



# Genre-dependent effects of 3D film on presence, motion sickness, and protagonist perception<sup>☆</sup>



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## ABSTRACT

Do the increasingly popular 3D movies change how we perceive the content of the movie? We presented short (3.21 min) film sequences to observers equipped with shutter glasses. Three genres (horror, action, and documentary) were crossed with three between-subjects viewing conditions (director's 3D, artificial 3D, and 2D). Observers had to rate how the film impressed them in terms of arousal, motion sickness, presence, and immersion. They also judged the personality, attractiveness, and intelligence of the protagonist in all viewing conditions. Not surprisingly, horror films produced more arousal and presence than action films. Documentaries scored lowest on presence. Action movies produced the highest immersion ratings. 2D viewing tended to produce less presence than 3D viewing. Surprisingly, artificial 3D was indistinguishable in terms of presence from the director's 3D. The same was true for motion sickness: 3D viewing, regardless whether intended by the director or introduced artificially, was more nauseating than 2D viewing. We also found a genre effect regarding the impression of the protagonist, the latter was more agreeable in documentaries presented in 2D. The same protagonist was judged to be less extroverted and weighing more when viewed in director's 3D. We conclude that 3D film has complex effects that interact with the film genre. Directors should consider these interactions when planning to produce a 3D movie.

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## 1. Introduction

With the rise of 3D movies and 3D TV, several questions arise. Supporters of this technology argue that 3D viewing produces a whole new level of immersion while critics are concerned with the health-related issues this technology might cause. Both, advantages and disadvantages have been studied in recent years (see e.g. [25]). Two issues have been largely ignored in the scientific literature, the interaction of genre with 3D technology and the perceptual difference between director's 3D (movies that are shot with two cameras and merged to one film) and artificial 3D (movies that are shot with one camera and later converted into 3D in post-production). We first spell out how these two issues might affect the viewer directly, for instance producing more visual discomfort or presence, and then outline how they might affect the viewers' evaluation of the movie, making it more likeable or more annoying. We then report an extensive experiment that shows how film

genre and viewing mode interact with regard to effects on the viewer and the viewer's perception of movie content.

### 1.1. Effects on the viewer

One of the biggest problems associated with 3D movies is that prolonged viewing may cause visual discomfort. Carrier et al. [6] found that 3D movie viewers were almost three times more likely to experience headaches and over four times more likely to experience eyestrain than did 2D movie viewers, when watching a feature length movie in a theater. The most common complaints related to 3D movies have been nausea, visually induced motion sickness (VIMS), headaches, and eyestrain [18,25,28,29,35]. Lambooij et al. [21] identified three factors that may cause visual discomfort: (1) changing demands on accommodation-vergence linkage over time, which might be caused by fast movement; (2) three-dimensional artifacts resulting from inadequate depth information, which produce spatial and temporal inconsistencies, for instance conflicts between depth cues and geometrical distortions; and (3) an unnatural amount of blur, leading to ambiguous depth percepts. Particularly the last factor points toward a problem with automated 2D-to-3D conversion, which might result in a surplus of blur. In another study, Kooi and Toet [20] found that visual

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discomfort increases with errors in stereo presentation. Both studies indicate that artificial 3D might increase visual discomfort, which is already higher in director's 3D than in 2D [28].

While 3D movies have been associated with visual discomfort, they have also been linked to a heightened feeling of presence in some studies [13,25,35]. Presence itself is a very heterogeneous concept. In the context of movies it is usually used to describe a feeling of how much the consumer is “lost” in the movie or experiences a sense of “being there”. For further discussion of the concept see Lombard and Ditton [23]. Other factors like memory, attention, or elicited emotions seem not to be affected by 3D-presentations [2,5,7,16].

Few studies have investigated the effect of genre on 3D movies. Je and Lee [15], for example, discovered that 3D documentaries produced higher levels of narrative engagement and 3D action movies engendered more enjoyment and presence, compared to their 2D counterparts. A further study by Janicke and Ellis [14] found that sports content in 3D led to higher enjoyment, but this was not so in a movie trailer. In contrast, Rooney and Hennessy [27] found higher levels of perceived apparent reality related to 3D but observed no significant group differences in attention, emotional arousal or satisfaction for the fantasy movie *Thor* (2011). However, data were obtained by questioning movie goers after they had left the cinema and not in a laboratory setting. These findings indicate that 3D movies produce genre specific effects on the subjective experience of movie goers. These were movies originally produced with 3D technology involving two cameras (or a stereo camera with two lenses). We refer to this technology as director's 3D.

### 1.2. Protagonist perception

In this study, we focused on the perception of the protagonist in three particular genres: action movies, horror movies, and documentaries. This choice was, in part, motivated by a pre-study in which we tested 175 subjects who saw a documentary, a dance film, and two short stories either in 2D or in director's 3D [32]. We found that 3D produced higher presence ratings except for the documentary. We also found that subjects liked the documentary in the 2D version just as well as in the 3D version. In contrast, subjects preferred the 3D over the 2D versions of the short stories. One problem we encountered was that we used custom-made movies (in co-operation with a local film school (Rhein-Main Hochschule; Zeitabsierte Medien), some of which received only moderate presence ratings. To minimize such potential floor effects, we have decided to use mainstream movies made with the intent to please large audiences.

One factor that might contribute to a feeling of general discomfort when watching 3D movies is perceptual impact of binocular disparity. The differences between the two retinal images contribute decisively to depth perception at close range in so-called personal space (see e.g. [9,11,12]). With the introduction of sizable disparity, observers are likely to experience objects as closer than in 2D viewing, where such disparity is absent. This feeling of proximity to the events on screen may in turn generate more presence. For instance, Wilcox et al. [33] asked subjects to rate their level of comfort in response to objects and people in a stereoscopic projection and in real life. They found that observers showed the same strong negative reactions to violations of their personal space in 3D as in the natural environment. This effect translates to movies and is amplified when movie protagonists are filmed at close range [4].

Almost no studies exist that compare the impressions made by protagonists as a function of 2D vs. 3D viewing. This is surprising given how important it is to evaluate such potential 3D effects. Not only movies but also teleconferences or even private telephone

conversations of the future are very likely to be held in stereoscopic projection. One reason could be that most experts do not expect significant differences here because such differences have not been found in direct communication settings. One study that supports this suspicion is by Hauber et al. [10]. The authors compared conferences either transmitted in 2D, 3D, or in real life. They found that real life conferences were preferred to video conferences but did not find significant differences between 2D and 3D videos except for social presence. Conference calls in 2D were just as warm, personal, sensitive, sociable, pleasant, formal, and positive as in 3D. 3D may play a very different role when watching movies, and we thus investigated if stereoscopic viewing makes a difference in this domain.

### 1.3. The current study

We conducted a  $3 \times 3$  mixed design with the within factor genre (action, horror, documentation) and the between factor viewing condition (director's 3D, artificial 3D, 2D). We expected the artificial 3D condition, which merely doubled each frame with a slight offset between the eyes, to produce the highest amount of visual discomfort, operationalized as visually induced motion sickness, followed by director's 3D and 2D. We also assumed that horror movies would produce the highest amount of visual discomfort, because of the disgust and arousal they should produce. We further expected artificial and director's 3D to produce a higher amount of presence and immersion, compared to 2D presentations.

Concerning the protagonist perception, we were concerned that ratings might involve deliberations about viewing modalities and introduced a task in which subjects had to assume a comfortable distance to the picture of the protagonist. They should prefer a larger distance in the director's 3D, compared to the 2D condition if 3D moves the protagonist perceptually closer. Based on our preliminary findings, we also expected the subjects to prefer a larger distance in documentaries, compared to action and horror movies. We thought that a higher presence in the 3D version would also lead to a higher identification with the protagonists, which in turn should result in more favorable personality ratings. The stereo presentation should further result in a more intense experience which in turn might let the protagonist appear more intense, as operationalized with ratings of body height, weight, and attractiveness.

## 2. Methods

### 2.1. Participants

One hundred and eight (84 female and 24 male) psychology students participated in the experiment in exchange for partial course credit. Mean age was 25.11 years ( $SD = 8.08$  years). We only used subjects with self-reported normal or corrected-to-normal vision.

### 2.2. Film selection

We selected 6 popular movie clips that were all shot in director's 3D based on their genre. We used two action movies (*Gravity*, 2013; *The Amazing Spiderman*, 2012), two horror movies with splatter elements (*Final Destination 5*, 2011; *One Way Trip*, 2011), and two documentaries (*Pina*, 2011; *Die Huberbuam*, 2012). Of each movie a 3.21 min. scene was chosen, which was representative for the genre (see [Appendix A](#) for a detailed description of each scene we used). We deliberately chose short scenes in order to present several movie clips representing different genres within subjects in one session. We know that 3-min sequences are sufficient to induce a representative level of visual discomfort [18].

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