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A Study of Danmaku Video on Attention Allocation, Social Presence, Transportation to Narrative, Cognitive Workload and Enjoyment

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Abstract

Danmaku video (video with overlaid comments) is a relatively new social TV format and is getting popular in China. This study conducted a 3-condition experiment to examine Danmaku video watching experience in terms of 5 aspects: attention allocation, social presence, transportation into narrative, cognitive workload and enjoyment. 61 Chinese college students from the Northeast region of US were recruited to participate the study. Result indicated out that Danmaku distracted some attention from the initial video content but fostered a feeling of joint viewing with others. The presence of Danmaku also had some effect on the enjoyment of watching videos, but did not affect cognitive workload or the degree of feeling being transported into video's narrative.

Keywords: danmaku video, attention, social presence, enjoyment, eye-movement, human-computer interaction,

A STUDY OF DANMAKU VIDEO ON ATTENTION ALLOCATION, SOCIAL PRESENCE, TRANSPORTATION TO NARRATIVE, COGNITIVE WORKLOAD AND ENJOYMENT

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Chapter One Introduction

Danmaku Overview

The word “Danmaku” is getting popular in China recently. This word literally means bullet curtain, but in the context of “Danmaku video”, it refers to overlaid comments that scrolling above videos, see Figure 1 in Appendix A. These comments are posted by viewers while watching videos. Once the comments are posted, they will be attached to the video’s timeline. In other word, every time viewers watch the video to a particular timeline points, the comments posted by other viewers at that point of timeline will appear (Li, 2015; Ma & Ge, 2014). Typically, the comments enter the video frames from the right hand side and then scroll to the left hand side and disappear. When comments are scrolling, they look like moving bullets. If there are large amount of “Danmaku” appearing at the same time, these “moving bullets” will consist a “bullet curtain” covering the initial video, which is why the name “Danmaku” is given (Li, 2015; Ma & Ge, 2014).

Danmaku video was firstly introduced to public in 2006 by Niconico.jp, which is a Japanese video sharing website (Ma & Ge, 2014). This video format entered China in 2007 and gained huge popularity. The Chinese major Danmaku video site Bilibili.com, which is a video sharing site supporting Danmaku function, is having more than 10 million daily active user and more than 5 million members in 2016 (Qianzhan.com, 2016). According to Alexa.com (2016), the web traffic of Bilibili.com is ranked 160 globally and 34 in China in 2016. Besides Bilibili.com, other Chinese major video streaming sites are also adopting Danmaku function. In 2014, iQIYI, LeTV, Tencent and Sohu announced the adoption of Danmaku feature (iResearch.cn, 2014; Tech.163.com, 2016). Youku and Tudou also adopted Danmaku feature in 2015 (Youku.com, 2015). Because these major video streaming sites have bought the intellectual property right of considerable amount of TV series, web-series, films and sports events (Tech.163.com, 2012), the presence of Danmaku nowadays is not only limited to user-generated videos, which is the most popular video genre on Bilibili.com (Qianzhan.com, 2016), but also extends to online streaming TV series, web-series, films and sports events.

Danmaku as Social TV

Since the feature of Danmaku has been adopted by Chinese major video streaming sites which have purchased the intellectual property right to broadcast numbers of TV series, web-series, films and sports events, watching Danmaku video is actually becoming a novice form of social TV activity. The concept of social TV refers to the integration of social interactions into simple TV viewing experiences (Chorianopoulos, 2004; Chorianopoulos & Lekakos, 2008; Shin, 2013). Conventionally, social TV activities can be either asynchronous or synchronous. Asynchronous social TV activities constitute social commentaries, for example people posting comments and reviews about TV shows at online forums. Synchronous social TV activities are closely related to second screen experience, which means using social media to interact with other audiences while a TV show is going on so that a joint viewing experience can be created (Doughty, Rowland & Lawson, 2011, 2012; Giglietto & Selva, 2014; Lim, Kim & Biocca, 2015a).

Regarding Danmaku video, it supports both synchronous and asynchronous social commentary activities, and has the unique potential to foster an illusion of synchronous interaction even though asynchronous interaction is actually going on (Li, 2015; Ma & Ge, 2014). Danmaku can appear on live streaming videos, such as live sports events. In these scenarios, Danmaku is supporting synchronous interaction. But different from second screen experience, which requires people to use social media sites or mobile applications to participate in the interaction, Danmaku and the live streaming video are presented on the same screen.

Alternatively, Danmaku can also support asynchronous interaction and appear on non-live streaming videos such as online streaming TV series and films. Nevertheless, because all the Danmaku comments are attached to the initial video's timeline, people will be able to see other viewers' comments about particular timeline points when the video is going on, and are able to post their own comments to further enrich the conversations (Li, 2015; Ma & Ge, 2014). From this perspective, although the interaction is in fact asynchronous, Danmaku video viewers can possibly have an illusion of participating in synchronous interaction and therefore have the joint viewing experience (Y. Chen, Gao, & Rau, 2015; Ma & Ge, 2014).

Danmaku and the Cognitive Augmentation of Video Experience

Social Presence of Others.

The concept of social presence means sensing the existence of others in mediated environments (Biocca, Harms, & Burgoon, 2003; IJsselstejin, van Baren, & van Lanen, 2003). This concept is closely related to the experience of joint viewing in social TV activities (Shin, 2013) as social TV joint viewing basically means using technology, such as social media, to feel like watch TV with virtual others (Chorianopoulos & Lekakos, 2008; Shin, 2013). Since Danmaku can either facilitate actual synchronous interaction or potentially create an illusion of synchronous interaction, this thesis firstly approaches Danmaku video watching experience under the theory of social presence.

Enjoyment.

Prior literature suggested that one important motivation for people to engage in social TV activities is the willingness of sharing and exchanging watching experiences, and the pleasure gathered in the sharing activities (Doughty et al.,2012; Lim, Kim & Biocca, 2015b; Shin, 2013). Danmaku is facilitating such shared watching experience by augmenting the original video by adding additional social commentary and potentially fostering an illusion of social presence of others. This study intends to examine to what extent can the presence of Danmaku enhance the enjoyment of watching videos.

Danmaku as Cognitive Degradation of the Original Content

Transportation into Narrative.

In the same way that Danmaku add to the video experience, it might also degrade or interfere with the experience of watching the original content. One aspect that might be interfered is the degree to which viewers are immersed in the story of the original video. Literatures on social TV have suggested that social interactivities during TV watching may distract people from paying attention to the initial TV content and therefore make viewers less immersed (Chorianopoulos, 2004; Chorianopoulos & Lekakos, 2008; Li, 2015). However, on the other hand, compared to others forms of social TV experience, which require the viewer to look away from the video and switch between screens, it is possible that the Danmaku's feature of overlaid comments actually makes the social interaction experience less distracting than other forms of social TV activities. This study examines the degree of transportation into narrative as the third aspect of Danmaku video watching experience.

Cognitive Workload.

Furthermore, because Danmaku comments are actually additional information added to the initial video, these comments can potentially increase the cognitive workload of viewers. Because human have limited amount of cognitive resource, once too much information is presented for human brain to process, people will encounter cognitive overload (Lang, 2000; Mayer, 2002) and such cognitive overload may degrade viewers' experience of watching the original video. Therefore, cognitive workload is the forth aspect of Danmaku video watching experience being examined in this study.

Individual Differences in Danmaku Watching

Since Danmaku videos present 2 types of content, viewer comments and the initial video, on the same scree, how do audiences allocate their attention becomes a question and is examined in this study. Also, it is very likely for different people to allocate their attention differently. With different attention allocation, individuals' Danmaku video watching experience can be different. This study therefore also examines to what extent do individuals' attention allocation related to their other aspects of Danmaku video watching experience.

In addition, individual's prior Danmaku video watching experience, including the frequency they watch Danmaku videos and the frequency they post Danmaku, may also affect the way people watch Danmaku videos. Prior study has pointed out that novice and experienced Danmaku video viewers had some different attitudes toward Danmaku (Chen et al., 2015). The current study intends to figure out how do individuals' difference in prior Danmaku video experience be reflected in the aspects of attention allocation, feeling of social presence, enjoyment, transportation into narrative and cognitive workload.

Moreover, individual's personal preference of multitasking may also affect people's Danmaku video watching experience. Reading Danmaku comments and watching the original video are essentially two different tasks. It is possible that people preferring multitasking enjoy more about Danmaku videos than the viewers do not prefer multitasking.

Role of Danmaku Text Transparency

Danmaku video sites such as Bilibili.com supports some advanced Danmaku features such as allowing users to adjust the transparency of Danmaku texts. Chen's et al (2015) qualitative study on Danmaku has suggested that some people prefer more transparent Danmaku because they felt less distraction with highly transparent Danmaku. However, on the other hand, highly transparent Danmaku text means low Danmaku visibility, which can also reduce the quality of social interaction and possibly degrade the feeling of joint viewing and may interfere with enjoyment. The current also examines the role of Danmaku text transparency in Danmaku video watching experience.

Chapter Two Literature Review

Social TV

Social TV is defined as integrating social interactions into simple TV viewing experiences (Chorianopoulos, 2004; Chorianopoulos & Lekakos, 2008; Shin, 2013). Though conventional TV viewing experiences may also include social interactions, such as family members talking to each other when watching TV in the living room (Chorianopoulos & Lekakos, 2008), recent discussions around social TV tend to concern more about computer-mediated social TV activities (Cesar, Bulterman, & Jansen, 2008; Doughty et al., 2012; Giglietto & Selva, 2014; Lim et al., 2015b; Shin, 2013). Computer-mediated social TV activities can be synchronous or asynchronous (Chorianopoulos & Lekakos, 2008; Shin, 2013). Synchronous interaction means people use computer technologies, such as instant message and social media, to communicate with each other while a show is going on (Shin, 2013). In contrast, asynchronous interactions do not require people to watch a show parallel while the show is being aired. Fans posting online comments after a show is aired can be regarded as an example of asynchronous social TV activity (Chorianopoulos & Lekakos, 2008).

In order to support social TV activities, a number of social TV systems have been developed (Chorianopoulos, 2004; Chorianopoulos & Lekakos, 2008; Coppens, Trappeniers, & Godon, 2004; Harboe et al., 2008). Amigo TV is a typical early social TV system, which is developed in 2004 (Chorianopoulos, 2004; Coppens et al., 2004). This system enables synchronous audio communication between friends while watching broadcasting TV shows. People participating in the communication will be represented as animated avatars on screen, and will use headset microphone to transmit audio messages. Nevertheless, instead of into the public, early social TV systems are more likely to stay in laboratory settings (Chorianopoulos & Lekakos, 2008).

The advent of social media provides the opportunity for social TV to go public (Shin, 2013). Social media are supporting "real-time backchannel conversations" while a TV show is going on (Doughty et al., 2011, p. 141). People are allowed to use hash-tags to discuss around a particular topic, and use the function of mention to bring other people into the conversation (Doughty et al., 2011; Lim et al., 2015b). The usage of social media during lived TV show is facilitating a synchronous interaction among viewers and are usually called second screen activity (Lim et al., 2015b). Such second screen activity is said to construct a viewer community and allow viewers to share instant thoughts about the show that is going on (Highfield, Harrington, & Bruns, 2013; Lim et al., 2015b).

Besides using social media, another interactive watching experience, Danmaku viewing, is also getting popular, especially in China and Japan (Li, 2015; Ma & Ge, 2014). Different from using social media to instantly communicate with others, Danmaku viewing can be both synchronous and asynchronous. But because Danmaku technology allows viewers' comments to be attached to the initial video's timeline and appear in sequence when the video is going on, even though when asynchronous Danmaku activities were actually going on, an illusion of synchronous interaction can be possibly fostered (Li, 2015). Considering creating an awareness of co-viewing is an important criterion in evaluating social TV systems (Chorianopoulos & Lekakos, 2008), this thesis will examine Danmaku viewing experience with particular reference to social presence theory.

Social Presence

The concept of social presence, which generally means sensing the existence of others in mediated environments (Biocca et al., 2003; IJsselstejin et al., 2003) has been discussed for decades in the field of telecommunication and computer-mediated-communication (CMC) (J. Kim, 2011; Sivunen & Nordbäck, 2015). This concept was first raised by Short, Williams, and Christie (1976, p. 65) with the definition of "the degree of salience of the other person in the interaction." In this earliest definition, the attributes of the communication medium are emphasized, especially to what extend can a medium transmit non-verbal cues, such as facial expressions and eye gazes. Short et al. (1976, p. 66) suggested that if a medium can convey richer social cues, this medium would be regarded as more "sociable, warm and personal," and therefore could afford higher social presence. Such emphasis on medium's characteristics per se was echoed in the information richness theory (Daft & Lengel, 1984), which pointed out that the richest social cues would be transmitted through face-to-face communications. In contrast, computational numerical outputs would afford the lowest information richness and therefore make people feel this medium as being impersonal.

Nonetheless, the argument that the degree of social presence solely depends on medium attributes was challenged by more recent literatures. CMC scholars have found that the quality of communication is also affecting people's perceived social presence (J. Kim, 2011; Sivunen & Nordbäck, 2015). For example, Sivunen and Nordbäck (2015) analyzed social presence in a 3D virtual collaborative working environment. They found that the degree of perceived social presence was changing by time. Higher degree of social presence tends to be perceived along with higher quality of communication, such as receiving instant responses from team members. Based on this finding, Sivunen and Nordbäck (2015, p. 19) suggested that social presence is a "situational phenomenon", which is not only based on the medium attributes, but also varied with the communication qualities time by time. This argument is also reflected in Biocca, Harms, and Gregg's (2001, p.2) conceptualization of social presence which indicates that social presence is a "moment-by-moment awareness" of others' co-presence in virtual environments.

Moreover, it is pointed out that interactivity is playing a crucial role in determining the communication quality and therefore affecting the degree of perceived social presence (Gunawardena, 1995; J. Kim, Kwon, & Cho, 2011; Sivunen & Nordbäck, 2015). Prior studies have indicated that, for example in virtual learning environments, students tend to sense higher level of social presence when they are interacting with the instructor and co-learners (Gunawardena, 1995; J. Kim et al., 2011). Nonetheless, besides interactivity itself, the technologies affording such interactivities can also be important. Sivunen and Nordbäck (2015) found that lower level of social presence would be perceived when the technological problems happen, such as Internet disconnection. Therefore, a more solid conceptualization of social presence would be that social presence is not solely depending on medium attributes or communication quality. Instead, these two factors are intertwined with each other and are both affecting the degree of social presence (Biocca et al., 2003; Gunawardena, 1995; J. Kim, 2011; Sivunen & Nordbäck, 2015).

Applying social presence theories to study "Danmaku," Danmaku is a text-based CMC (Li, 2015; Ma & Ge, 2014), which means it is not transmitting numbers of non-verbal cues. Nonetheless, having low social information richness is not equal to incapable of creating social presence (Sivunen & Nordbäck, 2015). Instead, the technology of Danmaku is facilitating interactivity among viewers. Danmaku viewers interact with each other, either synchronously or asynchronously, by posting comments and letting others to see the comments at particular scenes

(Ma & Ge, 2014). With these interactivities, Danmaku viewers are possible to have a sense of co-viewing and perceive some degree of social presence. Therefore, this study hypothesizes that: H1a: Danmaku can foster a sense of social presence of others.

Moreover, major Danmaku video websites such as Bilibili.com not only allows users to turn on or off Danmaku function, but also allows them to adjust the presentation of Danmaku, for example Danmaku text transparency. Higher Danmaku text transparency means lower Danmaku text visibility, which may degrade the presence of social cues and impair the quality of social interaction. Based on these, this thesis hypothesizes:

H1b: Higher level of Danmaku text transparency indicates lower level of feeling social presence.

In addition, prior studies have pointed out that individuals might perceive different degrees of social presence in the same mediated environment because they engaged in interactivities at different levels (Gunawardena, 1995; Sivunen & Nordbäck, 2015). Such disparities in the degree of perceived social presence can also exist in Danmaku video watching experience because Danmaku video viewers may pay different amount of attention to Danmaku. Therefore, the current study hypothesizes:

H1c: The degree of perceived social presence co-varies with viewers' amount of attention to Danmaku.

Transportation into Narrative

Transportation into narrative refers to the experience of being immersed in the story of media contents (Green, 2004; Green & Brock, 2000). It contains three aspects of immersion, cognitive, emotional and imagery (Green, 2006). The cognitive aspect particularly refers to the amount of cognitive attention that viewers pay to media content. When being fully cognitively engaged in narrative, viewers will become less aware of the surroundings (Gerrig, 1993). The emotional and imagery aspects are closely relevant to the experience of identifying with media characters, which means an audience "imagines him or herself being that character"; adopts the character's goals and develops "emotional and cognitive connections with the character" (Cohen, 2001). By identifying with the character in story, audiences tend to experience what the story's protagonists are experiencing, such as encountering danger (Bruner, 2002) and overcoming difficulties (Nell, 2002).

The concept of transportation into narrative is similar to some other concepts in communication studies, such as tele-presence. The concept of tele-presence refers to "the experience of 'being there' in a mediated environment" (IJsselstejin et al., 2003). The feeling of tele-presence contains two aspects of experience: people's sensory in the physical environment and immersion in the virtual environment (Kim & Biocca, 1997). When people become less aware of the physical environment but more engaged in the virtual environment created by media, they are said to be experiencing higher degree of tele-presence.

Prior studies have also found that higher level of transportation into narrative indicates higher perceived realism of media content (Green, 2004), better attitudes and purchase intention toward the brands being advertised (Chen, 2015) and more enjoyment about the story (Green, Brock, & Kaufman, 2004). Experiencing higher degree of tele-presence also tends to enhance audiences' memory performance, make people aroused and enjoyed in the mediated virtual environment and have better attitudes toward advertised brands (Heo & Sundar, 2004; T. Kim & Biocca, 1997; Lombard & Ditton, 1997).

However, in the scenario of watching Danmaku videos, since viewers may "have become familiar with an established set of audiovisual techniques that keeps the video area clear of other visual distraction” (Chorianopoulos & Lekakos, 2008, p. 116), Danmaku, which are actually overlaid comments above videos, can become some unfamiliar distractions. Therefore, Danmaku could possibly distract people’s attention from the original video and degrade their experience of transportation into narrative and feeling of being in the virtual world. Therefore, this thesis hypothesizes:

H2a: Danmaku will degrade viewers’ experience of transportation into narrative.

Moreover, since some Danmaku sites allow users to adjust Danmaku text transparency, this thesis also concerns about how Danmaku text transparency affect the degradation of transportation into narrative. With higher level of Danmaku text transparency, viewers can actually see through these overlaid comments. In other words, the original video become visible when they are covered by semi-transparent Danmaku. Prior study of Danmaku has also pointed out that some people think Danmaku became less distracting when they were semi-transparent (Chen, Gao & Rau, 2015). Considering these, the current hypothesizes:

H2b: Higher level of Danmaku text transparency indicates higher level of transportation into narrative.

Cognitive Workload

Cognition theorists have come up with slightly different explanations about how do human cognitive process happen. For instance, Mayer (2002) suggests that there are two distinct cognition channels, auditory and visual. Both channels have limited cognitive capacity. Cognitive overload will happen when either one of the channels has exceeding information to process.

Lang (2000) holds a slightly different explication about the process of cognition. Lang (2000) believes that there is only one cognitive resource pool, but still with limited amount of cognitive resources. Three cognition sub-processes, encoding, storing, and retrieving share this resource pool. Encoding means paying attention to the information and generate mental representations; storing refers to the process of memorizing messages; and retrieving is about searching for the memorized information in human mind (Lang, 2000, 2006). Lang (2000, 2006) also points out that these three sub-processes are working simultaneously, and if one sub-process, such as encoding, consumes too many cognitive resources, the rest two sub-processes will suffer. Also, it is not impossible that a message requires too many cognitive resources; therefore none of the sub-processes can thoroughly go through (Lang, 2006; Lang, Kurita, Gao, & Rubenking, 2013). In these cases, cognitive overload will to occur.

Despite cognition theorists' different explications on the detailed human cognitive process, the basic assumption is unanimous, which is human only have limited amount of cognitive resources. When people do not have sufficient cognitive resources to process a piece of information, cognitive overload may happen (Lang, 2000, 2006; Mayer, 2002; Mayer & Moreno, 2003). Applying cognition theories to studying Danmaku, Danmaku can be regarded as additional visual materials, which may increase the workload of the visual channel. Because the available cognitive resources in the visual channel is limited, when there are too many Danmaku on screen, viewers are very likely to encounter cognitive overload. Alternatively, according to the theory of Lang (2000, 2006), large amount of Danmaku may draw too many cognitive resources to the sub-process of encoding, while leave insufficient resources for storing and retrieving. Also, it is possible that processing Danmaku requires too many cognitive resources that even the encoding sub-process cannot go through thoroughly.

Regarding the consequences of encountering cognitive overload, Lang (2000, 2006) suggests that people will not able to recall message contents if the sub-processes of storing and retrieving suffer. Neither can people recognize the message they saw before, if the encoding sub-process does not go through successfully. Prior empirical studies have found some evidences supporting such weakened memory performance caused by cognitive overload. For example, Potter (2000, p. 156) finds that frequently changing speakers in a radio program can impede listeners' recognition memory about the auditory content, especially the contents "immediately after the voice changes." Concerning video contents, Kurita, Sungkyoung, Zheng, and Lang (2008) find that people tend to perform unsatisfying cognition memory when seeing large amount of new information after a camera change. Therefore, this thesis also hypothesizes:

H3a: Danmaku will increase audiences' cognitive workload while watching videos.

H3b: Danmaku will degrade audiences' memory about the video's content.

Enjoyment

Though media enjoyment has been generally defined as pleasurable experience while consuming media contents (Zillmann, 1994), communication scholars are actually conceptualizing media enjoyment from different perspectives (Nabi & Krcmar, 2004; Tamborini, Bowman, Eden, Grizzard, & Organ, 2010). For example, Nabi and Krcmar (2004) define media enjoyment as an attitude toward media messages based on audiences' affective, cognitive and behavioral experience while consuming media messages. In this conceptualization, the affective experience refers to audiences' affective process, such as having empathy for character (Zillmann, 1991) and becoming emotionally aroused (Nabi, Stitt, Halford, & Finnerty, 2009). Cognitive experience refers to building cognitive judgement, such as morally judging a drama character being ethical and intelligent (Raney, 2003; Raney & Bryant, 2002). Behavioral experience means enjoying media contents on the behavioral level, such as developing a para-social relationship with media characters (Nabi & Krcmar, 2004).

Slightly different from Nabi and Krcmar's conceptualization, Tamborini et al. (2010) define media enjoyment as the satisfaction of intrinsic psychological needs. Tamborini et al. (2010) adopts self-determination theory (STD) (Deci & Ryan, 2000), which argues that people will conduct activities that can satisfy 3 basic psychological needs: autonomy, meaning people have willingness when conducting the activity; competence, meaning the need for challenge; and relatedness, meaning the feeling of connected with others. Tamborini et al. (2010) argues that the satisfaction of these needs can be applied to understanding enjoyment of entertaining media, especially digital games. This thesis applies this conceptualization of media enjoyment to Danmaku video watching experience.

When watching Danmaku video, the first intrinsic need that can be satisfied is the need to be connected with others. Danmaku viewers are likely to enjoy watching Danmaku video since Danmaku can possibly foster social presence of others, and make viewers feel like connecting with viewer communities (Chen et al., 2015). The second intrinsic need that may be satisfied is the need for challenge. Danmaku create additional information on screen and require human brain to allocate more cognitive resource to process the additional information. Therefore, watching Danmaku videos can possibly be more challenging than watching normal videos.

However, on the other hand, prior literature also points out that in order for a media to be enjoying, the difficulty of a media message need to match viewers' ability to interpret the message (Sherry, 2004). In other words, if Danmaku consume too much cognitive resource from viewers' brain, viewers may no longer enjoy the challenging experience of watching Danmaku videos. A third factor that may affect viewers' enjoyment of watching Danmaku video is the degree to which can viewers be immersed in the original video's content. Since media enjoyment is suggested to be predicted by the level of viewers' transportation into narrative (Green et al., 2004), and Danmaku is expected to distract viewers from the original video content, whether viewers will perceive enhanced enjoyment with Danmaku is questioned. With these possibilities of enjoyment while watching Danmaku video, this thesis asks the research question:

RQ: How will people's video watching experience affected by the presence of Danmaku?

Individual Differences

Chen et al's qualitative study on Danmaku has found that Danmaku watching experience vary between novice Danmaku viewers and experienced Danmaku viewers. Novice Danmaku viewers tend to think Danmaku being abundant information and prefer less amount of Danmaku, while experienced Danmaku viewer are less likely to be bothered by large amount of Danmaku. The current study further specifies people's prior experience with Danmaku video into their prior experience of watching Danmaku and prior experience of posting Danmaku, and regards these 2 factors as 2 moderators for the hypothesized relationships in H1-H3:

H4a: People's prior experience of watching Danmaku videos moderates the hypothesized relationships in H1-H3.

H4b: People's prior experience of posting Danmaku moderates the hypothesized relationships in H1-H3.

Chen et al (2015) also suggested that Danmaku video watching experience might be different between people with high and low preference of multitasking. Since reading Danmaku comments and watching the original video are essentially two tasks, it is possible that people who like multitasking would feel more comfortable about watching Danmaku videos. The current study regards people's preference of multitasking as a third moderator for the hypothesized relationship in H1-H3:

H4c: People's personal preference of multitasking moderates the hypothesized relationships in H1-H3.

Chapter Three Method

A 3-condition between subject experiment was conducted to examine people's Danmaku video experience. The 3 conditions had the same video content but 3 levels of Danmaku text transparency, 100% (no Danmaku), 50% (semi-transparent) and 0% (non-transparent). The experiment was approved by Expedited Protocal Review by Institutional Review Board of Syracuse University.

Participants

Sixty-six Chinese college students from the Northeast region of the U.S were recruited as subjects to participate the experiment. The snowball sampling process was started with the researcher's own personal network. Because the Danmaku comments were in Mandarin, all the recruited subjects were native Mandarin speakers. These subjects were recruited with purposive and snowball sampling strategy. Each subject received $10 reimbursement to participate in the study

Stimulus

Stimuli came from a recent Chinese web series called The Brother on the Top Bunk Bed, a 26-episode drama about Chinese college students' lives. The Danmaku version was released on Letv.com and Bilibili.com, which are video streaming platforms supporting Danmaku function. This show was played more than 12 million times when its first episode was released, and hashtag about this show ranked top 10 on the Weibo (Chinese equivalence of Twitter) trending (Sohu.com, 2016). Moreover, this show is a good case of Danmaku video because it received huge number of Danmaku comments. Before the experiment started, this show's first episode had received more than 11,000 Danmaku comments on Letv.com and Bilibili.com respectively (Bilibili.com & Letv.com, 2016).

This study used the first 309 seconds of the first episode of the show to create stimuli. These 309 seconds contain a complete short story. The researcher legally downloaded the initial video content and Danmaku comments from Bilibili.com, which supports membership downloading. The downloaded video and Danmaku was firstly played in a software called Bilibili PC/Mac which enables users to adjust the transparency of Danmaku text. By setting Danmaku text transparency to 0% (non-transparent), 50% (semi-transparent) and 100% (no Danmaku), 3 versions of stimulus were created, see Figure 2 to 4 in Appendix A. These 3 versions of stimuli were recorded by QuickTime Player and loaded into Gazepoint Media Player for presentation and eye movement recording.

Measures

Self-reported Attention.

Self-report attention allocation was measured with 3 questions on 7-point Likert scales, which Robert F Potter and Choi (2006) used to measure people's attention on media messages. The items were adapted to fit the scenario of the current study. Considering in the current study, the attention to the video's content and attention to Danmaku needed to be differentiated, 2 sets of attention scales were used. The first set measured the attention to the initial video content, for example "How much did you pay attention to the show's content you just watched?" The second set of scale measured the attention to Danmaku comments, for example "How much did you pay attention to the Danmaku's content you just watched?" Moreover, the set of attention scale about Danmaku was only displayed to the subjects who are assigned to the semi-transparent Danmaku condition and the non-transparent Danmaku condition.

Visual attention.

Visual attention, specifically amount of time spent on different areas were measured using Gazepoint GP3. The eye-tracker capturing people's pupils' motion and fixation (GazePoint.com, 2016b). Attention to Danmaku was measured via spatial distribution of the screen, which will be explained in detail in the section of data process.

Social Presence.

Social presence was a composition measure using three dimensions of the construct. The first dimension was about the perceived salience of other viewers (Short et al., 1976) in the Danmaku environment. This dimension concerns about people's feeling of having "face-to-face conversations" with others (Lee & Shin, 2012, p.1097). This dimension was measured by 4 items on 7 point Likert scales, which have been used by Lee and Shin (2012) to measure social presence in a prior social media research. The items were adapted to fit the context of the current study. An example item is "Having the comments appearing above the video, I felt as if other viewers were speaking directly to me."

The second dimension measured Danmaku viewers' message and affective understanding of other viewers based on Danmaku comments. This dimension concerns about the degree to which people could understand other viewers' thoughts in mediated environment. Another issue being addressed in this dimension is whether emotion could be contagious based on Danmaku comments. The message and affective understanding dimension was measured with 7 items on 7 point Likert scales. These items were initially developed by Harms and Biocca (2004) and were adapted to fit the context of the current study. An example item is "I was sometimes influenced by others viewers' moods based on their comments."

The third dimension concerns about Danmaku viewers' sense of belonging to viewers' communities. This dimension was measured with the factor of "global community" under the scale of “Feeling Connected via Television Viewing” developed by Xu and Yan (2011). This measurement had 3 items on 7 point Likert scales and had been applied to a prior social TV study about people’s feeling of being connected to viewers’ communities (Lim et al., 2015b). The 3 items were adapted to fit the context of the current study, for example “Having the comments appearing above the video, I felt myself being part of a big viewers' family.”

Transportation to Narrative.

Transportation was measured by a validated scale developed by Green and Brock (2000). The scale has 15 items, capturing 3 aspects of transportation, which are cognitive, affective and imagery. An example items will be I was mentally involved in the narrative while watching it”.

Cognitive Workload.

This thesis used NASA TLX (Hart & Staveland, 1988) to measure participants’ cognitive workload while watching Danmaku videos. NASA TLX is a validated subjective workload measurement (Hart & Staveland, 1988). It measures workload from 6 aspects: mental demand (“how mentally demanding was the task”), physical demand (“how physically demanding was the task”), temporal demand (“how hurried or rushed was the pace of the task”), performance (“how successful were you in accomplishing what you were asked to do”), effort (how hard did you have to work to accomplish your level of performance), and frustration (how insecure, discouraged, irritated, stressed, and annoyed were you”). Subjects rated their subjective workload from these 6 aspects on 7 point Likert scales.

In addition, the 6 aspects can be combined into 15 pairs. Subjects were presented with the 15 pairs of workload aspects and asked to weight the aspects by picking 1 from each pair as the aspect that being more important as generating workload for this study’s task. Within each pair, the chosen aspect scored 1 while the other scored 0. The scores for each workload aspect were summed as their weights. The production term of each aspect's rating and weight were summed. These summed numbers were then divided by 15 and yielded each subject's final weighted workload. Final weighted workload could range from 0 to 7 theoretically.

Memory Performance.

Subjects' memory performance about the initial video's content was measured with signal detection approach. The researcher created 30 screenshots (15 were randomly selected from the stimuli video and 15 were randomly selected from other episodes of the web series). The screenshots were presented in E-Prime 2.0 during the experiment. Subjects were asked to indicate whether they had seen the screenshot in the stimuli video as quickly as possible. Subjects' accuracy and reaction time were recorded.

Enjoyment.

This thesis used the interest/enjoyment subset of the Intrinsic Motivation Inventory (IMI) to measure enjoyment. It is a validated scale (McAuley, Duncan, & Tammen, 1989; Ryan, 1982) and has been applied to study self-reported media enjoyment (Tamborini et al., 2010). This original scale contained 7 items on 7 point Likert scales. The items were modified to fit the video watching task in the current study, for example "I thought watching this video was quite enjoyable."

Prior Experience with Danmaku.

This thesis also measured individual differences from 3 aspects: prior experience of watching videos with Danmaku, prior experience of posting Danmaku and preference of multitasking. Prior experience of watching Danmaku videos was measured by a single item asking "on a scale of 1 to 5, please indicate how often you turn on Danmaku function while watching videos?" Prior experience of posting Danmaku was measured by a single item asking “on a scale of 1 to 5, please indicate how often post comments while watching Danmaku videos?”

Preference for Multitasking.

Preference of multitasking was measured by the Multitasking Preference Inventory developed by Poposki and Oswald (2010). This is a unidimensional measurement for individual differences in polychronicity with 14 items on 7 point Likert scales. An example item is “I would like to work in a job where I was constantly shifting from one task to another, like a receptionist or an air traffic controller.”

Design and Procedure

Pilot Test.

One week before the experiment, a pilot test was conducted with 7 subjects, 4 of them wore glasses and 3 did not. These subjects were invited to a media lab. Subjects were randomly assigned to the 3 conditions. The purpose of the pilot test was to ensure the measure instruments were bug free. Some modifications were made after the pilot test. Firstly, the questions about social presence were removed from the condition of no Danmaku. Pilot test subjects in this condition were confused about these questions’ content since there were actually no social presence cues in this condition. Also, in the memory test, the duration for screenshots’ presence was changed from 250ms to infinite. Pilot test subjects were sometimes unable to respond or were very likely to accidently choose the opposite choice as their initial willingness if each screenshot only existed for 250ms or 500ms or 1000ms. The duration for each screenshot’ presence was changed into infinite so that subject would have sufficient time to make the judgement. Subjects would still be asked to respond as quickly as possible and their reaction time would index memory performance with long reaction time indexing poorer memory performance.

In addition, a major concern for the eye-tracker was that for subjects who wear glasses, their glasses may reflect light and make eye-tracker unable to detect subjects' pupils. This light reflection from glasses was mitigated by adjusting the eye-tracker's position "to point up at the users eyes at a steeper angle than for someone without glasses" (GazePoint.com, 2016a). Also, by cleaning subjects' glasses, the light reflection was also reduced.

Formal Experiment.

During the formal experiment period, the subjects were invited to a media lab. After reading and signing the consent form, subjects were led to the experiment room and were randomly assigned to 1 of the 3 conditions. The researcher gave subjects instructions, calibrated the eye-tracker and started the video. The eye-tracker recorded subjects' eye-movement during the video watching process.

After watching the video, subjects were asked to complete the memory test and a computer-based questionnaire measuring their video watching experience in the sequence of enjoyment, workload, self-report attention, degree of social presence and transportation, preference of multitasking, prior experience of watching or posting Danmaku and demographic information. After completing the questionnaire, each subject will be thanked for their time and reimbursed.

Data Process

Data cleaning.

All eye movement data was visually inspected for artifacts. Subjects with eye glasses created some artifacts due to glass reflection. The researcher reviewed all the participants' eye-movement recording and removed the time period during which light reflection occurred. The cases having light reflection for more than 103 seconds, which accounted for 1/3 of the total length of stimuli video, were regarded as not having sufficient valid data and excluded from further analysis.

Eye data reduction.

Gazepoint GP3 records coordinates of participants' eye-movement, and defines the screen's left top point as (0, 0), the center of screen as (0.5, 0.5) and the right bottom point as (1, 1). Since the stimulus video is at widescreen ratio and has top and bottom black bars. Each black bar takes 11/90 (12.2%) of the screen's height. The current study defines the areas without the black bars as the area of video frame, which will have y axis coordinate large than 0.12 and small than 0.88. In the stimulus video, most Danmaku appear at the top of screen within the height of approximately 2 black bars. Therefore, the area of Danmaku was defined as having Y-axis coordinate equal or large than 0 and equal or less than 0.244 In addition, the Danmaku area was further divided into the left half and right half using the X-axis coordinate of 0.5. Subtitle in the stimulus video appear above the bottom black bar with height of approximately 1 black bar, so the area of subtitle was defined as having Y-axis coordinate equal or large than 0.756 and less than 0.878. The current study also defines an area as the video content area, which has Y-axis coordinate large than 0.244 and less than 0.756, see Figure 5 in Appendix A.

The amount of time each participant looking at each area were counted and divided by the length of each participant's valid eye-movement recording. In other words, each participant had a visual attention score, on a 0% to 100% scale, for each defined area.

It is necessary to notice that these visual attention areas could contain error. For example, Danmaku could appear outside the Danmaku area, and not all pixels in the Danmaku area are covered by Danmaku. Also, video content could also appeared outside the defined video content area. Therefore, the eye-movement data was only used to examine where participants' visual attention were allocated. Regarding further analysis about attention allocation and video watching experience, self-report attention measured in questionnaire was used.

Memory Data.

Each participant had a mean accuracy and reaction time at memory test by averaging his or her memory performance through all the 30 memory test screenshots. To reduce error caused by participants not paying attention to the memory test, outliers in reaction time were replaced with mean value.

Self-report data.

Other video watching experience and individual differences were measured by Qualtrics and were processed in SPSS 22. Participants who had watched the stimulus video previously were excluded from further analysis.

In each condition, individual difference variables, namely the frequency of watching Danmaku, the frequency of posting Danmaku and preference of multitasking, were recoded into 2 levels (low and high) using the median value as the split point. After recoding individual difference variables into 2 levels, the main effect of individual difference variables and the interaction effect between experimental condition and individual differences could be examined using factorial ANOVA.

Path analysis was conducted using the Lavaan package (V 0.5-22) under R 3.3.2. Maximum likelihood estimation was used to calculate the path parameters.

Chapter Four Result

Demographics

After filtering out subjects who had previously watched the stimuli video, 61 qualified subjects were remained in the sample for analysis. Among the 61 subjects, 25 were male and 36 were female. Subjects' age ranged from 20-32 with the mean age of 24.87. 17 subjects were in the no Danmaku condition; 20 were in the semi-transparent Danmaku condition; 24 were in the non-transparent Danmaku condition, see Table 1 in Appendix B.

All the scales used in the current study had a Cronbach alpha reliability exceeded 0.70, see Table 2 in Appendix B.

Attention Allocation

Eye-movement Attention.

The researcher first conducted 1-way ANOVA to test whether participants' visual attention were different across conditions. Result turned out that condition had a significant effect on visual attention to video content area [$F(2,43)=4.88$, $p<.05$] as well as Danmaku area [$F(2,43)=7.56$, $p<.01$]. When comparing conditions pairwise, post hoc Tukey HSD analysis indicated that participants in the no Danmaku condition spent significantly more time looking at the video content area but significantly less time at the Danmaku area compared to participants in the 2 Danmaku conditions. Visual attention allocation was not significantly different between the 2 Danmaku conditions.

The researcher also examined whether participants paid different degree of visual attention to the right hand side and left hand side of Danmaku area. Paired samples t-test was calculated within each condition. Result turned out that participants paid significantly more visual attention to the left hand side of Danmaku area in the no Danmaku condition [t (12) =2.92, *p*<.05], while paid significantly more visual attention to the right hand side of Danmaku area in the semi-transparent Danmaku condition [*t* (13) =-2.76, *p*<.05] and also the non-transparent Danmaku condition [*t* (16) =-3.80, *p*<.01].

See Figure 6-9 in Appendix A as illustration of how participants' visual attention was allocated on the screen. Within each condition, all participants' eye movements throughout the duration of the stimulus video were aggregated into these 3 heat maps which were generated by the Gazepoint analysis software. These heat maps indicated the amount of time participants looking at different areas. Areas covered by color closer to red indicated more time spent while areas covered by color closer to blue indicated less time spent. Areas not covered by any color were areas never been looked at. As showed in these figures, the center of screen and the area with subtitle were the 2 areas that attracted the most visual attention. Also, compared to participants in the no Danmaku condition, participants in the 2 Danmaku conditions paid more visual attention to the top of the screen where most Danmaku appeared. In addition, in the 2 Danmaku conditions, the top right quarter of the screen attracted more visual attention than the top left quarter, which suggested that participants tended to pay more attention to Danmaku when they just appeared from the right hand side of the screen.

Self-report Attention Allocation.

Participants' self-report attention to the video content were also different across conditions. 1-way ANOVA showed that condition had a significant effect on self-report attention to video [*F* (2, 58) =3.43, *p*<.05]. Participants in the no Danmaku condition paid the highest attention to the video content (*M*=5.49, *SD*=0.92), followed by participants in the semi-transparent Danmaku condition (*M*=5.39, *SD*=0.90), followed by the non-transparent Danmaku condition (*M*=4.78, *SD*=1.02), though Tukey HSD post hoc analysis indicated that the differences were not significant when comparing conditions pairwise, see Figure 10 in Appendix A.

Regarding participants' self-report attention to Danmaku, though participants in the non-transparent Danmaku condition (*M*=3.80, *SD*=1.10) paid more attention to Danmaku than participants in the semi-transparent Danmaku condition (*M*=3.10, *SD*=1.22), such difference was not statistically significant when conducting an independent samples t-test.

Danmaku and Social Presence

H1a and H1b hypothesized that Danmaku would foster a feeling of social presence of other viewers, and the degree of perceived social presence would be affected by Danmaku text transparency. Since social presence questions were not asked to participants in the no Danmaku condition, it would not be possible to compare social presence across 3 conditions. For participants in the 2 Danmaku conditions, because the social presence measuring instruments were all on 7-point Likert scales with 4 being the value of neutral, participants who rated above 4 would be regarded as perceived social presence. Result turned out that 70% participants in the semi-transparent Danmaku condition and 75% participants in the non-transparent Danmaku condition perceived social presence. Also, participants in the non-transparent Danmaku condition perceived higher degree of social presence (*M*=4.51, *SD*=1.00), compared to participants in the semi-transparent Danmaku condition (*M*=4.40, *SD*=1.19), see Figure 11 in Appendix A. Nonetheless, such difference was not statistically significant when an independent samples t-test was conducted.

H1c hypothesized that the degree of perceived social presence was related to people's attention allocation. To examine this hypothesis, in each Danmaku condition, a multiple regressions were calculated using social presence as the dependent variable, and self-report attention to video and self-report attention to Danmaku as predictors entered into the model. Result turned out that self-report attention to Danmaku was a significant predictor for social presence in the non-transparent Danmaku condition while not in the semi-transparent Danmaku condition. Self-report attention to video was not predicting social presence in neither Danmaku conditions, see Table 3 in Appendix B.

Danmaku and Transportation into Narrative

H2a and H2b hypothesized that Danmaku would degrade people's feeling of being transported into the video's narrative, and the degree of perceived transportation would be affected by Danmaku text transparency. Nonetheless, result turned out that people in the semi-transparent Danmaku condition perceived the highest degree of transportation into narrative (*M*=4.18, *SD*=0.72), followed by participants' in the no Danmaku condition (*M*=4.03, *SD*=0.70), followed by participants in the non-transparent Danmaku condition (*M*=3.81, *SD*=0.67), see Figure 12 in Appendix A. 1-way ANOVA indicated that Danmaku text transparency did not significantly affect the degree of transportation into narrative [F (2, 57) =1.57, *n.s.*].

The relationship between people's attention allocation and the degree of transportation into narrative was also examined. In each Danmaku condition, a multiple regression was calculated using transportation as the dependent variable, self-report attention to video and self-report attention to Danmaku as predictors entered into the model. For the no Danmaku condition, a linear regression was calculated using transportation as the dependent variable and self-report attention to video as the predictor. Result turned out that self-report attention to video was a significant predictor for the degree of transportation in both Danmaku conditions, but not in the no Danmaku condition. Also, self-report attention to Danmaku was a significant predictor for transportation in the non-transparent Danmaku condition, see Table 4 in Appendix B.

Danmaku and Cognitive Workload

H3a hypothesized that Danmaku would increase audiences' cognitive workload while watching videos. However, opposed to the hypothesis, participants in the no Danmaku condition actually reported the highest workload (*M*=3.05, *SD*=0.80), followed by participants in the semi-transparent Danmaku condition (*M*=2.83, *SD*=1.04), followed by participants in the non-transparent Danmaku condition (*M*=2.60, *SD*=1.25), see Figure 13 in Appendix A. Though 1-way ANOVA indicated that workload differences were not significant across conditions [*F* (2, 58) =.88, *n.s*].

The researcher also examined whether workload were related with attention allocation. For each condition, a multiple regressions was calculated using workload as the dependent variables. Self-report attention to video and self-report attention to Danmaku were entered as predictors into the models. Result turned out that self-report attention variables were not predicting workload in any conditions, see Table 5 in Appendix B.

Danmaku and Memory for Video

H3b hypothesized that Danmaku would degrade participants' memory accuracy about the video's content and increase participants' reaction time while doing the memory test. However, result turned out that participants in the semi-transparent Danmaku condition had the highest accuracy in memory test (*M*=88.17%, *SD*=6.06%), followed by participants in the no Danmaku condition (*M*=87.25%, *SD*=5.03%), followed by participants in the non-transparent Danmaku condition (*M*=85.83%, *SD*=5.04%), see Figure 14 in Appendix A. Though the memory accuracy differences across conditions were not statistically significant when the researcher conducted a 1-way ANOVA [*F* (2, 58) =1.05, *n.s*].

Regarding the reaction of memory test, participants in the non-transparent Danmaku condition had the longest reaction time (*M*=2349.23, *SD*=239.40), followed by the no Danmaku condition (*M*=1171.89, *SD*=316.32), followed by the semi-transparent Danmaku condition (*M*=1153.33, *SD*=203.46), see Figure 15 in Appendix A. Though the differences across conditions were not statistically significant neither when a 1-way ANOVA was calculated [F (2, 58) =.90, *n.s*].

The researcher also examined whether memory performance were related with attention allocation. For each condition, 2 multiple regressions were calculated using accuracy at memory test and reaction as the dependent variables. Self-report attention to video and self-report attention to Danmaku were entered as predictors into the models. Result turned out that self-report attention variables were not predicting memory performance, see Table 6-7 in Appendix B.

Danmaku and Enjoyment

Regarding how would Danmaku affect people's enjoyment while watching video, 1-way ANOVA result indicated that experimental condition had a significant effect on enjoyment [F (2, 58) =4.73, p<.05], with participants in the semi-transparent Danmaku condition reported the highest enjoyment (*M*=5.91, *SD*=.54), followed by the no Danmaku condition (*M*=5.60, *SD*=.54), followed by the non-transparent Danmaku condition (*M*=5.05, *SD*=1.09), see Figure 16 in Appendix A. Tukey HSD post hoc test showed that when comparing experimental conditions pairwise, difference of enjoyment was only significant between the semi-transparent Danmaku condition and the non-transparent Danmaku condition (p<.05).

The researcher then examined to what extent would enjoyment affected by other video watching experience variables. Within each Danmaku condition, a hierarchical regression was conducted using enjoyment as the dependent variable, self-report attention to video and self-report attention to Danmaku were entered into the model as predictors in the first step, social presence, transportation and workload were entered in the second step. For the condition without Danmaku, a hierarchical regression was also conducted using enjoyment as the dependent variable, self-report attention to video as the predictor entered in the first step, transportation and workload as predictors entered at the second step.

Result turned out that for the condition of no Danmaku, a significant equation was found only in the first step [r^2=.38, F (1, 14) =8.43, p<.05] with self-report attention to video being a significant predictor for enjoyment (β=.61, p<.05). When transportation and workload were entered in the second step, no significant equation was observed. The non-transparent Danmaku condition was similar to the no Danmaku condition in the first step as a significant equation was observed [r^2=.57, F (2, 21) =13.98, p<.001], with self-report attention to video being a significant predictor for enjoyment (β=.72, p<.001). When social presence, transportation and workload were entered in the second step for the non-transparent Danmaku condition, a significant equation was again observed [r^2=.66, F (5, 18) =6.96, p<.01], with self-report attention to video being the only significant predictor (β=.99, p<.001). For the semi-transparent Danmaku condition, no significant equation was observed in neither step, see Table 8 in Appendix B.

Path Analysis Results

To better visualize the relationship between video watching experiences, 2 path analysis models were tested. In model 1, the 2 Danmaku conditions were aggregated. In other words, this model compared Danmaku condition against no Danmaku condition, as indicated in Figure 17 in Appendix A. Eye-movement variables were only used to analyze their relationships with condition, but not with other video watching experience variables. Since questions about attention to Danmaku were not asked to participants in the no Danmaku condition, self-report attention to Danmaku was not placed in this model.

Similar with the results observed in previous sections, participants in the Danmaku condition paid significantly more visual attention to Danmaku area (β=1.15, p<.001) while significantly less attention to the video content area (β=-.94, p<.01). However, condition did not predict self-report attention in this model. In addition, participants who reported paying more attention to video also tended to perceived higher degree of transportation (β=.58, p<.001), workload (β=.29, p<.05) and enjoyment (β=.70, p<.001), see Figure 18 in Appendix A.

Model 2 was tested only among the 2 Danmaku conditions. In other words, it was comparing the semi-transparent Danmaku condition against the non-transparent Danmaku condition, see Figure 19 in Appendix B. Again, Eye-movement variables were only used to analyze their relationships with condition, but not other video watching experience variables.

Result turned out that in this model, Danmaku text transparency was only predicting self-report attention allocation, but not visual attention allocation. Also, participants who reported paying more attention to video tended to perceive higher degree of transportation (β=.64, p<.001) and enjoyment (β=.71, p<.001); participants who reported paying more attention to Danmaku tended to perceive more social presence (β=.26, p<.05), but less enjoyment (β=-.34, p<.01) and had longer reaction time during memory test (β=.37, p<.05). Apart from these, participants who perceived higher degree of social presence also tended to be more enjoyable about the stimulus video (β=.36, p<.05), as indicated in Figure 20 in Appendix B.

Role of Individual Differences

To test hypothesis H4a-H4c, the researcher examined whether individual differences (i.e. frequency of watching Danmaku, frequency of posting Danmaku and preference of multitasking) had main effect on Danmaku video watching experiences (i.e. attention allocation, social presence, transportation, workload, memory performance and enjoyment) or whether individual differences and experimental condition had interaction effects on Danmaku video watching experiences. Individual difference variables were examined one at a time. For each individual difference variable, several factorial ANOVA were calculated using video watching experiences as the dependent variables one at a time, and using experimental condition and the examined individual difference variable as main factors.

Result turned out that no individual difference variable had significant main effect on any video watching experience variables. Regarding the interaction effect between experimental condition and individual differences on video watching experience, only preference of multitasking and condition had significant interaction effect on memory accuracy [$F(2,54)=6.674$, $p<.01$]. As illustrated in Figure 21 in Appendix A. In the no Danmaku condition, participants with low preference of multitasking had similar accuracy at memory test (M=87.68, SD=5.39%) as participants with high preference of multitasking (M=87.33, SD=4.94%). However, in the semi-transparent Danmaku condition, participants with low preference of multitasking had significantly [t (18) =2.727, $p<.05$] low accuracy at memory test (M=83.81, SD=7.80%) than participants with high preference of multitasking. In the non-transparent Danmaku condition, participants with low preference of multitasking had significantly [t (21.96) =2.502, $p<.05$)] high accuracy at memory test (M=87.95, SD=4.82%) than participants with high preference of multitasking (M=83.33, SD=4.22%).

In addition, though individual differences did not significantly affect self-report attention allocation, the researcher found that participants' preference of multitasking intervened the relationship between self-report attention to video and self-report attention to Danmaku. It was found that self-report attention to video was negatively correlated with self-report attention to Danmaku among participants having low preference of multitasking in the 2 Danmaku conditions. However, among participants with high preference of multitasking, self-report attention to video and self-report attention to Danmaku were not correlated in either Danmaku conditions, see Table 9 in Appendix B. Other individual difference variables did not intervene the relationship between the 2 self-report attention allocation variables. Self-report attention to video and Danmaku were not significantly correlated when individual differences were not considered (r=-.028, ns).

Chapter Five Discussion

Danmaku's Effect on Attention Allocation

The appearance of Danmaku did affected people's attention allocation while watching videos. As pointed out by prior studies, people have central fixation bias meaning they would pay more attention to screen center when looking at images or videos presented on monitors (Tatler, 2007; Bindemann, 2010), either because important information are usually located at the central area of screen (Judd et al, 2009) or human being instinct tend to start searching for information from screen center (Tatler, 2007). Such central fixation bias was also observed in the current study as screen center was the area that attracted the most visual attention in all 3 conditions. Nonetheless, compared to the condition of no Danmaku, participants in the Danmaku conditions in fact paid less attention to the central area of screen but extended their visual attention to the top corners of screen where participants in the no Danmaku condition barely looked at. This observation indicates that though people still paid the most attention to the central area of screen, the appearance of Danmaku would distract some of their attention to the areas with Danmaku, Moreover, this study also found that the top right corner attracted more visual attention than the top left corner, suggesting that people preferred to reading Danmaku when they initially appeared from screen's top right corner than when they about to disappear from the top left comer.

Perceived Joint Viewing Experience

This study finds empirical evidence of Danmaku's capability of fostering a joint viewing experience. In fact, different from second screen activity, which typically takes place while a TV show is going on and can be regarded as a synchronous social TV interaction (Buschow, Schneider & Ueberheide, 2014), Danmaku video viewers do not necessarily watch videos simultaneously. Interactivities facilitated by Danmaku are very likely to be asynchronous (Ma & Ge, 2014) and are actually asynchronous in the scenario of the current study. Nonetheless, because Danmaku comments are attached to the initial videos' timelines, people are able to see others' comments for a particular scene when this scene is going on. In this way, the presentation of Danmaku interaction is in a synchronous format and an illusion of synchronous social TV interaction could be created. Observing social presence in the current study's Danmaku conditions suggests that not only synchronous social TV interaction, such as second screen activity, can foster joint viewing experience (Lim et al., 2015), but also asynchronous social TV activity can achieve the same goal if the social interaction can be presented in a synchronous way.

Unaffected Transportation Level and Cognitive workload

The appearance of Danmaku did not significantly degrade people's experience of being immersed into video story's narrative based on this study's findings. However, actually compared to the condition of no Danmaku, participants in the Danmaku conditions paid less attention to the initial video's content while self-report attention to the initial video was found to predicting with the degree of transportation into narrative in this study.

Two possible reasons could account for the reason why the degree of transportation into narrative was not degraded although Danmaku have distracted people's some attention from the initial video content. The first reason is that though Danmaku distracted people's some attention, the remaining amount of attention being paid to the initial video was still sufficient to foster the feeling of being transported into the story's narrative.

Different from second screen activity, Danmaku comments appear on the same screen of the initial video. This feature allows people to quickly move their visual focus back and forth between Danmaku and the initial video. In other words, when watching Danmaku videos, people are able to interact with comments without turning away from the screen that plays the initial video. Also, this study's stimulus material does not have heavy amount of Danmaku. In this study, Danmaku never covered the most part of the screen and makes people barely able to see the initial video content. Considering these factors, the degree of being immersed into narrative could be retained because people could still pay sufficient amount of attention to the initial video with the present of Danmaku and in fact, as pointed out before, the central area of screen was still the area that attracted the most visual attention when people watch Danmaku videos.

The second possible explanation is that the Danmaku can possibly also help engage audience into the story's narrative. The current study found that self-report attention to Danmaku was also a significant predictor for the degree of transportation. In fact, prior studies (Chen et al., 2015; Zhang, Chang & Chen, 2014) have pointed out that Danmaku's content could include other viewers' personal expressions or evaluations about the story in video. Some of these expressions or evaluations could resonate with Danmaku viewers' own feelings and make them engage more in the story. Also, some Danmaku could contain background information about the story, the characters and the actors/actresses, and audiences to better understand the story being told. Therefore, although Danmaku distracted some attention from the initial video, the distracted attention was not wasted but instead could possibly also help audiences to engage with the story in video.

In the current study, the appearance of Danmaku were not found to significantly affect participants' workload while watching the stimulus video and performance at memory test. Prior literature has suggested that overwhelming amount of Danmaku could make audience feel incapable of processing all the presented information (Ma, Ge & Rau, 2015), but in the scenario of the current study, the amount of Danmaku is actually not heavy. In this study's stimulus video, Danmaku mostly appeared at the top 1/3 of the screen, rarely reached the middle of screen, and never covered the whole screen. The non-significant results in the current study suggests that Danmaku at this amount or less are not likely to generate too much extra cognitive workload to audience while watching videos similar to the stimulus material. With this amount of, or less Danmaku, people could still process information in the initial video as thorough as in the scenario of having no Danmaku.

However, it is necessary to notice that the current study only examined Danmaku video watching experience with 1 stimulus video. As pointed out by prior literature, videos with more information density and structural complexity would consume more cognitive resource than ease and relaxing videos (Fox et al., 2007; Lang et al., 2013). Therefore, it is possible for the amount of Danmaku at the current study to be overwhelming if it is presented on a more complex and intense video content.

Danmaku's Effect on Enjoyment

The appearance of Danmaku was found to have a significant effect on enjoyment while watching videos. This section will discuss around the non-transparent Danmaku condition which yielded the lowest enjoyment degree among the 3 conditions. Next section will particularly focus on the semi-transparent Danmaku condition which yielded the highest enjoyment degree among the 3 conditions.

According to result in the second path model, there was a path between self-report attention to Danmaku to enjoyment indicating participants paying more attention to Danmaku tended to enjoy less about the video. Since participants in the non-transparent Danmaku condition paid the most attention to Danmaku. This might explain why this condition yielded the lowest enjoyment. However, there was also a path from self-report attention to Danmaku, to social presence then to enjoyment and indicated that participants reported paying more attention to Danmaku tended to perceived higher degree of social presence, and participants who perceived higher degree of social presence tended to perceive higher degree of enjoyment. This path suggested that attention to Danmaku could possible enhance enjoyment through creating the feeling social presence of co-viewers, which resonated Ma, Ge and Rau's (2015) finding that seeking a feeling of joint viewing is one major motivation for people to watch Danmaku videos. Nonetheless, besides fostering jointing viewing experience, attention to Danmaku could degrade enjoyment of watching video through other video watching experiences which were not observed in the current study.

The Role of Danmaku Text Transparency

This study also observed Danmaku text transparency's effect on Danmaku video watching experience. Unlike the non-transparent Danmaku condition, no significant correlation was found between self-report attention to Danmaku and social presence in the semi-transparent Danmaku condition. Also, different from the no Danmaku condition and non-transparent Danmaku condition, self-report attention to video was not correlated with enjoyment in the semi-transparent Danmaku condition. Regarding the reason for the non-significant results in the semi-transparent Danmaku condition, it could be that some people in this condition inaccurately estimated their attention allocation. Because Danmaku were semi-transparent (50% text transparency), audience were able to see the video content beneath the overlaid Danmaku comments. Once the video content became visible beneath the Danmaku comments, it could be harder for people in this condition to differentiate whether they were actually paying attention to the video content or Danmaku content or both than people in the other 2 conditions. With the difficulty of estimating attention allocation, the relationship between self-report attention to video and enjoyment, and the relationship between self-report attention to Danmaku and social presence could be contaminated and became non-significant.

In addition, instead of overestimating, it is more likely that participants in the semi-transparent Danmaku condition underestimated their attention to video content. It is possible that Danmaku comments appeared as new stimuli on the monitor and caused orienting response, which is a phenomenon about people's physiological response to a sudden change in the environment (Graham & Clifton, 1996). According to prior studies (Lang, 2000; Lang, 2006; Lang, 2015), orienting responses would let people allocate more cognitive resource to the presented media content. Following this logic, it is possible that participants in the semi-transparent Danmaku condition allocated more cognitive resource to process the information on screen than participants in the no Danmaku condition. Also, because Danmaku comments were semi-transparent in this condition, people would be able to see through Danmaku comments and could possibly be paying attention to the video content even though they were intentionally looking at Danmaku comments. With such underestimation, participants in the semi-transparent condition could actually pay more attention to the video content than participants in the no Danmaku condition.

Two other findings could also support the interpretation about participants in the semi-transparent Danmaku condition underestimating their attention to the video content. First, though not statistically significant, participants in the semi-transparent Danmaku condition yielded the highest mean value of transportation level among 3 conditions and transportation level was found to be positively correlated with attention to video content. Second, though not statistically significant either, participants in the semi-transparent Danmaku condition also yielded the highest mean value for memory test accuracy and based on prior literature (Lang, 2000; Lang, 2006; Lang, 2015), before encountering cognitive overload, more orienting response would make people allocate more cognitive resource to process the presented information lead to better memory performance.

Admittedly, it is hard to say that enjoyment of watching the video content would be positively correlated with attention to video if people in the semi-transparent Danmaku condition accurately estimated their attention allocation. Nonetheless, if the positive correlation exists in idealized scenario and participants in the semi-transparent Danmaku condition did underestimate their attention to video, it would explain why the semi-transparent Danmaku condition yielded the highest degree of enjoying the video content.

The Role of Individual Differences

Ma, Ge and Rau (2015) pointed out that since Danmaku videos actually present 2 sets of content on the same monitor, it would possible for people with high preference of multitasking to feel more comfortable about this video format than people with low preference of multitasking. The current study also found some evidence about preference of multitasking's role in Danmaku video watching experience. Firstly, self-report attention to Danmaku and self-report attention to initial video were negatively correlated among participants with low preference of multitasking, while such correlation was not observed among participants with high preference of multitasking. This finding indicates that for participants with low preference of multitasking, they were more likely to either pay much attention to the initial video while pay little attention to Danmaku or the opposite. In this way, the tradeoff between enjoying the initial video content and gratifications afforded by Danmaku is more likely to be pushed toward one direction and is hard to be balanced.

However, compared to those with low preference of multitasking, for participant with high preference of multitasking, the tradeoff between attention to video and attention to Danmaku was less apparent. These people were more likely to balance their attention to the 2 types of content on the same monitor and therefore would possibly gain the optimal overall Danmaku video watching experience by obtaining adequate enjoyment of watching the video content and satisfactory gratification afforded by Danmaku at the same time.

Nonetheless, though people with high preference of multitasking were more likely to allocate balanced attention to both video content and Danmaku content, they could also possibly encounter cognitive overload. The current study found that the accuracy at memory test was only significantly different across conditions for participants with high preference of multitasking, with participants in the semi-transparent Danmaku condition yielded the highest accuracy at memory test while participants in the non-transparent Danmaku condition yielded the lowest accuracy. As mentioned above, the appearance of semi-transparent Danmaku could possibly cause orienting response and let semi-transparent Danmaku condition yielded higher memory accuracy than the no Danmaku condition. Nonetheless, for the non-transparent Danmaku condition, because video content was no longer visible beneath the Danmaku content, if some participants with high preference of multitasking intended to pay adequate attention to both Danmaku and the video content, they would have to constantly switch their visual focus back and forth between the video and Danmaku. Such constantly switching attention focus could possibly cost them more cognitive resource and let them encounter cognitive overload. When cognitive overload was encountered, those participants in the non-transparent Danmaku condition would be unable to thoroughly process the information on screen and yielded lower memory test accuracy than participants in the other 2 conditions.

Application of the Current Study

Resonates prior Danmaku studies' findings (Ma & Ge, 2014; Ma, Ge & Rau, 2015), the current study also found that Danmaku could foster a joint viewing experience and potentially helped viewers to engage in the video content by providing extra relevant information. Also, the current study examined Danmaku video watching experience using a quantitative research method, which is an approach barely used by prior Danmaku studies. This study found that attention to Danmaku could foster an experience of joint viewing which could possibly enhance the enjoyment of watching video. However, attention to Danmaku might also degrade the enjoyment of watching video through other video watching experiences since this study also observed a negative correlation between attention to Danmaku and enjoyment. It would be meaningful if future studies on Danmaku can identify the factors which degrade the enjoyment of watching Danmaku videos. Once Danmaku could afford more positive watching experiences than negative experiences, the overall Danmaku video could move toward the positive direction. In addition, by using eye-tracker, this study visualized the way people allocate their visual focus while watching Danmaku videos. Also, the current study examined the role of Danmaku text transparency, which was only briefly mentioned in Ma, Ge and Rau's (2015) study. Some findings of the current study suggested that semi-transparent Danmaku could possibly yield better video watching experience than non-transparent Danmaku. Nonetheless, though the current study provided some interpretations about the reason for semi-transparent Danmaku being a better presentation format, more solid evidence about the role of Danmaku text transparency still need to be examined in future studies.

Limitations

There are 3 major limitations of this study. First, Danmaku video watching experience can vary with different video content, Danmaku content and Danmaku amount while the current study only used 1 stimulus video. Therefore, the generalizability of the current study is limited. Future studies can examined Danmaku video experience in different video genres with different Danmaku content and amount.

Second, the current study did not examine audiences' continuous response while watching Danmaku videos. Though eye-movement data was collected, the data was aggregated across time. Future study can incorporate more continuous response measurements, such as measuring skin conductance, heartrate and brain activities, to better understand how are people interacting with Danmaku comments and video content time to time.

Third, the current study's experiment did not allow participants to post Danmaku comments while contributing comments can be an important factor in Danmaku video watching experience. Future study can approach Danmaku video by examine how and why do people make contribution to the comments and how can such contribution affect people's Danmaku video watching experience.

Appendix A

Figure 1. Screenshot of Danmaku Video.

Figure 2. Screenshot of No Danmaku Condition.

Figure 3. Screenshot of Semi-transparent Danmaku Condition.

Figure 4. Screenshot of Semi-transparent Danmaku Condition.

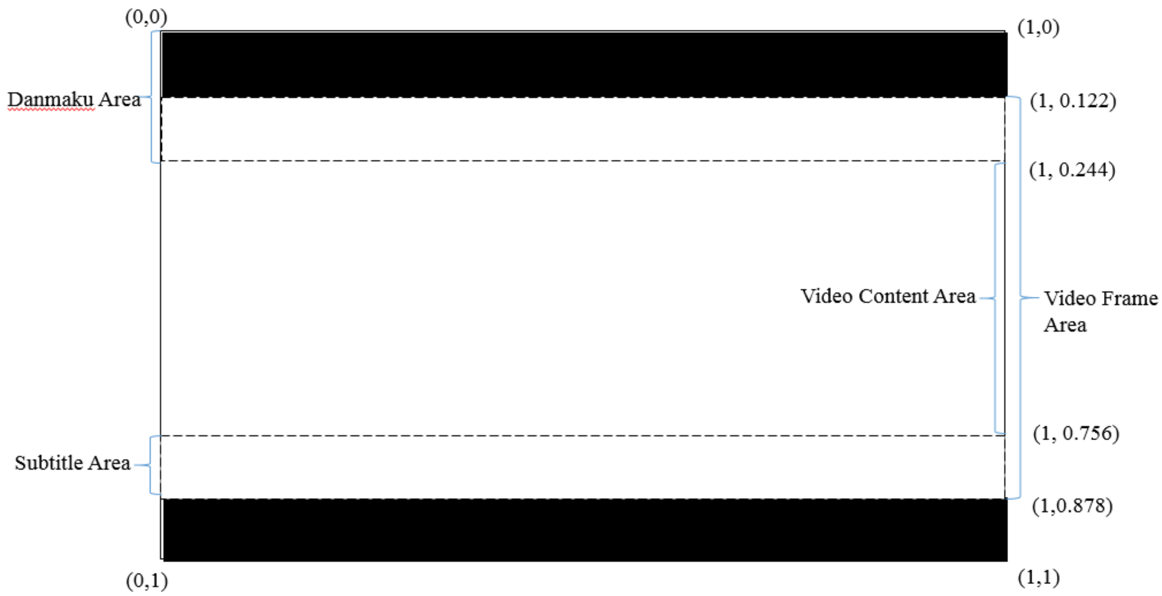

Figure 5. Coordinates of Eye-movement Data.

Figure 6. Screenshot of the Initial Video.

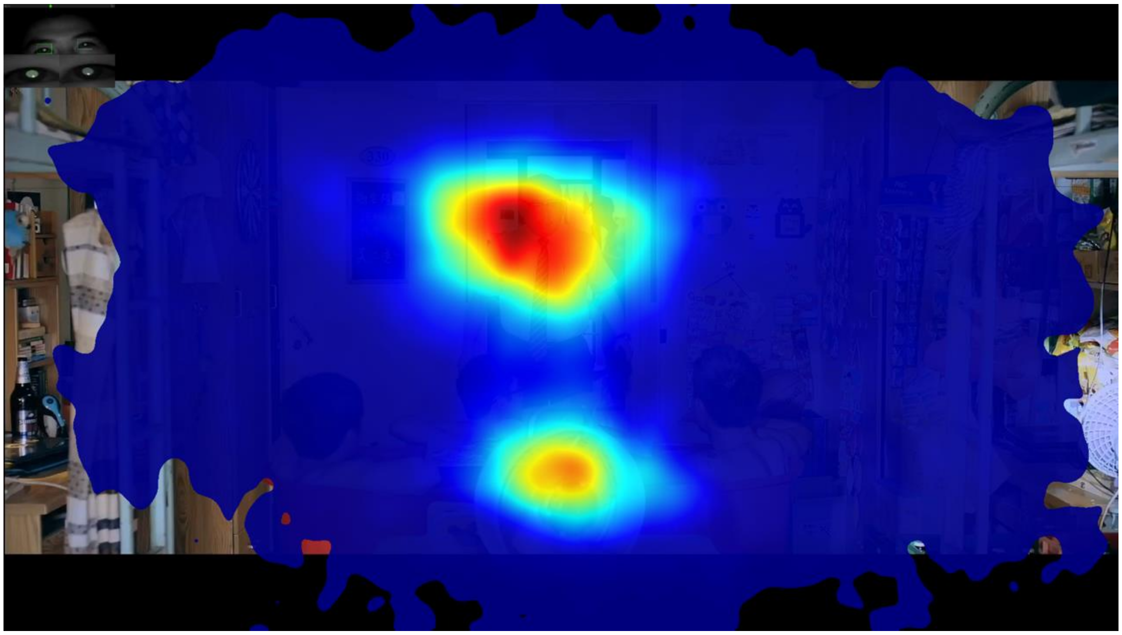

Figure 7. Heat Map of Visual Attention in the no Danmaku Condition.

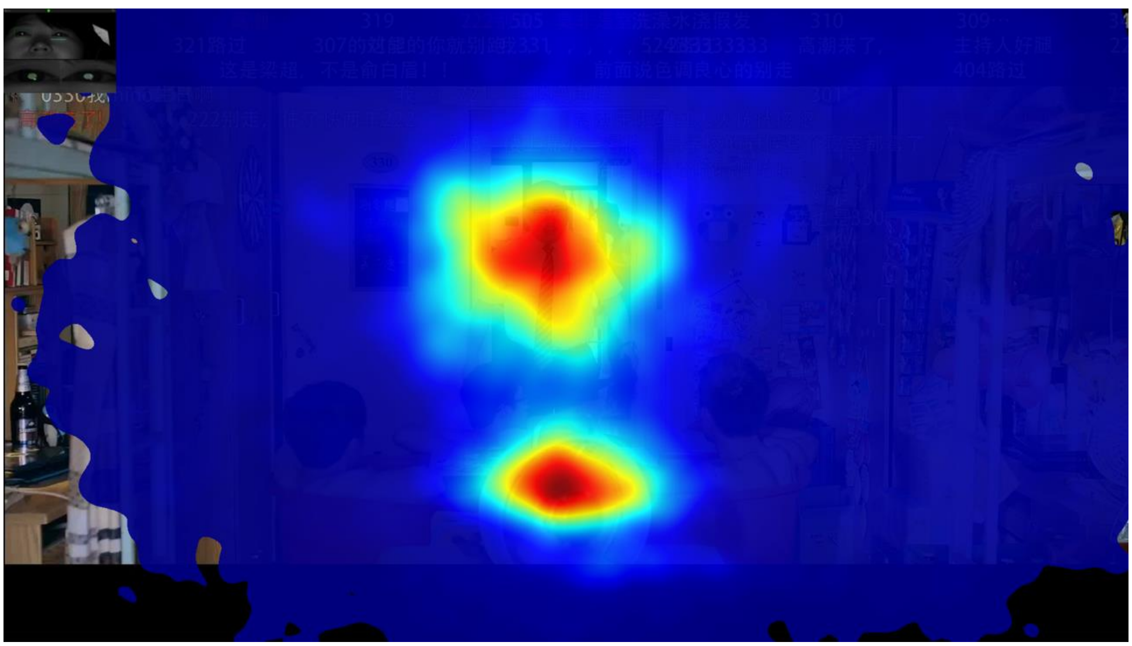

Figure 8. Heat Map of Visual Attention in the Semi-Transparent Danmaku Condition.

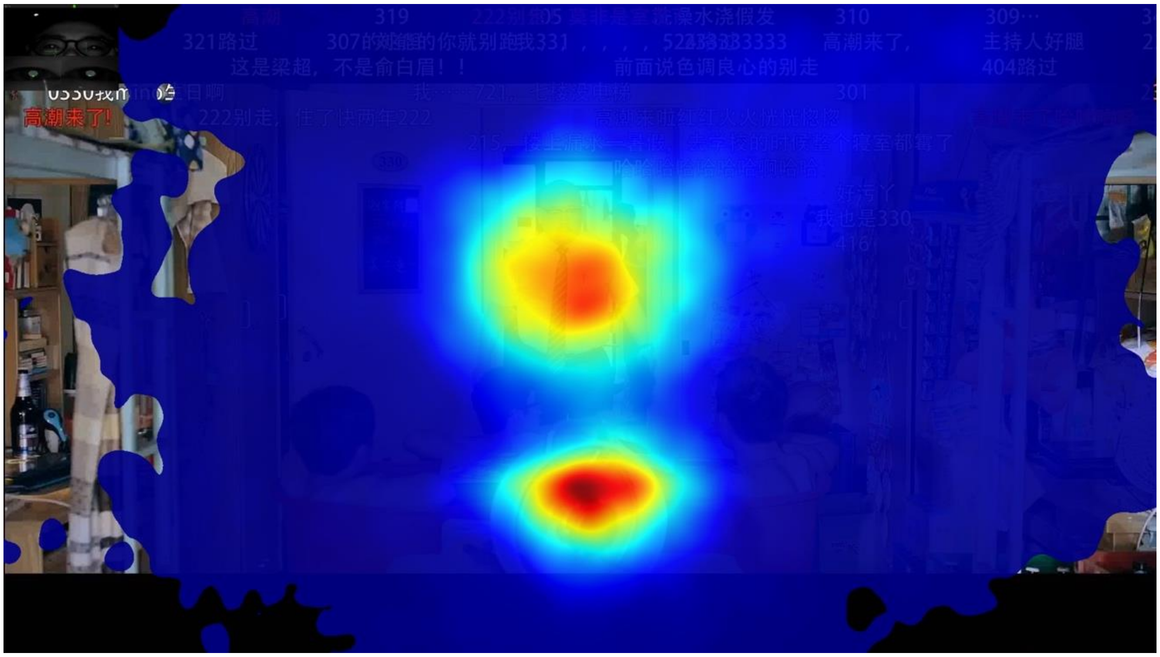

Figure 9. Heat Map of Visual Attention in the Non-Transparent Danmaku Condition.

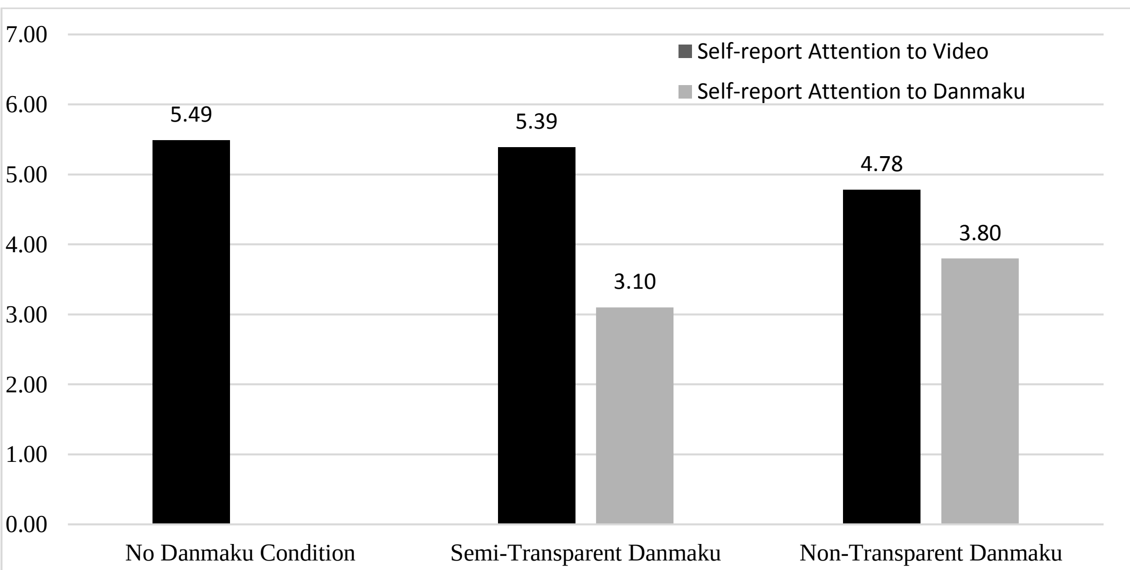

Figure 10. Self-report Attention Allocation by Condition (Mean)

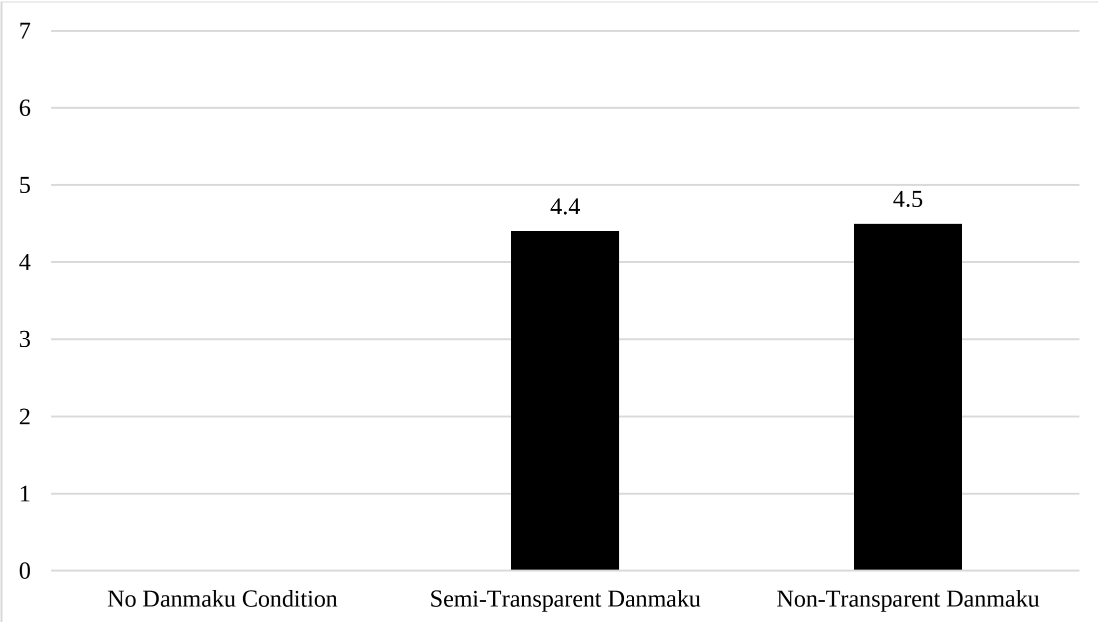

Figure 11. Degree of Social Presence by Condition (Mean)

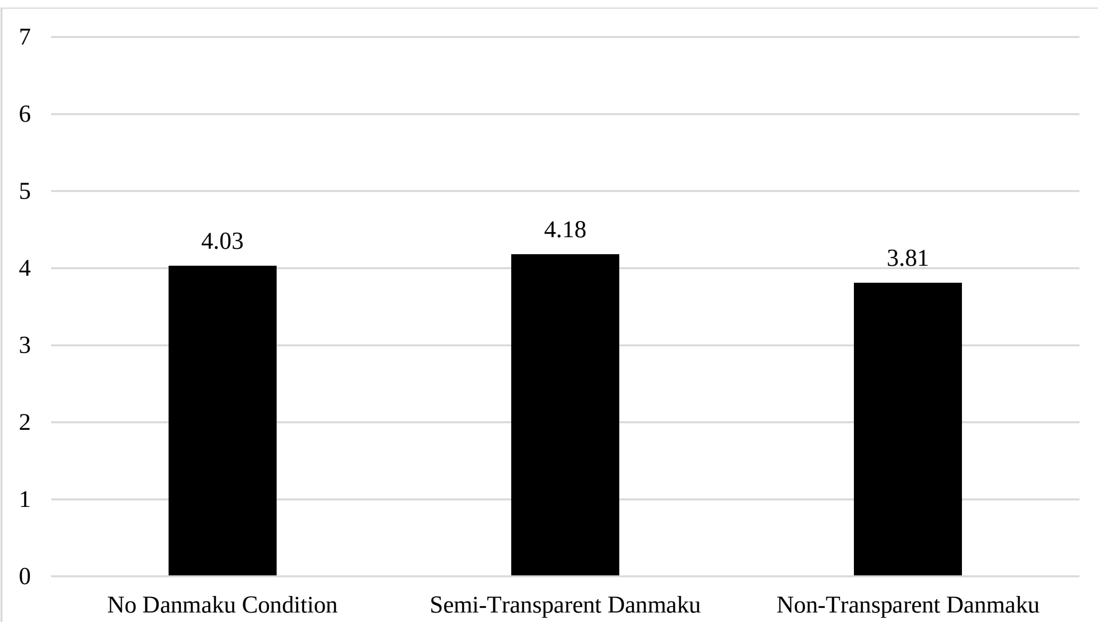

Figure 12. Degree of Transportation by Condition (Mean)

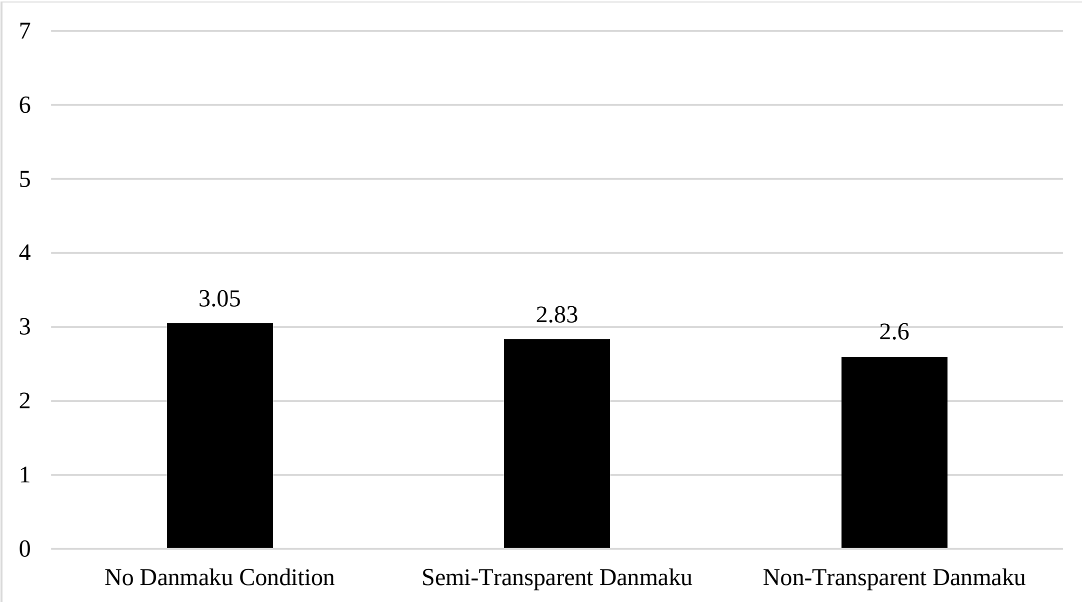

Figure 13. Degree of Cognitive Workload by Condition (Mean)

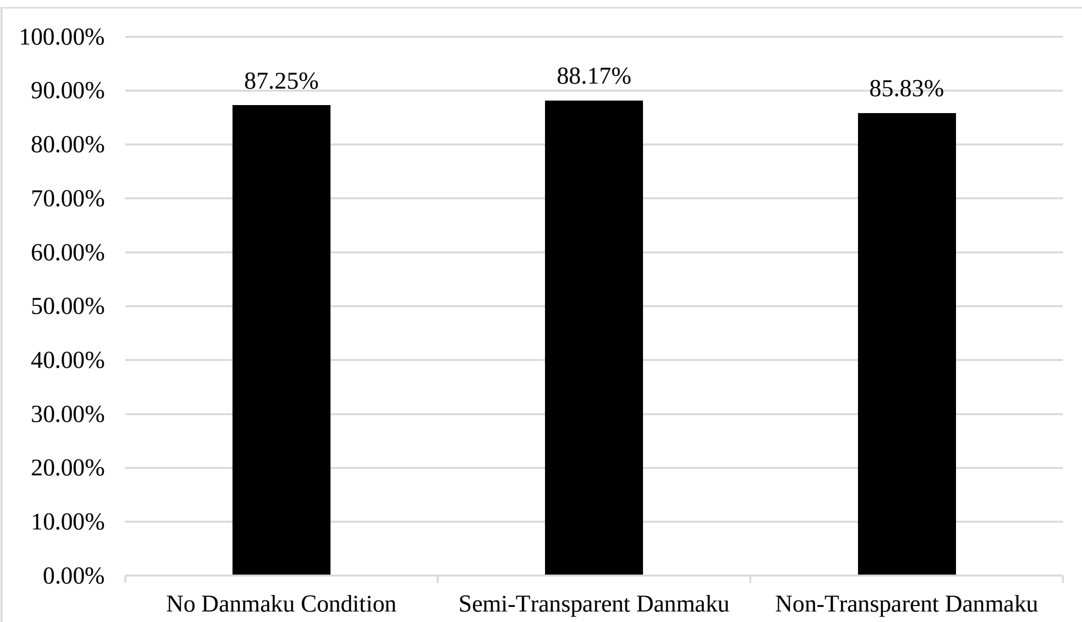

Figure 14. Accuracy at Memory Test by Condition (Mean)

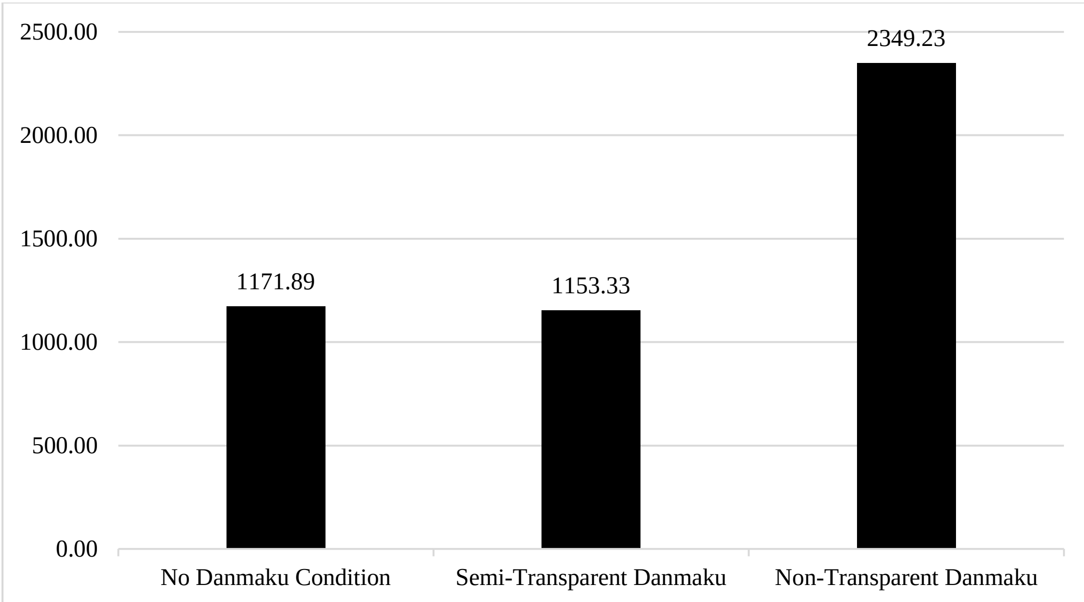

Figure 15. Reaction at Memory Test by Condition (Mean, Unit=millisecond)

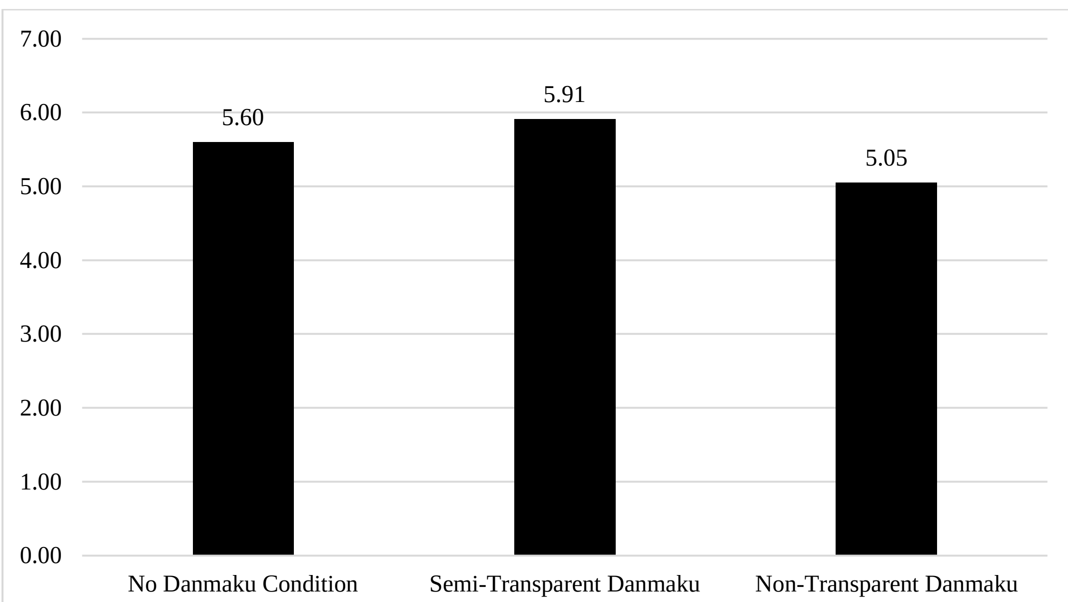

Figure 16. Degree of Enjoyment by Condition (Mean)

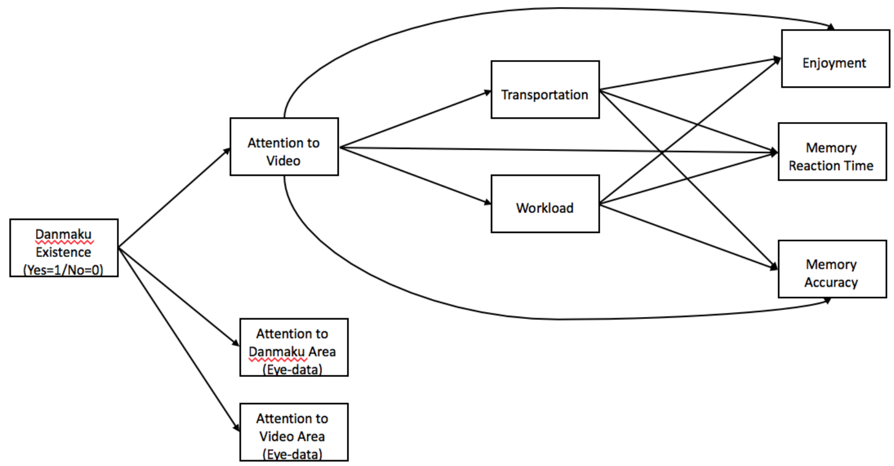

Figure 17. Hypothetical Model 1

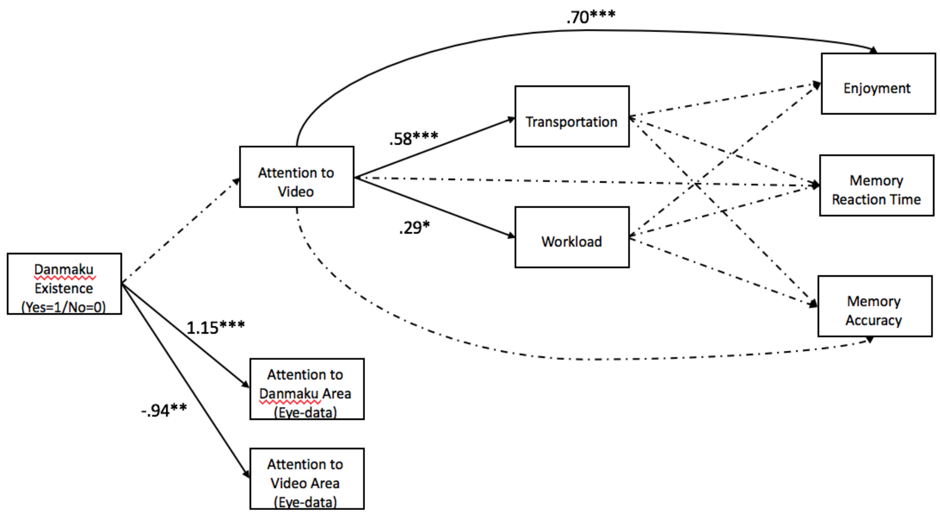

Figure 18. Model 1 Results
Note. * $p < .05$, ** $p < .01$, *** $p < .001$
Solid lines indicate significant path; Dash lines indicate non-significant path.

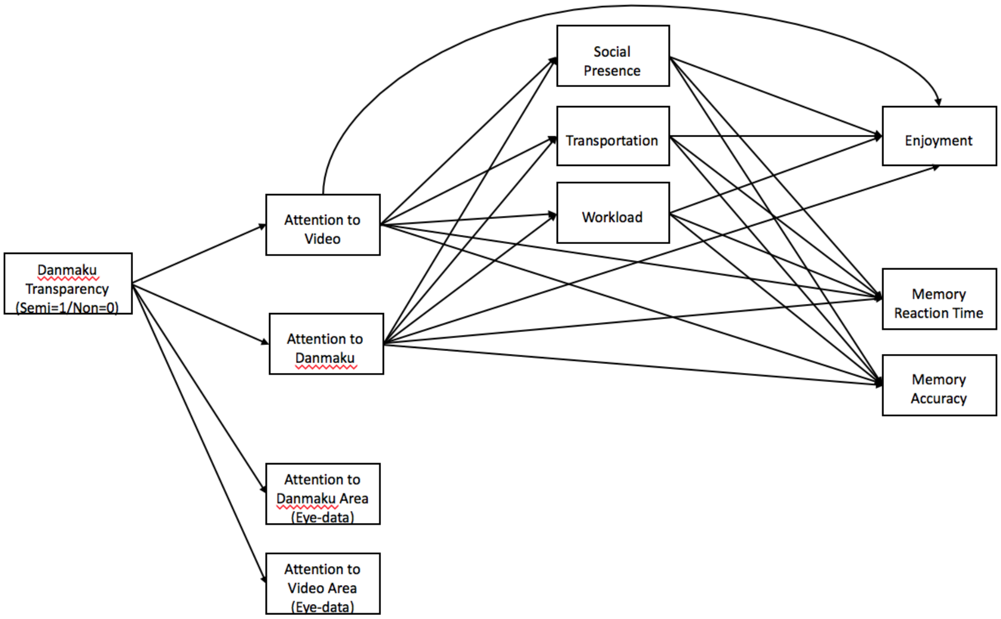

Figure 19. Hypothetical Model 2

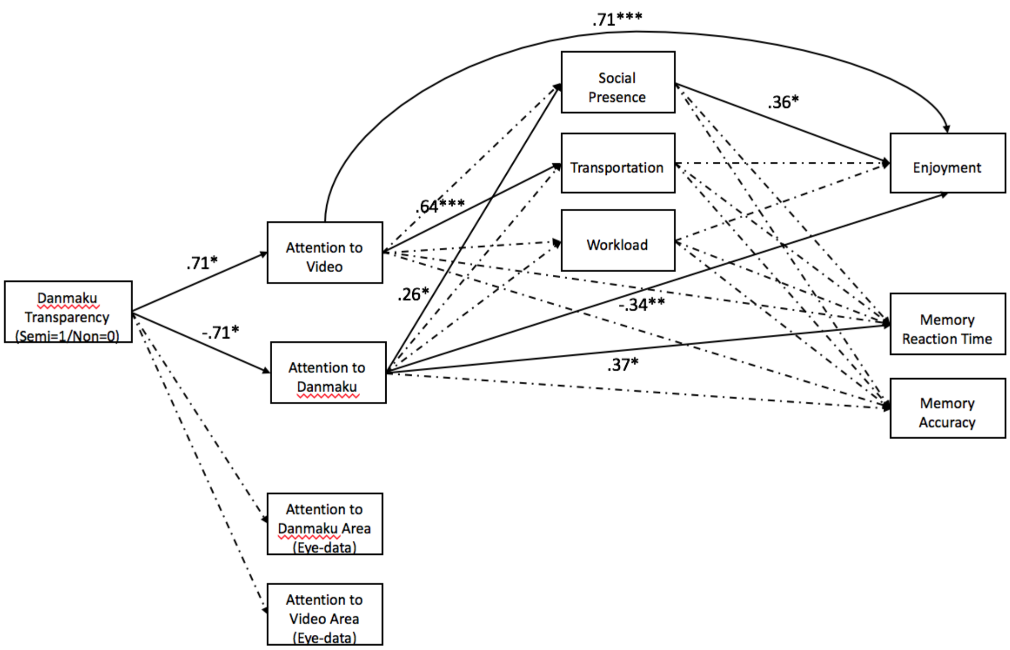

Figure 20. Model 2 Result

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Solid lines indicate significant path; Dash lines indicate non-significant path.

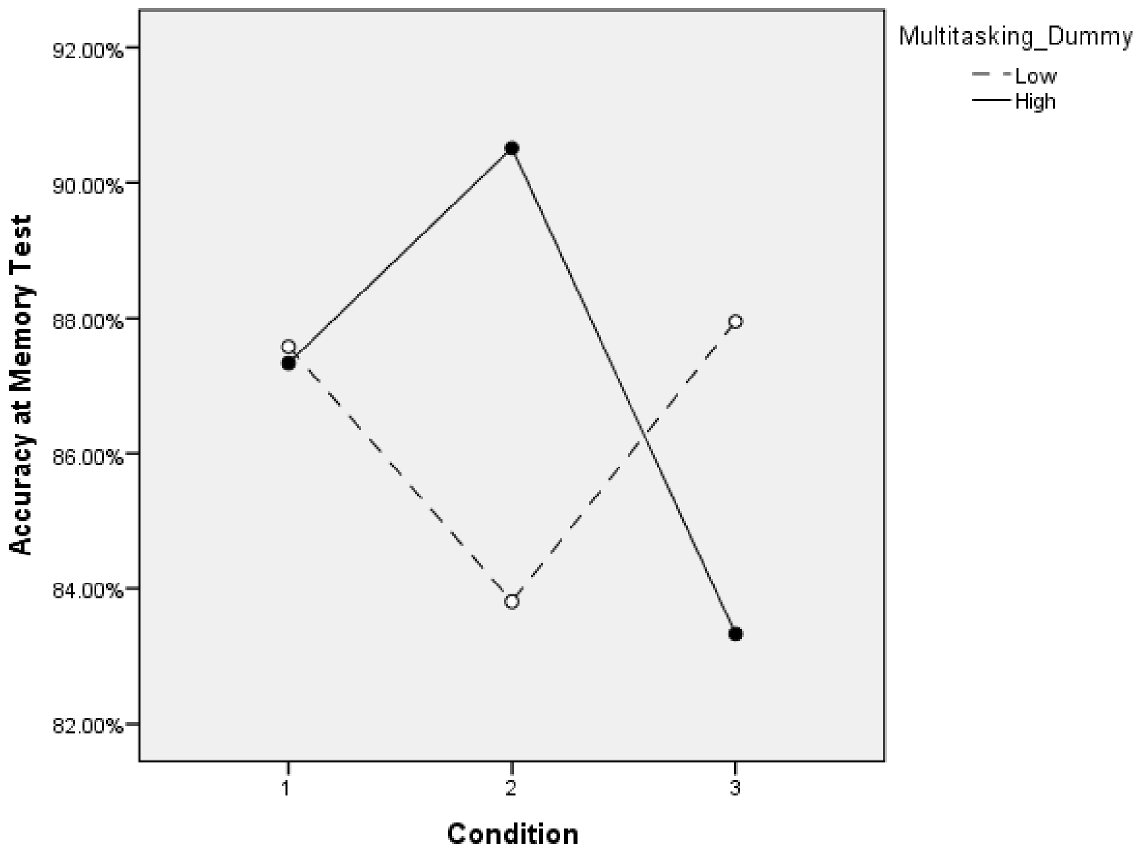

Figure 21. Interaction Effect between Experimental Condition and Preference of Multitasking on Accuracy at Memory Test

Appendix B

Table 1

Sample Descriptive

	Condition 1	Condition 2	Condition 3	Overall
N	17	20	24	61
Age				
Age Range	20-28	21-32	20-32	20-32
Age Mean	24.60	24.44	25.50	24.87
Age SD	2.13	2.36	3.45	2.71
Gender				
Male	6 (35.5%)	10 (50.0%)	9 (37.5%)	25 (41.0%)
Female	11 (64.7%)	10 (50.0%)	15 (62.5%)	36 (59.0%)

Note. Condition 1 refers to the no Danmaku condition;
Condition 2 refers to the semi-transparent Danmaku condition;
Condition 3 refers to the non-transparent Danmaku.

Table 2

Scale Reliability

Scale	Cronbach's alpha
Attention to Video	0.73
Attention to Danmaku	0.87
Social Presence	0.92
Transportation into Narrative	0.72
Enjoyment	0.83
Preference of Multitasking	0.80

Table 3

Multiple Regression of Self-Report Attention Predicting Social Presence

	Predictors	r^2	F	df	B	SE (B)	β
Condition 2	Attention to Video	0.21	2.26	2,17	0.37	0.28	0.28
	Attention to Danmaku				0.37	0.21	0.38
Condition 3	Attention to Video	.46**	8.84	2,21	0.23	0.17	0.23
	Attention to Danmaku				0.64	0.15	0.71***

Note. * p < .05, ** p < .01, *** p < .001
Condition 2 refers to the semi-transparent Danmaku condition;
Condition 3 refers to the non-transparent Danmaku Condition.

Table 4

Multiple Regression of Self-Report Attention Predicting Transportation

	Predictors	r^2	F	df	B	SE (B)	β
Condition 1	Attention to Video	0.241	4.45	1,14	0.37	0.18	0.49
	Attention to Danmaku				—	—	—
Condition 2	Attention to Video	0.25	2.82	2,17	0.39	0.17	0.49*
	Attention to Danmaku				0.09	0.13	0.14
Condition 3	Attention to Video	.57***	13.99	2,21	0.49	0.10	0.74***
	Attention to Danmaku				0.29	0.09	0.48**

Note. * p < .05, ** p < .01, *** p < .001
Condition 1 refers to the no Danmaku condition;
Condition 2 refers to the semi-transparent Danmaku condition;
Condition 3 refers to the non-transparent Danmaku Condition.

Table 5

Multiple Regression of Self-Report Attention Predicting Workload

	Predictors	r^2	F	df	B	SE (B)	*β*
Condition 1	Attention to Video	0.23	4.42	1,15	0.41	0.2	0.48
	Attention to Danmaku				—	—	—
Condition 2	Attention to Video	0.03	0.22	2,17	0.05	0.28	0.04
	Attention to Danmaku				-0.13	0.21	-0.15
	Attention to Video	0.11	1.24	2,21	0.02	0.27	0.01
Condition 3	Attention to Danmaku				0.37	0.24	0.33

Note. * p < .05, ** p < .01, *** p < .001
Condition 1 refers to the no Danmaku condition;
Condition 2 refers to the semi-transparent Danmaku condition;
Condition 3 refers to the non-transparent Danmaku Condition.

Table 6

Multiple Regression of Self-Report Attention Predicting Accuracy at Memory Test

	Predictors	r^2	F	df	B	SE (B)	*β*
Condition 1	Attention to Video	0.04	0.66	1,15	1.13	1.39	0.21
	Attention to Danmaku				—	—	—
Condition 2	Attention to Video	0.00	0.02	2,17	0.32	1.63	0.05
	Attention to Danmaku				-0.09	1.2	-0.02
	Attention to Video	0.02	0.18	2,21	-0.25	1.12	-0.05
Condition 3	Attention to Danmaku				-0.62	1.03	-0.14

Note. * p < .05, ** p < .01, *** p < .001
Condition 1 refers to the no Danmaku condition;
Condition 2 refers to the semi-transparent Danmaku condition;
Condition 3 refers to the non-transparent Danmaku Condition.

Table 7

Multiple Regression of Self-Report Attention Predicting Reaction Time at Memory Test

	Predictors	r^2	F	df	B	SE (B)	β
Condition 1	Attention to Video	0.08	1.25	1,15	95.87	85.63	0.28
	Attention to Danmaku				—	—	—
Condition 2	Attention to Video	0.07	0.64	2,17	-43.23	52.72	-0.19
	Attention to Danmaku				-32.47	39.00	-0.20
Condition 3	Attention to Video	0.03	0.29	2,21	34.07	52.94	0.15
	Attention to Danmaku				28.58	48.82	0.13

Note. * p < .05, ** p < .01, *** p < .001

Condition 1 refers to the no Danmaku condition;

Condition 2 refers to the semi-transparent Danmaku condition;

Condition 3 refers to the non-transparent Danmaku Condition.

Table 8

Hierarchical Regression of Video Watching Experience Predicting Enjoyment

	Predictors	r^2	F	df	B	SE (B)	β
Condition 1	Step 1	.38*	8.43	1,14			
	Attention to Video				0.74	0.25	0.61*
	Attention to Danmaku				—	—	—
	Step 2	0.42	2.84	3,12			
	Attention to Video				0.68	0.33	0.56
	Attention to Danmaku				—	—	—
	Social Presence				—	—	—
	Transportation				0.36	0.42	0.23
	Workload				-0.16	0.36	-0.12
Condition 2	Step 1	0.27	3.14	2,17			
	Attention to Video				0.19	0.12	0.32
	Attention to Danmaku				-0.17	0.09	-0.38
	Step 2	0.43	2.08	5,14			
	Attention to Video				0.15	0.14	0.25
	Attention to Danmaku				-0.14	0.10	-0.32
	Social Presence				-0.17	0.12	-0.38
	Transportation				0.30	0.19	0.40
	Workload				-0.10	0.11	-0.19
Condition 3	Step 1	0.57***	13.98	2,21			
	Attention to Video				0.77	0.16	0.72***
	Attention to Danmaku				-0.10	0.15	-0.10
	Step 2	.66**	6.96	5,18			
	Attention to Video				1.06	0.23	0.99***
	Attention to Danmaku				-0.06	0.21	-0.06
	Social Presence				0.22	0.21	0.20
	Transportation				-0.70	0.35	-0.43

Workload	0.07	0.13	0.08

Note. * p < .05, ** p < .01, *** p < .001
Condition 1 refers to the no Danmaku condition;
Condition 2 refers to the semi-transparent Danmaku condition;
Condition 3 refers to the non-transparent Danmaku Condition.

Table 9

Pearson's r between 2 Self-report Attention Allocation Variables Considering Individual Differences

		Condition 1	Condition 2	Condition 3
Frequency of Watching Danmaku	Low	—	-0.49	-0.54
	High	—	0.47	-0.02
Frequency of Posting Danmaku	Low	—	-0.04	-0.39
	High	—	-0.09	-0.05
Preference of Multitasking	Low	—	-0.83*	-0.61*
	High	—	0.41	-0.002

Note. * p < .05, ** p < .01, *** p < .001
Condition 1 refers to the no Danmaku condition;
Condition 2 refers to the semi-transparent Danmaku condition;
Condition 3 refers to the non-transparent Danmaku Condition.

Table 10

Variable Descriptive

	Condition 1		Condition 2		Condition 3	
	M	SD	M	SD	M	SD
Attention to Video Frame (eye-movement)	93.40%	4.45%	85.91%	6.76%	86.16%	7.20%
Attention to Danmaku Area (eye-movement)	4.30%	2.56%	13.16%	9.46%	13.97%	7.58%
Attention to Danmaku Area (Left Side, eye-movement)	2.81%	1.85%	5.30%	4.37%	3.35%	2.15%
Attention to Danmaku Area (Right Side, eye-movement)	1.49%	1.10%	7.86%	5.63%	10.63%	7.44%
Attention to Subtitle Area (eye-movement)	7.90%	6.42%	8.66%	6.23%	10.07%	5.58%
Attention to Video Content Area (eye-movement)	81.66%	6.60%	65.60%	21.33%	67.95%	11.55%
Attention to Video (self-report)	5.49	0.92	5.39	0.90	4.78	1.02
Attention to Danmaku (self-report)	—	—	3.10	1.22	3.80	1.10
Social Presence Overall	—	—	4.40	1.19	4.51	1.00
Social Presence Factor 1	—	—	3.83	1.33	4.11	1.40
Social Presence Factor 2	—	—	4.90	1.21	4.90	0.85
Social Presence Factor 3	—	—	3.98	1.44	4.11	1.50
Transportation	4.03	0.70	4.18	0.72	3.81	0.67
NASA TLX Workload	3.05	0.80	2.83	1.04	2.60	1.25
Accuracy at Memory Test	87.25%	5.03%	88.17%	6.06%	85.83%	5.04%
Reaction Time at Memory Test	1230.08	400.80	1288.63	406.38	1283.54	285.95
Enjoyment	5.60	1.10	5.91	0.54	5.05	1.09

Table 11

Pearson Correlations between Eye-movement Attention Allocation and Self-report Attention Allocation (No Danmaku Condition)

Variables	1	2	3	4	5	6	7
1. Attention to Video Frame (eye-movement)	—						
2. Attention to Video Content Area (eye-movement)	0.314	—					
3. Attention to Danmaku Area (eye-movement)	-0.296	-0.453	—				
4. Attention to Danmaku Area (Left Side, eye-movement)	-0.216	-0.274	0.927***	—			
5. Attention to Danmaku Area (Right Side, eye-movement)	-0.327	-0.595*	0.774**	0.480	—		
6. Attention to Subtitle Area (eye-movement)	0.434	-0.651*	-0.121	-0.235	0.113	—	
7. Attention to Video (self-report)	0.433	0.091	-0.064	-0.099	0.016	0.204	—

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 12

Pearson Correlations between Eye-movement Attention Allocation and Self-report Attention Allocation (Semi-transparent Danmaku Condition)

Variables	1	2	3	4	5	6	7	8
1. Attention to Video Frame (eye-movement)	—							
2. Attention to Video Content Area (eye-movement)	0.255	—						
3. Attention to Danmaku Area (eye-movement)	-0.734**	-0.194	—					
4. Attention to Danmaku Area (Left Side, eye-movement)	-0.750**	-0.309	0.930***	—				
5. Attention to Danmaku Area (Right Side, eye-movement)	-0.651*	-0.086	0.958***	0.786***	—			
6. Attention to Subtitle Area (eye-movement)	-0.291	-0.303	-0.115	-0.131	-0.092	—		
7. Attention to Video (self-report)	0.292	0.033	-0.560*	-0.440	-0.599*	0.166	—	
8. Attention to Danmaku (self-report)	-0.698**	-0.135	0.722**	0.729**	0.647*	-0.033	-0.070	—

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 13

Pearson Correlations between Eye-movement Attention Allocation and Self-report Attention Allocation (Non-transparent Danmaku Condition)

Variables	1	2	3	4	5	6	7	8
1. Attention to Video Frame (eye-movement)	—							
2. Attention to Video Content Area (eye-movement)	0.822***	—						
3. Attention to Danmaku Area (eye-movement)	-0.806***	-0.777***	—					
4. Attention to Danmaku Area (Left Side, eye-movement)	0.193	0.032	0.209	—				
5. Attention to Danmaku Area (Right Side, eye-movement)	-0.878***	-0.802***	0.959***	-0.076	—			
6. Attention to Subtitle Area (eye-movement)	0.010	-0.481	-0.077	-0.026	-0.071	—		
7. Attention to Video (self-report)	0.296	0.336	-0.405	0.013	-0.417	0.005	—	
8. Attention to Danmaku (self-report)	- 0.436	-0.424	0.126	-0.114	0.161	0.157	-0.298	—

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 14

Path Analysis Model 1 Output

	Estimate	Std.Err	z-value
Attention to Danmaku Area (eye-movement)			
~Condition	1.15***	0.27	4.19
Attention to Video Content Area (eye-movement)			
~Condition	-0.94**	0.29	-3.19
Attention to Video			
~Condition	-0.41	0.32	-1.30
Transportation			
~Attention to Video	0.58***	0.12	4.67
Workload			
~Attention to Video	0.29*	0.14	2.08
Enjoyment			
~Transportation	0.12	0.14	0.84
~Workload	-0.09	0.12	-0.70
~Attention to Video	0.70***	0.15	4.75
~Memory Accuracy	0.14	0.13	1.10
~Memory Reaction Time	-0.01	0.11	-0.06
Memory Accuracy			
~Transportation	0.02	0.17	0.09
~Workload	0.07	0.15	0.47
~Attention to Video	0.00	0.17	0.02
Memory Reaction Time			
~Transportation	-0.28	0.19	-1.47
~Workload	0.07	0.17	0.43
~Attention to Video	0.18	0.20	0.92

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Variables start with ~ were regressed on preceding variables without indent.

Table 15

Path Analysis Model 2 Output

	Estimate	Std.Err	z-value
Attention to Danmaku Area (eye-movement)			
~Condition	0.09	0.30	0.29
Attention to Video Content Area (eye-movement)			
~Condition	0.15	0.37	0.42
Attention to Danmaku			
~Condition	0.71*	0.34	2.12
Attention to Video			
~Condition	-0.71*	0.33	-2.11
Social Presence			
~Attention to Danmaku	0.26*	0.11	2.23
~Attention to Video	0.14	0.12	1.24
Transportation			
~Attention to Danmaku	0.21	0.14	1.48
~Attention to Video	0.64***	0.14	4.53
Workload			
~Attention to Danmaku	0.15	0.18	0.84
~Attention to Video	0.25	0.18	1.41
Enjoyment			
~Social Presence	0.36*	0.17	2.05
~Transportation	-0.02	0.14	-0.14
~Workload	-0.07	0.11	-0.65
~Attention to Danmaku	-0.34**	0.12	-2.70
~Attention to Video	0.71***	0.15	4.77
Memory Accuracy			
~Social Presence	0.38	0.23	1.63
~Transportation	-0.28	0.19	-1.45
~Workload	0.13	0.15	0.84
~Attention to Danmaku	-0.13	0.17	-0.80
~Attention to Video	-0.08	0.20	-0.41
Memory Reaction Time			
~Social Presence	-0.32	0.23	-1.36
~Transportation	-0.15	0.19	-0.76
~Workload	-0.17	0.15	-1.12
~Attention to Danmaku	0.37*	0.17	2.22
~Attention to Video	0.21	0.20	1.05

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Variables start with ~ were regressed on preceding variables without indent.

Table 16

Item Descriptive of Attention to Video Measure

Item	*Mean*	*SD*	Cronbach's Alpha if Item Deleted
How much did you pay attention to the show's content you just watched?	5.70	1.12	0.64
How interesting did you find the show's content you just watched?	5.46	1.41	0.71
How much did you concentrate on the show's content you just watched?	5.41	1.23	0.57
How much thought did you put into evaluating the show's content you just watched?	4.13	1.57	0.74

Table 17

Item Descriptive of Attention to Danmaku Measure

Item	*Mean*	*SD*	Cronbach's Alpha if Item Deleted
How much did you pay attention to the Danmaku's content you just watched?	3.48	1.27	0.80
How interesting did you find the Danmaku's content you just watched?	3.77	1.52	0.87
How much did you concentrate on the Danmaku's content you just watched?	3.55	1.42	0.80
How much thought did you put into evaluating the Danmaku's content you just watched?	3.14	1.42	0.88

Table 18
Item Descriptive of Social Presence Measure

Item	*Mean*	*SD*	Cronbach's Alpha if Item Deleted
Having the comments appearing above the video, I felt myself being part of a big viewers' family.	4.43	1.65	0.91
Sometimes I imagine a scene of numerous others sitting in front the monitor watching the video at the same time.	3.52	1.80	0.92
Watching this video gives me a strong sense of being in touch with other viewers.	4.20	1.59	0.92
Having the comments appearing above the video, I felt as if I was engaging in an actual conversation with other viewers.	3.93	1.82	0.92
Having the comments appearing above the video, I felt like I was in the same room with other viewers.	3.66	1.62	0.92
Having the comments appearing above the video, I felt as if other viewers were speaking directly to me.	3.95	1.57	0.92
Having the comments appearing above the video, I could imagine other viewers vividly.	4.39	1.59	0.92
Other viewers' thoughts in their comments were clear to me.	5.00	1.21	0.92
It was easy to understand other viewers' thoughts based on their comments.	5.16	1.14	0.93
I could tell how other viewers felt based on their comments.	4.93	1.39	0.92
Other viewers' emotions were clear to me based on their comments.	4.95	1.48	0.92
I could easily describe other viewers' feelings based on their comments.	4.45	1.50	0.92
I was sometimes influenced by others viewers' moods based on their comments.	5.11	1.39	0.92
Other viewers' attitudes, which were expressed through their comments, influenced how I felt.	4.70	1.37	0.92

Table 19
Item Descriptive of Transportation Measure

Item	*Mean*	*SD*	Cronbach's Alpha if Item Deleted
While I was watching the video, I could easily picture the events in it taking place.	5.30	1.18	0.70
While I was watching the video, activity going on in the room around me was on my mind. (reversed coded)	4.25	1.78	0.76
I could picture myself in the scene of the events described in the narrative.	3.77	1.71	0.70
I was mentally involved in the narrative while watching it.	4.60	1.64	0.69
After finishing the narrative, I found it easy to put it out of my mind. (reverse coded)	3.40	1.33	0.72
I wanted to learn how the narrative ended.	5.15	1.62	0.68
The narrative affected me emotionally.	3.97	1.65	0.67
I found myself thinking of ways the narrative could have turned out differently.	3.67	1.45	0.70
I found my mind wandering while watching the narrative. (reversed coded)	3.95	1.57	0.74
The events in the narrative are relevant to my everyday life.	3.67	1.67	0.70
The events in the narrative have changed my life.	1.87	1.02	0.69
While watching the video I had vivid image of Lin Xiangyu.	3.38	1.65	0.67
While watching the video I had vivid image of Xie Xun.	3.43	1.63	0.68
While watching the video I had vivid image of Gao Chao.	5.38	1.71	0.70
While watching the video I had vivid image of Hou Zi.	4.12	1.67	0.68

Table 20

Item Descriptive of Enjoyment Measure

Item	*Mean*	*SD*	Cronbach's Alpha if Item Deleted
I enjoyed watching this video very much	5.54	1.30	0.77
Watching this video was fun to do.	5.69	1.25	0.77
I thought this was boring to watch this video. (reverse coded)	6.13	1.24	0.81
Watching this video did not hold my attention at all. (reverse coded)	6.13	1.23	0.83
I would describe watching this video as very interesting.	5.48	1.50	0.78
I thought watching this video was quite enjoyable.	5.70	1.36	0.77
While I was watching this video, I was thinking about how much I enjoyed it.	3.74	2.00	0.89

Table 21
Item Descriptive of Transportation Measure

Item	*Mean*	*SD*	Cronbach's Alpha if Item Deleted
I prefer to work on several projects in a day, rather than completing one project and then switching to another.	3.63	1.74	0.77
I would like to work in a job where I was constantly shifting from one task to another, like a receptionist or an air traffic controller.	3.40	1.51	0.77
I lose interest in what I am doing if I have to focus on the same task for long periods of time, without thinking about or doing something else.	4.42	1.78	0.80
When doing a number of assignments, I like to switch back and forth between them rather than do one at a time.	3.22	1.37	0.77
I like to finish one task completely before focusing on anything else. (reverse coded)	2.78	1.24	0.78
It makes me uncomfortable when I am not able to finish one task completely before focusing on another task. (reverse coded)	2.95	1.28	0.79
I am much more engaged in what I am doing if I am able to switch between several different tasks.	3.93	1.54	0.78
I do not like having to shift my attention between multiple tasks. (reverse coded)	3.12	1.42	0.77
I would rather switch back and forth between several projects than concentrate my efforts on just one.	3.42	1.39	0.77
I would prefer to work in an environment where I can finish one task before starting the next. (reverse coded)	2.65	1.10	0.78
I don’t like when I have to stop in the middle of a task to work on something else. (reverse coded)	2.57	1.11	0.79
When I have a task to complete, I like to break it up by switching to other tasks intermittently.	3.72	1.57	0.79
I have a “one-track” mind (reverse coded)	3.28	1.24	0.79
I prefer not to be interrupted when working on a task. (reverse coded)	2.17	1.06	0.80

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