The speaker was placed onto a jack under a table in which a hole with a diameter of 12 mm had been drilled. The pointy bolt then had free passage through the hole and by raising the jack, the top of the bolt could then be placed with precision in relation to the upper side of the table top. In the other end of the table top a small USB numerical pad was placed and connected to the computer. The "Return"-key was marked to emphasize its significance above the rest of the buttons. The movie clip was displayed on a 32" LCD screen and the sound was provided through a set of muffled headphones connected to the screen. All the equipment was put up inside a sound proof room.

2.3. Procedure

The laboratory facilities at the campus of Aalborg University in Copenhagen were the setting of the experiment. 23 participants toke part in the experiment all between the ages of 20-30 years old. Prior to the test none of the participants had seen the particular movie clip before neither did they suffer from any heart disorders. It was also ensured that none of the participants knew Spanish beforehand (the spoken language in the movie). As it has been reported that low temperatures can have an effect on vibration perception [26] all participants where kept indoors for at least an hour before the experiment.

Each participant was asked to sit in a chair next to the table and then asked to put their left hand index finger on the "Return"-button on the numerical-pad. The participant was then asked to place his or her right hand on the surface of the table top just above the bolt-hole in a way that the bolt would hit the center of the first metacarpal of the thumb (the large pad in the palm just below the thumb). With their right hand in position the participant was instructed to keep it as still as possible. To ensure the same amount of pressure between the bolt and the skin of each participant, they were asked to hold

one end of an Ohm meter in the left hand while the other end was being attached to the bolt. When the jack was raised and made contact between the two ends of the circuit (the participants right hand and the bolt) the Ohm meter would display a reading. At this point the bolt would just barely touch the skin. To ensure full contact the bolt was then raised one millimeter.

The first phase of the experiment was used to find a participants perceivable limit of vibration (the vibration threshold) in a condition where the participant was unaffected by the test material. To do so the participant was asked to press the "Return"-button when he or she thought they could feel a vibration in their palm. Now the described mechanism for adjusting the strength of the stimulus in the adjustable distraction method was applied, but instead the reaction of the single participant was used to determine each test round. In this way the vibration signals send to the speaker (with random time intervals) was used to "close in" on each participant's threshold. During this phase the headphones emitted white noise to make sure that the vibrations could not be registered by their sound.

In the second phase the participant was equipped with electrodes in order to measure their heart rates. Instructions where again given to the participant regarding the pressing of the "Return"-button on the numerical-pad if they at any point thought they felt vibration in their palm. The playback of the movie clip was then started together with a computer program able to automatically (by the use of the adjustable distraction mechanism) send out signals to the speaker when a vibration should occur. After watching the movie clip each participant were asked to fill out the post-test questionnaire.

3. Results

It makes sense to list the results as graphs as the graphical relationships are helpful in detection of a pattern between the event-means. The means and standard deviations from the questionnaires are displayed in (Figure 1).

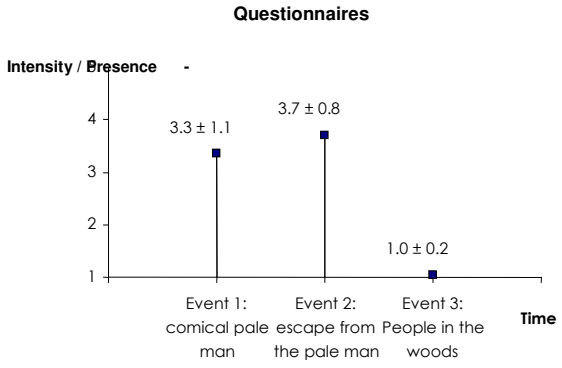

Figure 1: Mean and standard deviation of the questionnaires intensity ratings at each of the three events.

The means and standard deviations of the heart rates recorded at each of the three events are likewise displayed in (Figure 2).

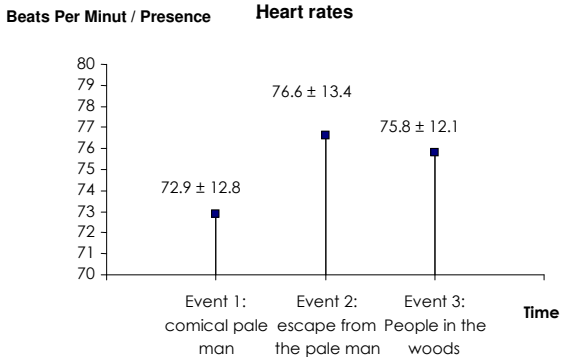

Figure 2: The mean and standard deviation calculated from the heart rate measurements taken at each of the three events.

The measuring of the participants' perceivable vibration threshold returned a mean value of 275.3 millivolts (mV) amplitude from peak-to-peak (p-p) of the sinusoid signal provided to the speaker. The standard deviation of the thresholds was rather high at 177.5 mV p-p. (Figure 3) illustrates the recordings from the AD method taken while the participants watched the movie clip.

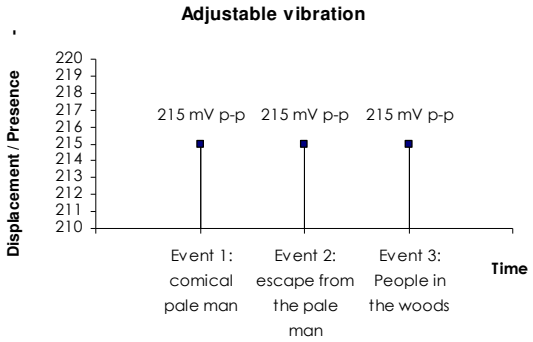

Figure 3: Results returned from the AD search algorithm at the three events. Each result is the amplitude measured in milivolts (peak-to-peak) of the sinusoid signal send to the speaker.

4. Discussion

By comparing the three events ratings internally from the questionnaires (Figure 1) it is clear that the results are coherent with our expectations. The heart rate recordings (Figure 2) do show a similar relationship between event 1 and event 2 measurements, but event 3 is here resulting in a "medium" heart rate reading. We speculate that the latter is an indication of something else than presence. For instance it could be argued that the inconsistency between the scene with event 1-2 and the scene with event 3 could have left the participants wondering if the experiment was about to end. The participants might have asked themselves: "Did they forget to turn of the movie?" and similar questions in this period, resulting in a high heart rate due to this uncertain real-life situation. The results from the AD method (Figure 3) show a very different pattern. The search algorithm returned the same value (215 mV p-p) at each of the three events. This result was unexpected (as the results from a prior experiment with visual distraction returned promising results [16]), but the large variance in the participants' perceivable thresholds (standard deviation 177.5 mV p-p) might be a part of the explanation for this odd measurement. It is likely that a person with the ability to perceive a very weak vibration would experience a certain vibration strength stronger than another person which is only able to perceive high amplitude vibrations. If this observation holds true it would revoke the purpose of search algorithm, as the presented stimulus would be evaluated according to threshold rather than the level of presence experienced. To work around this issue in future tests a thorough screening process, to ensure uniform perceivable thresholds, might be included.

5. Conclusion

The experiment showed some similarities between the results from questionnaires and heart rate measurements, while the AD method returned results displaying a different pattern. From the great variance in the recorded vibration threshold collected from the participants', we believe that the AD method will continue returning doubtable results, if an included screening process is not performed. Such screening would lead to comparable thresholds between participants.

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