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1 **TITLE:**
2 Loneliness Assuaged: Eye-Tracking an Audience Watching Barrage Videos
3
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20 **SUMMARY:**
21 The study proposes an activation-match model to study how loneliness is mitigated when a lonely
22 audience watches barrage videos of rational and emotional appeals. The protocol uses eye
23 tracking to document duration and fixation, accounting for the degree of satisfaction when
24 emotional needs are appeased by content and barrage.
25
26 **ABSTRACT:**
27 Researchers usually theorize media exposure based on traditional media capabilities. However,
28 a new interactive video viewing format, such as barrage video where viewers' comments are
29 overlaid over visual content, challenges past perspectives. This study proposes an activation and
30 match satisfaction model to study viewing behaviors of lonely people and to challenge previous
31 claims. It presents a protocol to examine the mechanism of how loners use barrage videos by
32 combining eye tracking and self-report measures. Eye tracking documents the audience's
33 conscious and subconscious watching behaviors in real time and allows for inference of the
34 amount of allocated cognitive resources in response to rational and emotional content. The self-
35 report gauges the amount of satisfaction obtained. Overall, results from the measures supported
36 an activation and match satisfaction model regarding loners and their barrage video viewing
37 behaviors. Implications are discussed.
38
39 **INTRODUCTION:**
40 **Eye-tracking technique**
41 The eye is often referred to as a window of the mind[1,2]. Eighty percent of human information
42 intake is obtained visually[3]. Since the 19th century, people began to study human psychological
43 activities by directly observing eye movements of participants. Miles invented the peephole to
44 make observations when participants read[4]. In the study, the experimenter sat opposite a

45 participant and observed the participant's eye movements through a small hole in the middle of
46 the reading material. Since then, technology has vastly improved. Currently, state-of-the-art eye-
47 movement tracking devices mainly focus on electric current-recording, magnetic-induction and
48 optical-recording, which includes corneal reflection and iris-scleral reflection methods[5,6,7]. The
49 noninvasive features widely prevalent today make eye movement recording more natural,
50 enhancing ecological validity. Today, eye movement techniques generally refer to the use of
51 computer-controlled eye tracking to record and analyze the positioning of the participant's eye
52 and the forms of eye movements during viewing of visual material.

53
54 Many theoretical perspectives regarding eye movements have matured over the years. These
55 include the vision buffer processing model, the parafoveally processing model, the E-Z Reader
56 model, the immediately processing model and the eye-mind processing model[8,9,10]. The
57 immediately processing model holds that the processing of viewing content at all levels is not
58 delayed, but occurs in real-time. The eye-mind processing model focuses on text information and
59 holds that as long as one is processing a word, one would look at it. Put in another way, the word
60 that one processes is exactly the very word one is looking at. The processing time of a word is the
61 total fixation time of the participant's eye.

62
63 There are three basic types of human eye movements: fixation, saccades and pursuit
64 movements[8,11,12]. The fixation duration and fixation count usually reflect the extent to which the
65 participant exerts cognitive resources to the content being viewed. Saccade refers to the
66 movement from one gaze point to another. Retrospective saccade can be used as an indicator of
67 the processing sophistication in the encoding process. Regression saccade indicates a deeper
68 processing of an area after the first gaze of the key areas, reflecting the difficulty or interest of
69 the content in that area. Pursuit movements are usually performed when there is visual noise,
70 and the eye seeks out a point of interest.

71
72 On the other hand, we can also measure pupil size and blink frequency; both reflect people's
73 psychological activities[13,14,15]. For example, there is a relationship between pupil size and the
74 specific task difficulty, motivation, interest, attitude, and fatigue. At present, the relationship
75 between pupil size and emotional valence is not clear[16]. However, if a researcher combines pupil
76 size with other indicators, such as electroencephalogram (EEG), the accuracy would be greatly
77 improved[17]. For blink indicators, according to the hedonic-blink hypothesis, the decrease of blink
78 frequency is usually associated with happy emotional thoughts, while the increase of blink
79 frequency is associated with unhappy emotional states[18].

80
81 The application of eye-tracking technology is extremely broad, including reading strategies, visual
82 information processing, compulsive behaviors, to even artistic intentions. The application in the
83 field of reading is the most mature. In communication, eye-tracking is useful in news
84 consumption studies and advertising effectiveness research. For example, a large number of eye
85 movement experiments have explored both exogenous and endogenous factors in
86 advertising[19,20], with the former exploring the physical characteristics of advertisements such as
87 size, pattern, color, position, originality and repeated presentations[21,22], and the latter exploring
88 individual factors such as product involvement, product motivation, prior knowledge and brand

89   familiarity[23,24,25,26,27].

90

91   In addition, eye tracking technology is widely used in many other fields, such as human-
92   computer interaction and usability research[28,29,30,31]; skills transfer[32]; infant and child
93   development research[33,34,35,36]; marketing and online consumer behavior research [37,38,39]; and
94   packaging design[40,41], among others.

95

96   In addition to being used alone, eye tracking is often combined with other multimodal
97   measurement techniques. For example, researchers can combine eye movement data with other
98   physiological indicators such as EEG, skin electrical response, heart rate, skin temperature, facial
99   expression, etc. In this way, users' emotional responses to different kinds of information can be
100   studied more effectively[42].

101

102   Eye movement technology can also be integrated into other technologies. For example, it is being
103   used with augmented reality technology[30]. At present, the integration of eye movement
104   technology and virtual reality (VR) technology is worthy of attention. On the one hand, such
105   integration can promote the rapid development of VR related equipment. For example, the
106   graphics processing unit (GPU) of most VR equipment is overburdened and consumes a lot of
107   energy. Eye tracking technology can detect the audience's fixation point in real time. VR devices
108   only need to focus on rendering this area and ignore other areas. This can significantly reduce
109   power consumption and GPU rendering load. On the other hand, the combination can enhance
110   its interaction features, and improve the immersion and involvement of VR users. For example,
111   players can use eye movement instead of hands to complete operations in a game[43]. In addition,
112   researchers can implement eye movement testing in a simulated environment. For example, in
113   consumer behavior research, researchers do not need to take subjects to a real shopping mall or
114   use real products, but test them in virtual research scenarios, as shown in **Figure 1**.

115

116   [Insert Figure 1 about here]

117

118   **Barrage video**
119   Barrage is a term originating from the military. In order to intercept moving targets, multiple
120   artillery guns are used to fire and to form a curtain composed of high-density projectiles before
121   the moving targets[44]. The term "barrage" is used in video viewing to describe a format and a
122   phenomenon in which audience members of a particular video comment and displaying such
123   comments on the video screen while watching a video, thus forming a comment wall curtain, as
124   shown in **Figure 2**. This format of interacting and commenting is also referred to as overlaid
125   comments[45,46]. Barrage videos first appeared on the "niconico" video website in Japan. The most
126   popular websites in China are AcFun (Station A, www.acfun.cn) and Bilibili (Station B,
127   www.bilibili.com). Many other streaming video sites in China, such as Youku, Tencent, LeTV and
128   iQiyi, have also added the barrage sending and viewing functions. Barrage videos have attracted
129   many Chinese viewers, and the attention of researchers in many disciplines.

130

131   [Insert Figure 2 about here]

132

133 Viewers of barrage videos can watch and interact with others by commenting to possibly meet a
134 few psychological needs. The audience of such videos may share similarities in age, background
135 and interests, so they may develop a sense of identity and belonging. There is research, for
136 example, that shows AcFun and Bilibili are home to the "quadratic element" genre enthusiasts,
137 with its audience being mainly between 17 and 25 years old[47,48]. These two websites have set up
138 an extremely strict membership review system in that membership is only granted after acing an
139 entrance exam by answering questions such as "What is the height of the heroine of the
140 Thousands of Defenders in *Hurricane Butler*?" "How many cruisers have been dispatched by
141 Gonon in the *Battle of Rum*?" Such criteria basically weed out most of the "heterogeneous"
142 audience who want to "invade" the group.

144 Related to this study, barrage video creates a sense of crowd watching, which is particularly
145 meaningful for lonely individuals. Because the content of the barrage is highly related to the plot,
146 and comments are immediate responses, it gives the audience an illusion of watching with others
147 even though they may be watching alone physically. This sense of companionship has been
148 shown to alleviate loneliness[49].

150 Barrage videos can also afford entertainment of a different kind in that viewers are not only
151 consuming but also creating video content by blending sometime serious film making with fun
152 plays. Barrage viewers can also find a sanctuary away from reality[50,51] in which they can vent their
153 anxiety and engage in emotional catharsis in a safe environment[52], or showcase their
154 personalities, demonstrate narcissism by getting others' attention, and even bypass conformist
155 norms in the real world[53] .

157 **Viewing mechanism of lonely audience on barrage video**
158 Barrage video viewing is an ideal platform to study media use and loneliness for its emotional
159 support afforded by the venue. In this study, the researchers found previous conceptualizations
160 of media exposure to be inadequate and therefore offer an activation and match satisfaction
161 model (AMSM) to explain the psychological underpinnings of viewing barrage, especially by
162 loners. In previous research, there are two perspectives that explain media use. The deficiency
163 paradigm holds that loners, for lack of companionship, would devote more cognitive resources
164 to the barrage content during watching, to seek company and to compensate loneliness. The
165 global-use paradigm maintains that media use is prevalent, and that it satisfies generic and
166 interpersonal needs in general. So regardless of emotional state, all viewers would pay attention
167 to barrage, and they obtain different gratifications[54]. However, AMSM posits that emotional
168 content serves to activate lonely audiences' interpersonal needs, and they would take initiatives
169 to search for interactive and interpersonal communication elements, such as barrage content in
170 the viewing process, and devote more attention to such components. The degree that these
171 elements satisfy their emotional needs determines the degree of satisfaction they obtain.

173 In order to understand the mechanism of barrage video watching by lonely people, one needs to
174 know the amount of cognitive resources that loners invest in different media content and how
175 they satisfy their needs. However, such data cannot be reliably obtained by traditional
176 participative reporting methods. Cognitive resources allocation operates consciously and

177 subconsciously. It is a tall order that audience members articulate to which parts of content they
178 invest more cognitive resources. To accomplish this, a suitable research methodology is needed
179 to record the viewing process, and to distinguish the amount of attention to different parts of
180 content, in addition to measuring the corresponding satisfaction from the viewing process.
181
182 For these reasons, this project tracked participants' eye movements, as measurements of
183 attention and the degree of cognitive resources allocated. The follow-up Likert scale questions
184 were designed to measure participants' degree of satisfaction from exposure. Eye-tracking is a
185 noninvasive technology that has high temporal and spatial resolutions, allowing recording while
186 participants process continuous visual stimuli without distraction[55,56]. In this study, duration time
187 and fixation counts are used as measures of attention. Duration time refers to the length of
188 attention, and fixation count refers to the number of gazes at a particular area of the video
189 material. Both of these eye movement indicators have been shown to be valid measures of
190 processing thoroughness, reflecting the cognitive resources allocated by individuals[57,58]. Results
191 of gaze probability, for example, allow researchers to infer attributes in the video that were
192 important to the participant. For self-reported measures, the researchers use a 7-point Likert
193 scale, asked and answered immediately after watching.
194
195 Based on arguments from previous explicated perspectives, the researchers designed a 2
196 (audience type) x 2 (ad appeal) x 2 (barrage) mixed experimental study and hypothesized the
197 amount of attention that normal and lonely participants would pay to barrage video. Audience
198 type (lonely and normal) was a between factor. Ad appeal had two levels, with either emotional
199 ads or rational ads. Barrage also had two levels, denoting video that either had barrage or not.
200 The last two were within subject factors. The general hypotheses were that lonely audience
201 would pay more attention to emotional ads than to rational ads, and they would pay more
202 attention to barrage than to non-barrage, whereas for normal audience, there was no such
203 difference. Satisfaction ratings followed the same patterns. The Chen et al.[59] original paper
204 detailed all these hypotheses.
205
206 **PROTOCOL:**
207
208 This protocol adheres to the Jinan University research guidelines. As only the medical school of
209 the university has an IRB board, no other discipline is required to have IRB approvals. However,
210 the researchers confirm that all ethical rules and regulations were followed. The project did not
211 pose any physical or psychological harm to participants.
212
213 **1.   Participant screening for the experiment**
214
215 1.1.   Recruit native Chinese speakers from a southern Chinese university with normal or
216 corrected-to-normal vision and no hearing impairments nor psychiatric history.
217
218 1.2.   Measure loneliness using the third edition of the UCLA scale[60,61]. Categorize those who
219 score 44 or above in the scale as the lonely group and place the rest in the normal group. In terms
220 of gender and age distribution, the group corresponds to the demographic characteristics of

221 barrage viewers[47].
222
223 **2.   Stimuli construction**
224
225 2.1.   Use rational appeal ads and emotional appeal ads as video stimuli. Positive emotional ads
226 provide emotional support for lonely audiences, where rational ads do not.
227
228 2.1.1. Choose ads that are standalone video pieces that do not require contextual information
229 to comprehend. The typical ad length is also ideal for quick variations, experimental
230 manipulations, and for eye-tracking data collection[62]. The length of each video is about one
231 minute.
232
233 2.2.   To ensure that emotional and rational appeals are manipulated successfully, have people
234 watch and rate a pool of preselected ads based on these appeals. Here, thirteen coders majoring
235 in advertising were used.
236
237 2.2.1. To maximize manipulation, choose videos with the highest scores in either categories to
238 be the experimental stimuli. The final selected ads represented eight kinds of products. The same
239 product has an emotional ad and a rational ad.
240
241 2.3.   Make the barrage video. There are two ways to make a barrage video for research.
242
243 2.3.1. Upload the video to a barrage website, such as the B station at Bilibili
244 (https://www.bilibili.com/). Have participants log into their accounts to watch, and comment.
245 The uploader controls the position of the barrage, usually at the upper third of the screen.
246
247 2.3.2. Alternatively, use video editing software to convert barrage into subtitles, so comments
248 can be manually added to the video barrage area. The ready-made video can then be called in
249 the data-collection process. This experiment used the second method.
250
251 2.4.   Produce four presentation orders for the experiment to randomize presentational effects.
252 In this design, each participant only saw one version of a particular video, either emotional or
253 rational appeal of an ad, and each saw eight ads altogether.
254
255 **3.   Eye tracking protocol**
256
257 3.1.   Eye tracking procedure
258
259 3.1.1. Use a commercial eye tracker in the study. Set the default setting for the tracker gaze
260 sample rate at 60 Hz per second.
261
262 3.1.2. Place a 24-inch computer screen 50 cm from the participant's chair. Attach the eye tracker
263 to the computer.
264

265 3.1.3. Invite the participant in the lab. Ask the participant to read and sign an informed consent
266 form. Ask the participant to sit comfortably in front of the test computer.
267
268 3.1.4. Have the experimenter check, and adjust the chair height if necessary, to make sure that
269 the TV screen is at the participant's eye level.
270
271 3.1.5. Ask participants to sit still to complete a calibration task to ensure that data collected
272 during the experiment are accurate. Inform participant that a 5-point calibration is necessary to
273 achieve the highest accuracy in data collection, and to track participants' gaze within 2° of
274 accuracy.
275
276 3.1.6. Ask participant to follow a moving red dot on the computer screen with both eyes and to
277 fixate on it when it stopped. If a participant looks away during calibration, then repeat the process.
278
279 3.1.7. Check the tracker software to see if a participant misses a calibration point. If so, repeat
280 the calibration.
281
282 3.1.8. Ask the participant to click the left mouse button to start an exercise test to familiarize
283 them with the experimental procedure.
284
285 3.1.9. Start the main experiment and tell the participant that he/she will see a red "+" sign in
286 the middle of the screen, which lasts 500 ms, alerting to the start of the experiment.
287
288 3.1.10. Ask participant to watch the first video while eye tracking is on.
289
290 3.1.11. After the first video, ask participant to complete a questionnaire page, which
291 automatically pops up. Have participants complete a battery of evaluative measures on
292 satisfaction with the viewing by clicking the left mouse button and choosing ratings.
293
294 3.1.12. Ask participant to take a break if desired or continue to another video (see **Figure 3,**
295 credited to *computers in Human Behaviors* (CHB) for a flowchart of the experiment).
296
297 [Insert Figure 3 about here]
298
299 3.1.13. Repeat the procedure seven more times for each participant to complete the entire
300 protocol and the eight ads for each.
301
302 3.1.14. Thank, debrief, and pay participant CN¥10.
303
304 3.2. Eye-tracking data and self-reported data analysis
305
306 NOTE: The eye tracker recorded the whole length of the experiment, including the segments of
307 ad watching and questionnaire responding. In this recording, eye movement data were
308 superimposed over video. Two measures were used in this study, including fixations and

309 durations. A fixation is where the eyes were relatively still, with the central foveal vision being
310 held in place so the human visual system could process the information in that point. A fixation
311 in an eye-tracker was typically defined as a succession of raw gaze points where the velocity was
312 below a pre-defined threshold in the tracker's gaze filter. More than 60 ms of gaze would be
313 considered as a fixation. Duration, on the other hand, was the length of time between the onset
314 of first gaze point and the last gaze point that make up a fixation.
315
316 3.2.1. Slice the entire recording into eight segments corresponding to each ad watching
317 segment. Each clip still contains the original ad and eye movement data.
318
319 3.2.2. On the sliced video, use the tracker software to draw an area of interest (AOI) to
320 distinguish between eye movement data in the barrage area and non-barrage area. The top third
321 was the AOI for barrage, and the lower two-thirds were the AOI for non-barrage.
322
323 3.2.3. First count the number of fixations for each video segment, and separate them into
324 fixations on the barrage AOI and non-barrage AOI.
325
326 3.2.4. Calculate durations.
327
328 3.2.5. Compare duration and the number of fixations at the barrage AOI relative to the whole
329 scene. These two measures allow researchers to infer where participants are focusing and what
330 elements they are paying attention to while watching the videos.
331
332 3.2.6. Analyze self-reported data to examine participants' satisfaction towards video
333
334 **REPRESENTATIVE RESULTS:**
335 Repeated measures MANOVAs were conducted using duration and fixation as dependent
336 variables, which indicated attention. Results confirmed proposed hypotheses that lonely
337 participants' gaze stayed on barrage longer than on non-barrage areas when the emotional ads
338 were present. However, when the rational ads were viewed, there was no difference. Such data
339 pattern did not replicate for the low loneliness participants, whose attention remained
340 statistically non-significant when watching emotional ads and rational ads. That is, there was no
341 difference between the gaze probability to the barrage area of interest and the gaze probability
342 of the non-barrage area of interest. The patterns of eye movement data were only in line with
343 the expectations of AMSM. Both duration and fixation count produced significant statistical
344 results[59]. See **Figure 4**, credited to CHB, below for the representative fixation count results.
345
346 [Insert Figure 4 about here]
347
348 For the significant interaction of loneliness, ad appeal, and barrage, pairwise comparisons were
349 computed. The results showed that lonely subjects gazed at the emotional/barrage area the most,
350 whereas a normal audience exhibited no gaze differences within either emotional or barrage
351 condition.
352

353 **Self-reported data and analyses**
354 The participants' satisfaction level was measured by using established satisfaction items from
355 previous research[63,64]. Satisfaction with watched videos largely replicated the duration and
356 fixation results, and as proposed by AMSM, and as shown in **Table 1**, credited to CHB[59]. Results
357 showed that a lonely audience was more satisfied watching emotional ads than rational ads, and
358 with barrage than non-barrage, whereas for a normal audience, there were no statistical
359 differences for both interactions.
360
361 [Insert Table 1 about here]
362
363 **Figure 1: Virtual research scenario**
364
365 **Figure 2: Comment wall curtain**
366
367 **Figure 3: Experimental flowchart**
368
369 **Figure 4: Percentage of fixation count in the barrage**
370
371 **Table 1: Evaluation results of advertising videos**
372
373 **Video 1: Sample barrage ad**
374
375 **DISCUSSION:**
376 In this study, eye tracking technology and self-reports are combined to test the validity of the
377 proposed AMSM model. Previous studies mainly used self-reports to explore the relationship
378 between loneliness and media use at the mercy of participants' ability to articulate. These offline
379 methods fail to understand the psychological processes while watching barrage videos. In this
380 study, eye tracking technology was used to record duration and fixation so researchers could
381 reliably infer how much cognitive resources the participants invested in different video content.
382 The technology is noninvasive, so participants watched the videos without interruption. Results
383 supported the proposed AMSM.
384
385 Specifically, this study provided evidence that lonely people gravitated toward emotional content.
386 When emotional content was watched and being discussed (i.e., with barrage), it was more
387 attention getting as measured in gaze duration and fixation counts. In contract, data did not show
388 such effects on people who were not lonely. Equally important, satisfaction evaluation after
389 exposure showed that lonely people were more satisfied with emotional, barrage video, whereas
390 no such conclusion could be drawn for people low in loneliness.
391
392 Theoretically, data from this study did not support traditional models of media consumption,
393 claiming either that people used media for the sake of compensating emotional needs, according
394 to the deficiency model, or viewers consumed for broader, more general purposes such as
395 learning and diversion, according to the general use model. Instead, data supported the proposed
396 AMSM model, which posited that emotional content activated viewers' affective needs,

397   encouraging them to seek out interactive features such as barrage in media to fulfill such needs.
398

399   Methodologically, even though eye tracking has been used in communication in a variety of areas
400   such as news consumption and advertising effectiveness, most of these studies explore physical
401   attributes of media such as story placement, layout designs, and product features to explore
402   attention-getting attributes. This study used eye-tracking creatively in the area of affect, by
403   measuring personality variables related to loneliness, and manipulating media variables of
404   emotional content and interactive barrage. It is the researchers' belief that eye tracking did not
405   have to focus on the obvious, it can also be used to investigate psychological processes. The new
406   barrage format also offers a new and interesting arena for research.
407

408   However, this study also has some limitations. For the sake of manipulation convenience, ads
409   were used instead of the usual entertainment content for barrage. Normally, barrage viewers
410   were highly involved in story plots to engage in barrage viewing and participation. Viewing a
411   number of ads seemed artificial. Also, because barrage was pre-produced before the experiment,
412   participants of this study did not have a chance to really engage in barrage activities. As such, the
413   activation process as proposed in AMSA was not specifically investigated. Future research may
414   want to focus on the before and after emotional states to infer whether activation occurs. Also
415   in this study, barrage appeared in the top part of the screen and its crawling direction was
416   predetermined to be from left to right. In real life, barrage texts appear in different styles. Future
417   research may need to allow natural barrage activity to increase external validity.
418

419   In sum, the combination of this approach—objective eye tracking data and subjective self-
420   reporting data—allows the researchers to not only untangle the viewing mechanism of lonely on
421   barrage videos, but also to identify the underlying mechanisms of attention allocation. Our hope
422   is that it can serves as a starting point for more such studies.
423

431

432   **DISCLOSURES:**
433   The authors declare that they have nothing to disclose.
434

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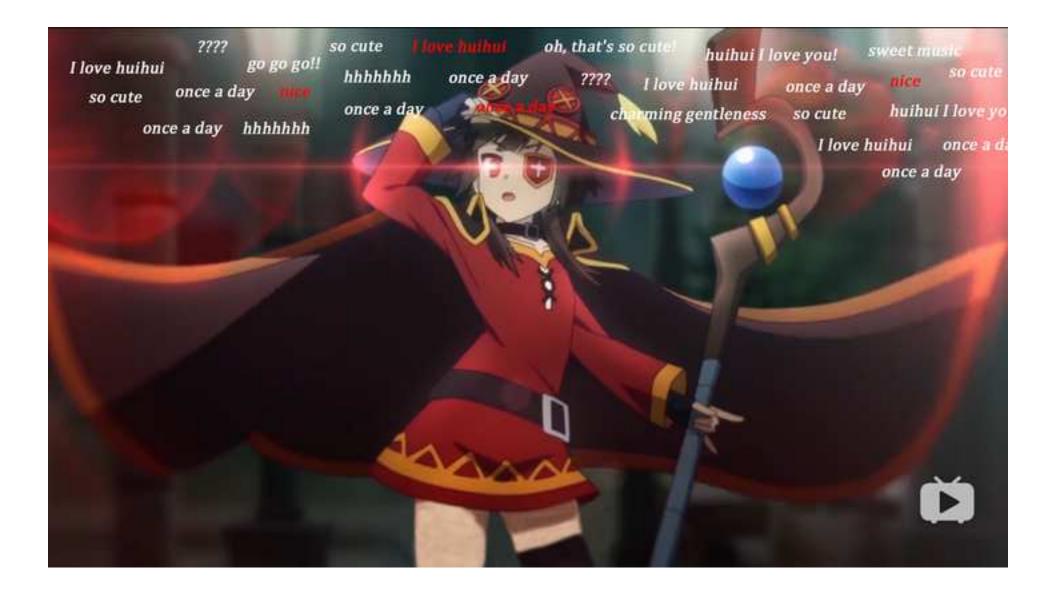528   36.   Hernik, M., Broesch, T. Infant gaze following depends on communicative signals: An eye-

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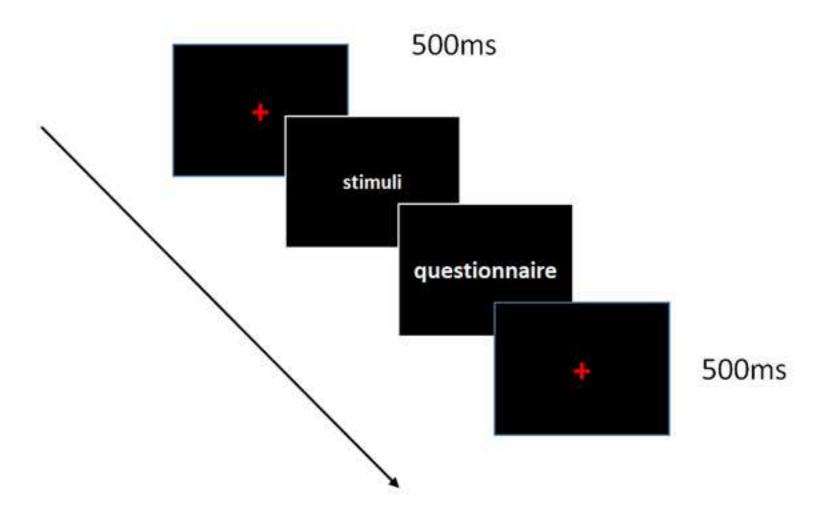573   integration in the network era. *Tianjin Social Sciences.* **5**, 80-83 (2013).

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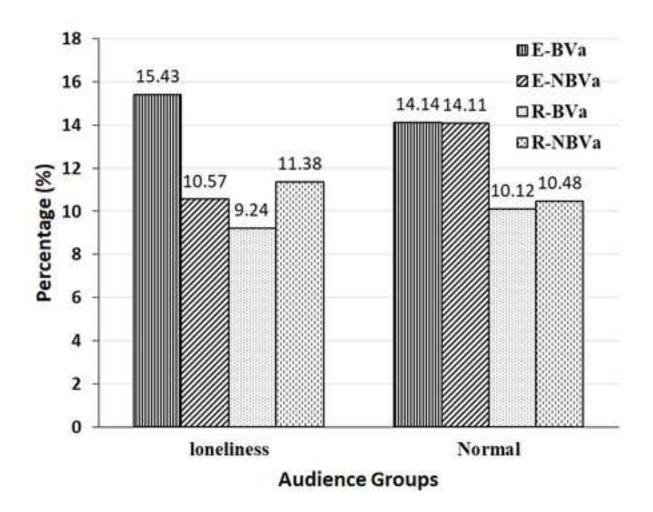583   104–109 (2000).

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599

Figure 3: Flowchart of Experiment

Figure 4: Percentage of Fixation Counts in AOI

Click here to access/download

Video or Animated Figure

ad sample.wmv

Table 1

Evaluation results of advertising videos (M ± SD)

Audience type	Story-base ads		Hard-selling ads	
	Barrage video	Non-barrage video	Barrage video	Non-barrage video
Loneliness	4.84±0.69	4.45±0.73	4.30±0.87	4.30±1.06
Normal	4.75±0.67	4.62±0.80	4.14±0.79	4.21±0.87

Note: revised from Chen & Zhou (2019) published in CHB

Table of Materials

name	company	talog number
eyetracker	Tobii	T60
questionnaire		

Authors' Responses to Editorial and Reviewers' comments

We sincerely thank the editor and the reviewers for the very thorough and constructive comments. These comments and suggestions have undoubtedly helped improve the manuscript and make it more compatible to JOVE as a visual method journal. We tried our best to address all of them. Below you will find our responses (AR) to each one of them. Again, thank you.

Editorial comments:
Changes to be made by the Author(s):
1. Please take this opportunity to thoroughly proofread the manuscript to ensure that there are no spelling or grammar issues. The JoVE editor will not copy-edit your manuscript and any errors in the submitted revision may be present in the published version.

(AR) We went through the manuscript thoroughly. We also invited a colleague and a former newspaper editor to edit the paper.

2. Please submit each figure as a vector image file to ensure high resolution throughout production: (.psd, ai, .eps., .svg).

(AR) We recreated all images using the .psd format. Hope all are OK.

3. Please ensure that the references appear as the following: [Lastname, F.I., LastName, F.I., LastName, F.I. Article Title. Source. Volume (Issue), FirstPage – LastPage (YEAR).] For more than 6 authors, list only the first author then et al.

(AR) All reformatted.

4. Please include volume and issue numbers for all references.

(AR) All done when such information is available.

5. Please define all abbreviations before use.

(AR) We checked all abbreviations, and make sure that they are defined before an abbreviation appears.

6. Please revise the table of the essential supplies, reagents, and equipment. The table should include the name, company, and catalog number of all relevant materials in separate columns in an xls/xlsx file. Please sort the Materials Table alphabetically by the name of the material.

(AR) There is only one entry. But we did xlsx file anyway. The table was included only because when we initially submitted the paper, the system kept asking for such a table, and did not allow further progress if request was not fulfilled.

7. For in-text formatting, corresponding reference numbers should appear as numbered superscripts after the appropriate statement(s).

(AR) All reformatted.

8. Please upload each Figure individually to your Editorial Manager account as a .png or a .tiff file. Please combine all panels of one figure into a single image file.

(AR) All figures are in the format requested. Will try to upload them individually.

9. All tables should be uploaded separately to your Editorial Manager account in the form of an .xls or .xlsx file. Each table must be accompanied by a title and a description after the Representative Results of the manuscript text.

(AR) All tables are done in .xlsx files. And will try to upload them individually.

10. Please obtain explicit copyright permission to reuse any figures from a previous publication. Explicit permission can be expressed in the form of a letter from the editor or a link to the editorial policy that allows re-prints. Please upload this information as a .doc or .docx file to your Editorial Manager account. The Figure must be cited appropriately in the Figure Legend, i.e. "This figure has been modified from [citation]."

(AR)We contact the journal (of which I am an associate editor)and its editor. We are reusing only three figures, with two tables revised and adapted. All reused figures and adapted tables were also credited to CHB and Elsevier). So it is within the fair use guideline defined by Elsevier, the parent company of our previously published article in *Computers in Humor Behaviors*.

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not more than five figures from a whole book or journal issue/edition;

Please see guideline at:

https://www.elsevier.com/about/policies/copyright/permissions#

11. Please include an ethics statement before the numbered protocol steps, indicating that the protocol follows the guidelines of your institution's human research ethics committee.

(AR) We adhere to Jinan University research guidelines. For your information, only the medical school of the university has an IRB board. No other discipline is required to have IRB approvals. However, we confirm that we followed all ethical rules and regulations. The project did not pose any physical or psychological harm to participants.

12. Please ensure that all text in the protocol section is written in the imperative tense as if telling someone how to do the technique (e.g., "Do this," "Ensure that," etc.). The actions should be described in the imperative tense in complete sentences wherever possible. Avoid usage of phrases such as "could be," "should be," and "would be" throughout the Protocol. Any text that cannot be written in the imperative tense may be added as a "Note." However, notes should be concise and used sparingly. Please include all safety procedures and use of hoods, etc.

(AR) All rephrased to ensure compliance.

13. The Protocol should contain only action items that direct the reader to do something. Please move the discussion about the protocol to the Discussion.

(AR) reorganized and discussions removed.

14. The Protocol should be made up almost entirely of discrete steps without large paragraphs of text between sections. Please simplify the Protocol so that individual steps contain only 2-3 actions per step and a maximum of 4 sentences per step.

(AR) Rephrased.

15. Please add more details to your protocol steps. Please ensure you answer the "how" question, i.e., how is the step performed? Alternatively, add references to published material specifying how to perform the protocol action.

(AR) Reorganized.

16. Please revise the text to avoid the use of any personal pronouns (e.g., "we", "you", "our" etc.

(AR) All personal pronouns are removed and sentences restructured.

17. Please note that Steps 1-3 are not appropriate for filming.

(AR) They were discussed in the methods section, rather than the protocol section.

18. Can example ads be provided?

(AR) We are uploading a sample video.

19. How long are the ads? How many ads are presented? Etc.

(AR) Ads are all about 60 seconds long. Eight ads are presented to each participant.

20. JoVE cannot publish manuscripts containing commercial language. This includes trademark symbols (™), registered symbols (®), and company names before an instrument or reagent. Please remove all commercial language from your manuscript and use generic terms instead. All commercial products should be sufficiently referenced in the Table of Materials and Reagents.

(AR) We now only referenced the company in the Table of Materials and Reagents.

21. Figure 2: Can the example of the barrage video be in English?

(AR) An English example is in place of the original.

Reviewers' comments:

Reviewer #1:
Keeping an Eye on Loners: Eye-Tracking Lonely Audience Watching Barrage Videos
Guangyao Chen1, Shuhua Zhou

Manuscript Summary:
This study proposes a model of activation and match satisfaction to study how lonely people used barrage videos by combining eye tracking and self-report measures. With the help of eye tracking approaches, the authors explore users' conscious and subconscious watching behaviors in real time. Moreover, they could infer the amount of allocated cognitive resources in response to rational and emotional content, especially the amount of satisfaction users had. The proposed model was empirically supported in the sample of loners. Overall, the study is innovative, which can be insightful for the JOVE readers and researchers who have an interest in studying the impact of video content on users.

(AR) Thank you very much. Appreciate the time and effort invested here.

Major Concerns:
I do not have a major concern. The language needs a good copy-editing to make it flow better.

(AR) We polished the language and eliminate all stylish errors and irregularities we are aware of.

Minor Concerns:
1. The manuscript contains the two authors' names, which makes my review no longer a blind review. I know both authors in person, though I had never co-authored any paper with either of them.

(AR) Did not know how author information sneaked in there. Sorry.

2. To make it flow better, a good copy-editing is needed.

(AR) We did, please see above response. Thanks.

3. The discussion is too brief, which lacks theoretical interpretations and extensions of the findings.

(AR). We were cautious not to introduce too much discussion not related to methods in results and discussion, as that was done in the paper published at CHB. However, in light of

the comments, we added two paragraphs in the discussion, on implication of theory, and methods.

Reviewer #2:
I write with a review of the manuscript titled, "Keeping an Eye on Loners: Eye-Tracking Lonely Audience Watching Barrage Videos." Per the journal's instructions for review, novelty is not a necessary feature of the paper's contribution and the journal also recommends considering a list of questions. In the spirit of these recommendations, I use the questions offered by the journal as the basis of my critique and recommendation.

(AR) We want to thank you for your review.

-Are the title and abstract appropriate for this methods article? Not at present. The term "barrage video" was new to me, even though I do research on media and eye-tracking, and a definition needs to be provided in the abstract. Additionally, I'm not sure that "lonely audience" is an accurate description of the population. What was measured was loneliness and the rates of loneliness were largely average (having gone back to the original measure validation paper) for students. The split at 44 seems arbitrary and lacking rationale. At the very least "loners" is inappropriate to use in the title.

(AR) Loner was meant to be cute. It is not 100% accurate accordingly to our definition, but it also captures what we want to study. However, in light of the suggestion, we have rephrased the title to be "Loneliness Assuaged: Eye Tracking Audience Watching Barrage Video." Thank you.

-Are there any other potential applications for the method/protocol the authors could discuss? Yes, though the authors do not provide much explanation about this in the current manuscript. Additionally, while novelty is not a factor, the procedures reported here are a bit like describing how to use a scale in a study in life sciences. Yes, the description could apply to other scales, but is an entire article needed to describe how to use a scale when numerous articles and instructions provide that information (i.e., in the case of eye tracking there are dozens of review articles, instruction manuals, etc.).

(AR) Thank you.

-Are all the materials and equipment needed listed in the table? No. Some material and equipment information is listed in text, but not as a table.

(AR) They are now. Thanks.

-Do you think the steps listed in the procedure would lead to the described outcome? Yes.

-Are the steps listed in the procedure clearly explained? For the most part. The authors skip over some of the complexities of ensuring calibration is maintained throughout an eye tracking session (and procedures to check for gaze drift, for example).

(AR) More calibration details are provided, with the five-point vs nine-point calibration debate added.

-Are any important steps missing from the procedure? Yes. The information about how the researchers calibrate the eye tracker beyond default settings is missing (e.g., what degree range or pixel rate was used to determine the size of the area required to have gaze behavior stalled to count as a fixation; no information on how many milliseconds gaze has to be stalled to count as a fixation, etc. etc.). There are MANY guidelines and recommendations for this, but the authors fail to report considerable technical specifications in their methodological overview.

(AR) More calibration details regarding fixation threshold and pixel rate are provided.

-Are appropriate controls suggested? No. No information on problems related to selecting areas of interest (e.g., a signal detection problem) or on environmental validity concerns (or concerns about video content influencing gaze direction) are brought up.

(AR) The AOI is the top third of the screen. Unlike other tracking projects, this is a broad area.

-Are all the critical steps highlighted? No (see previous comments).

(AR) With the added details, the critical steps are all included.

-Is there any additional information that would be useful to include? Yes (see previous comments).

(AR) More calibration details are provided.

-Are the anticipated results reasonable, and if so, are they useful to readers? Reasonable yes, but not any more useful than if this article was not available.

(AR) We do consider that eye tracking data for the study of barrage videos are interesting, and useful in its own right, especially in light of this new video format, and its ability to

provide emotional support.

-Are any important references missing and are the included references useful? Yes. Many reviews on eye tracking recommendations and procedures that already exist, as well as many methodological papers that address some of the intricacies one needs to consider prior to engaging in eye tracking research. If this paper were an empirical report of an experiment, the level of eye tracking reporting detail might be ok, but given the focus of this paper is to articulate a very specific eye tracking method paradigm, the paper fall short of including sufficient detail.

(AR) Thank you, we tried to add as much details as possible, but at the same time we also don't want it to be a manual, as most others have done.

Reviewer #3:
Manuscript Summary:
The eye-tracking experiment conducted to study lonely audiences watching barrage videos is interesting and the proposed new activation-match model is very much appreciable in your research.
The mechanism employed to examine the loners using barrage videos by combined eye-tracking and self-report measures is relevant to scientific research.

(AR) Thank you for your review, and time and insight.

Major Concerns:
During and fixations are interesting parameters to measure but in a real-time video how it is applied? If it were to be a static content, we can look at the fixations and eye moving pattern but in a dynamic video content how loners infer meaning need to be explained.

(AR) It is true that video is moving pictures. But at the same time, "movements" are relative. Videos are comprised of shots, and each shot stays or focuses on its subject for certain period of time. Within the shot, movements occur, but those are not different from real life when humans and animals move. Still duration and fixation occur because of concentrated human interest and attention to the object of focus.

Details of the barrage video content not clear which needs more clarity…
How cognitive resources invested in different media content by loners not clear.
What is the social relevance of this research?

(AR) We did not include description of every video because that is really not what we are interested. We are interested in the manipulations, and levels of manipulations. The

reviewer may be asking if content play a role in our DVs. While we can't rule out content may play a part, the hope is not, as we tried to randomize its content by using multiple videos, by randomizing its presentation order, and by randomizing ad types. As for social relevance, there is implication that this type of video format maybe more enjoyable for certain audience, ie, lonely vs. non-lonely audience.

Minor Concerns:
Is there any gender difference among normal group and loner group of participants?

(AR)Interesting question. We did check and ran the gender variables in our MANOVAs, not difference there.

Reviewer #4:
Comments to the Authors

I appreciate the work reflected here. As I noted in my comments to the editor, if the reporting and efficacy of the method is the primary evaluation criteria, then I favor acceptance of this piece. I agree with your logic and use of the method to examine cognitive resource allocation during stimulus viewing.

(AR) Thank you for your review and comments.

Regarding the method, I do offer the following suggestions.

My first minor concern is clarity of how the authors describe factorial variation of appeal type. The Method describes variation in terms of rational v. emotional appeals. However, the paper then later refers to "hard sell" versus "story based" ads. This creates confusion, and the authors should be consistent throughout.

(AR) Thank you for the comments. We want to maintain consistency in our manipulations therefore we are sticking with rational and emotional. It is true that story-based ads are more emotional based, but they can also based on dramatic elements. So the reviewer is right about this differentiation.

I suggest slightly greater description of the stimuli. I spent some time trying to understand "barrage videos." This may be unfamiliar to many readers. Please add one brief sentence in the Method to clarify in the method how factorial variation was achieved in "video type with barrage and non-barrage video." E.g., "In barrage videos, user comments were presented on top of video content, whereas in non-barrage videos, the video content was displayed without comments." Likewise, please edit Figure 2 to show a side-by-side comparison of the formats to aid clarity.

(AR) It is a novel term to most people unfamiliar with this type of video. So we added more description and an English example so people can see what it is.

This leads to a much bigger concern, which may not be relevant for this journal. In my opinion, there is a flaw in the logic of the design. As I understand the stimuli, viewers/participants watched stimuli with or without user comments (in the form of onscreen text) superimposed on top of the stimuli in the top third of the screen. Comparisons were then made in terms of visual attention allocated to that portion of the screen. Thus, it should be of no surprise that viewers spent less time/paid less attention to the top region of the screen when user comments were absent (i.e., the no barrage video condition). This would be analogous to testing attention allocation to the bottom third of the screen when a news ticker or crawl is present/absent.

(AR) We understand the reviewer's concern. In a simple two group design, this would have been a problem if comparison were only made between comments and no comments. However, this experiment had four groups, including rational and emotional appeal, so attention was in effect comparable, no comment served really as a control here.

In addition, what logic/reasoning is there to suggest individual differences in attention to user comments as a function of ad type? Your Results report "lonely audience scored higher when watching story-based ads than hard-selling ads." Why? What theoretical framework explains this? Again, I think the use of advertising content confuses/complicates the study. I think the theoretical rationale of the paper should be strengthened.

(AR) As the focus of the paper is on providing empirical evidence that barrage content satisfies different emotional needs, we did not elaborate further on alternative explanations. One such perspective is the mood management theory by Zillmann, which essentially states that humans strive to balance their mood, and they always try to aim at the positive. So if someone is sad, they are likely to want to see happy, joyful stimuli. The same is true of lonely audience, that they may seek uplifting emotional content to assuage their loneliness.

Lastly, and this is a more minor concern for this particular journal, I think the structure of the paper is reversed. The description of eye tracking comes with no context. I think the discussion of the research context and topic should come first. Then eye tracking can be introduced as a novel measurement approach to address the questions surrounding this topic/context.

(AR) Normally that is how we would structure a paper. But this is a methods journal, so that part was given emphasis as the journal requires.

Figure 1 seems irrelevant. A more useful visualization would be the "barrage video" with an area of interest (AOI) depicted visually.

(AR). We used a different figure (Figure1) to show how eye tracking is used in marketing research. Thanks to all reviewers again. We truly benefit from your insight, wisdom and hard work. We are grateful to all.

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