Creating Effective Infographics

Investigating the Effects of Animation and Signaling on the Appealingness and Persuasiveness of Infographics.

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Abstract

During the design process of an infographic, numerous choices have to be made, depending on the communicative intentions of the designer. Two intentions that are central to the current study are to create visually appealing and persuasive infographics. A challenge that designers face with such intentions is how they can be achieved. Therefore, the present study investigated the effects of animation and signaling on an infographic's appealingness and persuasiveness, where appealingness served as a mediator for persuasiveness. It was expected that including both animation and visual signals would positively affect the appealingness and persuasiveness of an infographic's design. Animation refers to a series of varying images to show motion and change over time, that can, for example, make visuals more dynamic and attractive. Signaling is the concept of including visual signals to highlight specific information, that can be used to shift or focus one's attention.

A 2 x 2 experimental between-subjects experiment was performed, with animation and signaling as independent variables. Participants were exposed to two infographics in one of the four conditions. After exposure, participants were asked to rate the appealingness and persuasiveness of the infographic's designs.

The results of the current study did not support the predefined hypotheses or the discussed literature. No evidence was found that animation or signaling influences the appealingness or persuasiveness of an infographic's design. Future research could expand the knowledge of these effects within infographics, by systematically measuring one's cognitive load to gain a better understanding of the underlying cognitive processes.

Keywords: infographics, animation, signaling, peripheral cues, appeal, persuasion

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1. Introduction

The introduction of Information Communication Technologies (ICT) drastically changed the way data, text or graphics can be visualized. This change goes back from "old-fashioned data visualizations", such as cave paintings, to different kinds of "new" infographics that are used in modern life (Lankow, Ritchie, & Crooks, 2012). Visual information became more important, and the effects of such information have been studied before. For example, Dur (2012) mentioned that the human brain can process visual information much faster and effective in a short period, compared to written, verbal information. Therefore, visual information appears to be an appealing concept for organizations that need to share information and it is interesting to further investigate its potential effects.

One way to visualize information is by combining text and images into a multimedia format, also known as an infographic. The term "infographics" originates from the word "information graphics" (Harrison, Reinecke, & Chang, 2015). In short, an infographic is "a type of picture that blends data with design, helping individuals and organizations to concisely communicate messages to their audiences." (Smiciklas, 2012, p. 3). Infographics have been widely investigated in the past, and the usage of infographics has changed over the years. Hilyer (2017) mentioned that an infographic helps to tell a story or to transmit a message by visualizing the content. This is not only useful for personal communication, but also for other purposes, such as science, business or public services (Toth, 2013).

Siricharoen and Siricharoen (2015) concluded that there are seven intentions that an infographic can fulfill: (1) to make information more appealing, (2) to display precious ideas, (3) to draw attention, (4) to make information easily understandable, (5) to make information more persuasive, (6) to make information more memorable and (7) to make information more easily to relay. Two interesting concepts from Siricharoen and Siricharoen (2015) that are central to the present study are the "appealingness" and "persuasiveness" of infographics.

These concepts are not only two of the seven intentions but are also relatable to the cognitive effects that infographics may have.

The appealingness of infographics is also known as visual appealingness or (visual) attractiveness and has been studied before. For example, Afify (2018) argued that visual attractiveness is the essence of an infographic. In line with this, Kos and Sims (2014) reasoned that infographics are attractive due to the nature of people, because an individual is drawn into visualizations, colors, and images. Therefore, the attractiveness of an infographic is an important factor within the design process. The same applies for the persuasiveness of infographics. Lazard and Atkinson (2015) mentioned that images often 'win' in terms of persuasiveness, compared to text-only, while also a Korean study concluded that infographics can be a useful tool for persuasion (Choi, Lee & Park, 2013).

What design choices can visual designers make to create appealing and persuasive infographics? Mayer (2005) published the Cognitive Theory of Multimedia Learning (CTML), which provides designers with guidelines about how the human brain processes and learns from multimedia formats. The CTML includes a set of 12 instructional principles, and a set of nine "advanced" principles. Two interesting principles that can be taken from the CTML (Mayer, 2005), and that may contribute to appeal and persuasiveness, are the Signaling Principle and the Animation and Interactivity Principle. The Signaling Principle is about cueing information, which may help to grab attention. This is important as Lima (2004) wrote that the first step in the persuasion process is to create attention to the message. The Animation and Interactivity Principle is about using animation and/or interactive elements into multimedia formats. This may affect the attractiveness of infographics as well, as Kim, Yoon, Whang, Tversky and Morrison (2006) found that animations are perceived as attractive and motivating. Also other researchers have found that animations are preferred over static images because of their attractiveness (Perez & White, 1985; Rieber, 1991; Sirikasem & Shebilske, 1991).

Both the Signaling Principle and the Animation and Interactivity Principle are interesting to investigate because of two reasons. Firstly, the Animation and Interactivity Principle is a less frequently investigated principle and from these existing studies both negative and positive effects have been found about whether or not it contributes to the learning process (Berney & Bétrancourt, 2016; Kim et al., 2006; Lin & Atkinson, 2011; Mayer, 2005). Because the CTML focusses on learning, this study will expand the current knowledge of the theory in a context of the persuasiveness and attractiveness of infographics. Secondly, it is interesting as to the researcher's knowledge, previous studies only focused on either the Signaling Principle or Animation and Interactivity Principle separately, but not together in the same study and context.

Therefore, and also in order to provide designers with guidelines for appealing and persuasive infographics, this study will focus on the design of infographics with regards to signaling and animation. This leads to the following research question:

RQ: *"To what extent do signaling and animation influence an infographic's visual appealingness and its ability to persuade?"*

2. Literature Review

2.1. What are infographics?

Various attempts have been made to come to one specific definition of what infographics are. To start with, Thatcher and Zadeh (2012) described an infographic as a data visualization that clearly represents complex information so it can be understood quickly. Another definition was proposed by Siricharoen and Siricharoen (2015), who state that infographics are visuals that present information in a limited space and artistic format. Nonetheless, infographics may have purposes other than being time-efficient or an artistic expression. In fact, they are visual displays to communicate information (Lester, 2013). This is in line with Lankow et al.'s (2012) definition, who stated that an infographic just uses visual cues to communicate information. Furthermore, they mentioned that there is no threshold for something becoming an "infographic", and thus that even simple road signs can be infographics.

Irrespective of specific definitions, it can be argued that infographics consist of three main elements. As proposed by Thatcher and Zadeh (2012), an infographic has (1) visual components (e.g., colours, icons and graphics), (2) content elements (e.g., facts, text and statistics) and (3) knowledge aspects (e.g., conclusions of the overall message and/or story). Despite these main elements, distinctions can be made between various types of infographics. Lankow et al. (2012) categorized infographics into three formats: (1) static, (2) motion and (3) interactive infographics. What is particularly interesting for the current study is the motion format. This format allows viewers to view, read, and if applicable, listen to the presented information. By nature, the display output of a motion infographic is animated and/or moving. These types of infographics often take the format of videos, which are capable of combining music, voice-overs and graphics. The focus in the present study will be on motion infographics because the video format appears to become more and more popular. Cisco (2019) predicted that by 2022, videos would make up for 82% of all consumer internet traffic. This is not only interesting for marketers but also for other organizations in general.

2.2. Communicative intentions of infographics

When considering the design of an infographic, it is essential to take the general intention of the infographic into account. Siricharoen and Siricharoen (2015) stated that the implicit purpose of infographics is to inform the viewer about how information is presented. From there on, one can start reading, viewing or listening to an infographic to analyze and process the content. As explained in the Introduction section, Siricharoen and Siricharoen (2015) mentioned seven intentions an infographic can serve. Two of these intentions that are central to the current study are: (1) make information more appealing and (2) make information more persuasive. These intentions are chosen because they might be related to each other, as will be explained later on in the Literature Review Section. From here on, the present study will refer to these intentions as the "appealingness" and "persuasiveness" of infographics.

2.2.1. Appealingness. The first intention that will be investigated is related to the aesthetics of an infographic. Dake (2005) argued that one of the most important parts of the visual communication puzzle is aesthetics. The importance of creating aesthetically pleasing infographics is related to a challenge within the current society. Niebaum, Cunningham-Sabo, Carrol and Bellows (2015) stated that due to all kinds of media exposure, the society is living in an information-saturated environment. In the year 2019, an individual already consumed 12 hours and 9 minutes of media per day (He, 2019), which might even increase in the near future. Furthermore, a study in the Time magazine concluded that the average attention span of an individual was just 8 seconds (Bradbury, 2016). Therefore, it is a constant challenge for designers to create aesthetically pleasing designs to stand out in this environment, where visuals such as infographics may help.

The aesthetics of an object can be investigated on all kinds of levels. The aesthetics of an object reflects the format in which the content is presented, the look and feel of the design,

and the overall experience it generates (Hallnäs & Redström, 2002; Norman, 2004). Therefore, the look and feel of a design are part of the visual communication process and are linked to the appealingness of an object, since design choices influence the way data is visualized and perceived. Although infographics may be successful due to the implementation of visual elements, just creating visual content will not necessarily contribute to successful and appealing designs.

Appealing means attractive or interesting, as mentioned in the Cambridge Online Dictionary (2019). Previous studies investigated appealingness as a construct by examining objects such as products and software (Hassenzahl, 2001; Hassenzahl, Platz, Burmester, & Lehner, 2000). Hassenzahl (2001) refers to appealingness as the global judgement of an object. In order to measure the appealingness of an object, Hassenzahl et al. (2000) developed a scale with eight items (e.g., pleasant, good and inviting) that can be used to access an appeal score. These items are related to the visual aspects of objects and are thus relevant for investigating the appealingness of infographics.

As a concept, appealingness seems to be related to attractiveness. Attractive refers to the quality of being pleasing in appearance and causing interest (Cambridge Online Dictionary, 2019). In a recent study about interactive infographics, Locoro, Cabitza, Actis-Grosso, and Batini (2017) defined attractiveness as the aesthetic satisfaction of information visualization which is capable of influencing the user's engagement in a positive way. Because of the overlap in the definitions of appealingness and attractiveness, the current study will use these terms interchangeably, although Locoro et al's. (2017) definition will be followed to define attractiveness.

What can designers do to make infographics more appealing? Afify (2018) discussed that visual attractiveness could be achieved when several graphic elements (e.g., icons, colours and images) and design principles are combined. These elements are able to orient the audience and grab their attention. Additionally, Locoro et al. (2017) argued that the

attractiveness of an infographic is related to two aspects. The first one is the aesthetic aspect, in which an infographic is a piece of art. Secondly, there is the aspect that takes the capacity to attract users towards the information into account. Taken together, this suggests that the attractiveness of infographics is two-sided and can act to either grab the attention or have a cosmetic function.

2.2.2. Persuasiveness. The second intention that will be investigated is related to the persuasiveness of the design of an infographic. This intention is chosen because, as discussed below, persuasion might be mediated by appealingness. According to Joo, Li, Steen, and Zhu (2014), persuasion is one of the core functionalities of communication in general. Persuasion includes influencing audience beliefs, desires and actions. In order to understand this core functionality, it is important to define persuasion. In an attempt to do this, Gass and Seiter (2016) investigated persuasion as multiple constructs, such as persuasion as a process, face-to-face persuasion and mass media persuasion. Taken together, Gass and Seiter (2016) stated that "persuasion involves one or more persons who are engaged in the activity of creating, reinforcing, modifying, or extinguishing beliefs, attitudes, intentions, motivations, and/or behaviors within the constraints of a given communication context" (p. 33). Because this definition conceptualizes persuasion as an activity between two persons, the definition will be adapted to fit the current study. Therefore, the current study sees the persuasiveness of infographics as the process of creating, reinforcing or modifying the attitudes, motivations and/or behaviour of the intended audience with an infographic's design.

Previous research already stated that visuals, in general, might be effective for persuasive purposes. For example, Trumbo (1999) mentioned that visuals are powerful tools for persuasion, because they can communicate more efficiently and effectively compared to textual communication. Dur (2014) stated that creating and distributing visuals, such as infographics, has been proven to be an effective way to persuade certain audiences. This is

because infographics support the process of seeing and connecting events in new or different ways to reveal (other) invisible patterns. Furthermore, Lima (2004) stated that changing an individual's attitude and persuasion can be performed by using media messages, which are as old as the propaganda during World War II. These messages often contained both textual and visual elements, like infographics nowadays. Therefore, an infographic seems to be an appropriate format for successful persuasion.

The Elaboration Likelihood Model (ELM), developed by Petty and Cacioppo (1986), might explain the persuasiveness of visuals, such as infographics. The ELM analyzes messages based on factors that explain attitude formation and behavioural change as a result of persuasive communication. This framework proposes a dual process model for persuasion which claims that one's attitude or behaviour can be influenced by persuasive messages that either evoke in-depth message processing (central route) or use heuristics for cueing a response (peripheral route). Central route processing suggests that when an individual is capable and motivated to process a persuasive message, in-depth arguments play an essential role in attitude formation and an individual critically processes the presented topic. Characteristics of attitudes that are established through central route processing are that they are more resistant to counter persuasion and more predictive of actual behaviour (Petty, Brinol & Priester, 2009). For example, if a viewer processes an infographic through the central route, all content will be read carefully, and a critical judgement will be established based on these arguments.

Moving over to the peripheral route of the ELM, Petty and Cacioppo (1986) stated that when an individual is not capable or sufficiently motivated, persuasive messages are processed based on simple heuristics. The arguments within the message are not evaluated and no critical judgements will be established based on these arguments. What happens is that the message will be evaluated based on peripheral cues within the message, which may lead to an attitudinal change. For example, in media-saturated environments (e.g., social

media), individuals may not thoughtfully analyze the content because this requires the capability, motivation and effort to process the message. However, because social media exposes a large number of stimuli to individuals in a short amount of time, central route processing may not always occur. Visuals such as infographics might help to stand out in such an environment due to their design and may thus be processed based on their peripheral cues. This results in an attitude that is established through peripheral route processing, where the message is evaluated based on more superficial elements such as visuals. An overview of the two processing routes within the ELM is provided in Figure 1.

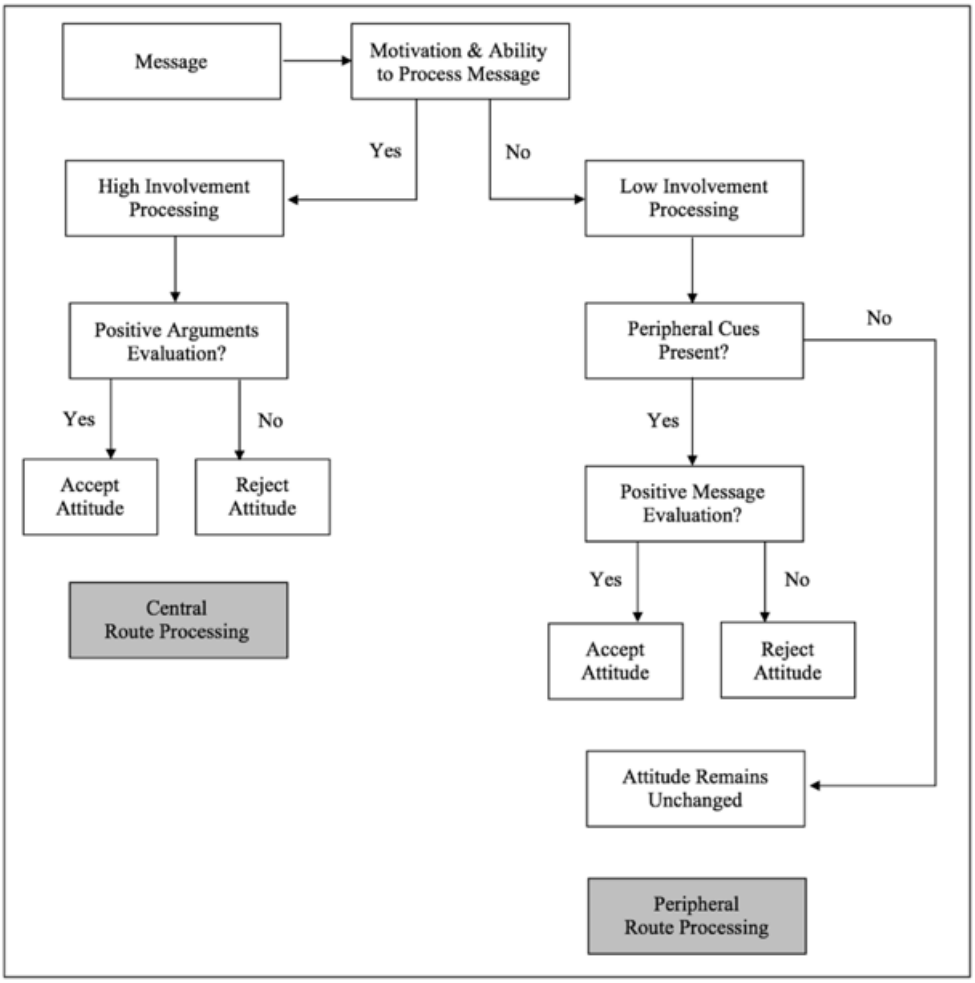


Figure 1. Schematic overview of the Elaboration Likelihood model. Adapted from "Advances in Experimental Social Psychology: The Elaboration Likelihood Model of Persuasion" by Petty and Cacioppo (1986)

Traditionally, the ELM tends to focus on the processing of persuasive messages by taking text-only content into account, without including the perception of both visual and textual content (Lazard & Atkinson, 2015; Petty & Cacioppo, 1986). The current study will contribute to the literature by investigating the ELM with regards to visual design elements that act as peripheral cues. Visual design elements within infographics influence the way an infographic is presented and perceived. Therefore, they are irrelevant to the quality of the message, but might act as peripheral cues. What is interesting about these peripheral cues is that they are related to the design of an infographic and may thus be influential upon their appealingness. In such an instance, peripheral cues contribute to the appealingness of infographics, wherein appeal will mostly contribute to the persuasion process when the message is processed more superficially.

2.3. Persuasion through attractive visuals

Investigating the appealingness and persuasiveness of the design of an infographic is interesting because persuasion might be mediated by appealingness. Although in a different context, previous studies have investigated the link between attractiveness and persuasiveness before. For example, Praxmarer (2011) investigated the effects of a presenter's attractiveness on their persuasive capabilities. She found that attractiveness is positively related to persuasion, whether receivers are highly involved or not. Vogel, Kutzner, Fiedler, and Freytag (2010) investigated the relation between attractiveness and persuasion as well. They concluded that attractiveness and persuasion are related in a way such that perceived attractiveness creates a persuasive advantage.

The link between attractiveness and persuasiveness might be explained by the role of attention. Previous research by Lima (2004) stated that persuasive communication occurs in five steps, where the first step is to create attention to the message. The attractiveness of infographics may support this first step because of design elements within infographics that

draw attention. This is supported by Matrix and Hodson (2014), who mentioned that infographics draw attention through the visual attractiveness of design elements. In addition, also Clark and Lyons (2011) concluded that infographics are appealing and that they contribute to grabbing or maintaining the attention of a viewer. Furthermore, as mentioned before, one of the aspects of attractiveness is the capacity to attract a viewer towards specific information or elements (Locoro et al., 2017).

In summary, previous studies support the fact that attractiveness is related to persuasion, although being investigated in a different context. Therefore, it is interesting to find out whether these results hold in the context of infographics. By taking the afore-mentioned research into account, the current study reasons that the appealingness and persuasiveness of the design of an infographic are indeed two related constructs. More specifically, the current study reasons that the persuasiveness of an infographics design is mediated by its appealingness.

2.4. Visual design elements as peripheral cues

One question that remains is which design elements contribute to making an infographic more appealing and persuasive. A theory that might answer this question is the Cognitive Theory of Multimedia Learning (CTML), published by Mayer (2005). The CTML is based on the idea that meaningful connections between words and pictures are built during a learning process. This is in line with the concept of an infographic, where text and graphics are combined into a single format. The theory consists of a set of instructional principles that can support designers to create multimedia formats. As mentioned in the Introduction section, two CTML principles that are central to the current study are the Animation and Interactivity Principle and the Signaling Principle. With regards to infographics, these principles influence the way information is presented. Therefore, the current study will investigate both principles as different types of peripheral cues.

2.4.2. Animation. The first peripheral cue that will be investigated is related to the Animation and Interactivity Principle. Mayer (2005) states that one way to combine both text and pictures into a single format is by implementing animation and interactive elements. Although Mayer's (2005) Animation and Interactivity Principle is about both animated and interactive elements, the current study focuses merely on animation due to practical considerations. To investigate the effects of animation as a peripheral cue, it is important to start with defining the concept of animation.

With regards to infographics, Lankow et al. (2012) categorized infographics that integrate animation techniques within their design as motion infographics. Previous research conceptualized animation based on several approaches. For example, Baek and Layne (1988) defined animation as "the process of generating a series of frames containing an object or objects so that each frame appears as an alteration on the previous frame in order to show motion" (p.132). This is a process-based definition where the input of a user is not taken into account. Another approach is provided by Gonzalez (1996), where animation is defined as "a series of varying images presented dynamically according to user action in ways that help the user to perceive a continuous change over time and develop a more mental model of the task." (p. 27). However, this definition is created in a Human-Computer Interaction (HCI) context, which takes the input of a user into account as an interaction between the user and animation.

Some elements of the above-provided definitions are relevant for the current study (e.g., the emphasis of motion) and some are not. For example, the input of a user is not relevant since interactivity is not investigated within the present study. Therefore, the definitions mentioned above were adapted to define animation in the context of the present study. Hence, the current research refers to animation as a series of varying images in order to show motion and change over time, which supports the development of a viewer's mental model.

Now it is clear what animation as a concept is, the features of animation are examined in more detail. Amongst others, Lowe and Schnotz (2014) investigated animations in terms of their functionalities. First of all, they made a clear distinction between video and animation. An animation differs from video such that it does not just capture images from the external world, but that it is the process of deliberate constructions such as drawing. Furthermore, they mentioned that one of the functions of an animation is to display spatial and temporal structures of objects, elements and events. This means that animations can display dynamic behaviours such as movement, growth and alterations. In addition, Weiss, Knowlton and Morisson (2002) stated that animation can have five functions, one of which is that animation can fulfil a cosmetic function that acts as a decorative feature to make content more attractive. This is interesting for the present study, because it investigates the persuasiveness of an infographic's design through its visual attractiveness.

There are two theories that might be central during the processing of visuals, such as infographics. Firstly, the Cognitive Load Theory (CLT), developed by Sweller (1988), reasons that the human brain has a limited cognitive capacity which can process three different types of cognitive load. One of these cognitive loads, the extraneous load, is generated by the way information is presented. Previous studies already investigated the cognitive effects of animation before. For example, Mayer, Hegarty, Mayer, and Campbell (2005) argued that animation requires less cognitive effort because it enables viewers to process stimuli more passively in order to construct a mental model. In addition, Lin and Atkinson (2011) found that animated graphics outperformed static graphics, in terms of retaining certain concepts within the graphic. A potential explanation was provided, which argued that animation supports the knowledge process because a mental model was more easily constructed. Contrary, Afify (2018) found in their recent study that static infographics performed better, compared to animated infographics. The results showed that, static infographics performed better in terms of recognizing elements and developing skills. Afify

(2018) reasoned that in a learning context, static infographics might have resulted in a lower cognitive load.

Although these studies were performed in a different context, it appears that animation does indeed have an influence on one's cognitive load. With regards to the present study, animation might lower one's extraneous load because it makes it less complex to process the infographics. The CLT (Sweller, 1988) reasons that the less complex a design will be, the lower its extraneous cognitive load; which eventually makes it easier to process.

The ease of processing is important according to the Processing Fluency Theory of Aesthetic Pleasure, developed by Reber, Swarch, and Winkielman (2004). This second theory will from here on be referred to as the Fluency Theory. Stimuli might be processed fluent when it is easy to see or understand, while disfluent stimuli is hard to see or understand (Reber, 2012). The theory reasons that the more fluent an individual can process an object or stimuli, the more positive its aesthetic evaluation is. Therefore, as it is expected that animation lowers one's cognitive load, this will result in a more fluent processing experience, which might result in a higher perceived appealingness.

In the context of appeal or attractiveness, previous research already found that animation, in general, appears to be an attractive way to present information (Flavián, Gurrea & Orús, 2017; Kim et al., 2006; Perez & White, 1985; Rieber, 1991; Sirikasem & Shebilske, 1991; Tversky, Morrison & Betrancourt, 2002). Furthermore, previous research found that animations are not only perceived as more appealing, but also more motivating compared to static graphics (Betrancourt, 2005; Kim et al., 2006).

Moving over to the persuasive aspects of animation, it might be that including animation makes the design of an infographic more persuasive. The current study already reasoned that appealingness and persuasiveness are related to each other, in a way that the persuasiveness of an infographic's design is mediated by its appealingness. Previous research by Morrison and Vogel (1998) already concluded that presentation visuals such as animations

are able to enhance persuasion because they are able to simplify complex materials. Hence, suggesting easier and more fluent processing of particular stimuli. Furthermore, Khanum, Shareef and Khanam (2015) stated in the context of advertising that animations are considered as a tool for persuasion as they have the ability to grab the attention.

The present study will investigate the influence of animation within infographics on their appealingness and persuasiveness. Besides the afore-mentioned results of previous research, a positive impact of animation on the appealingness and persuasiveness of infographics is expected because of two reasons. Firstly, as mentioned before, the present study expects that animation as a peripheral cue will enable the viewer to process the stimuli more fluently because it requires a more passive observation style. According to the Fluency theory (Reber et al., 2004), this will eventually lead to a higher perceived appealingness. Secondly, the present study already reasoned that the appealingness and persuasiveness of an infographic's design are two related constructs. They are related in a way that an infographics design might be persuasive through its appealingness. This reasoning was based on the Elaboration Likelihood Model (Petty & Cacioppo, 1986), which reasons that persuasion might occur through peripheral route processing, where in this case animation acts as a peripheral cue.

Hence, the following hypotheses are formulated:

(H1) *"Animated infographics are perceived as more appealing, compared to static infographics."*

(H2) *"Animated infographics are perceived as more persuasive, compared to static infographics."*

(H3) *"The effect of animation on persuasiveness is mediated by appealingness: animated infographics are more appealing than static infographics, which in turn makes them more persuasive."*

2.4.3. Signaling. The second peripheral cue that will be investigated is about highlighting information or specific elements within infographics. When designing an infographic, designers may decide to emphasize specific parts of the infographic. The Cognitive Theory of Multimedia Learning (Mayer, 2005) referred to this with the Signaling Principle. In essence, the Signaling Principle addresses the importance of adding cues that highlight essential information (Mayer, 2009). Van Gog (2014) stated that signaling could also be known as cueing and refers to the finding that multimedia formats are more effective when cues are added. It includes the idea that (visual) cues guide the viewer's attention to relevant or important aspects of the presented information. This basically means that multimedia formats may include subtle cues that prevent viewers or users from missing essential information. In a similar vein, Betrancourt (2005) proposed the attention-guiding principle. This principle also states that visual signals or cues are capable of guiding the attention of the viewer towards important aspects of multimedia formats. Although both principles appear to focus on guiding an individual's attention, the present study will follow Van Gog's (2014) definition because it is part of the Cognitive Theory of Multimedia Learning (Mayer, 2005).

Signaling can be implemented in multimedia formats in three ways: with either bottom-up or top-down cues, or with a combination of both (Van Gog, 2014). When implementing signals as a bottom-up cue, the characteristics of the materials (at least partially) determine what draws the attention or not. For example, these characteristics may be visual elements such as arrows, specific colours within a design or elements that will be "isolated" from other elements. However, signals can also be implemented as top-down cues (Van Gog, 2014). In that case, the knowledge of a task or the instruction that is provided mostly determines what draws the viewer's attention or not. For example, individuals may already have existing knowledge that implicitly instructs them what to do. When designers want to implement signaling, they may thoughtfully decide which approach they want to

follow. Both bottom-up and top-down cues provoke different actions from the viewer's perspective and require different techniques to be implemented. The present study will focus on Van Gog's (2014) bottom-up process because it directly impacts the design of stimuli, or in this case the design of an infographic.

In order to understand the effects of signaling, we could again turn to the theory about cognitive load and fluency. According to Mayer and Moreno (2003), one's cognitive load can be reduced by providing signals that help viewers process the provided stimuli. As reasoned within the Animation section, it is expected that a lower cognitive load results in a more fluent processing experience; which should result into a more positive appealingness judgement according to Reber et al.'s (2004) Fluency theory. Therefore, including signaling in infographics might yield similar results. When visual signals are included, this could make infographics more appealing because it enhances the processing fluency via a lower cognitive load.

Signaling appears to play a significant role in information processing. For example, Ozcelik, Arslan-Ari and Cagiltay (2010) concluded in their eye-tracking study that signaling is capable of effectively guiding one's attention to relevant information. In another study, performed by Schneider, Beege, Nebel and Rey (2018), a meta-analysis revealed that signaling is a beneficial way to increase an individual's retention score. Furthermore, they found that signaling affected an individual's motivation and indeed reduced one's cognitive load.

Although there is evidence that signaling supports guiding attention and lowers the cognitive load, yet little previous research has been performed of the effect of signaling as a peripheral cue. Therefore, the present study will investigate signaling as a peripheral cue, in the context of its appealingness and persuasiveness within infographics.

Signaling may contribute to the persuasion process because of two reasons. Firstly, Lima (2004) stated that the first step in persuasion is to grab the attention. Because signaling

appears to be an important feature in grabbing or shifting attention (Ozcelik et al., 2010; Van Gog, 2014), signaling may support the first step of persuasion. Additionally, the present study already reasoned that the appealingness and persuasiveness of an infographics design are related to each other. It is expected that an infographic's design is persuasive, when it is perceived as appealing. This relation can be explained by the Elaboration Likelihood Model (Petty & Cacioppo, 1986), which possesses that persuasion can take place through peripheral route processing, where in this case signaling acts as a peripheral cue.

Hence, the following hypotheses are formulated:

(H4) *"Infographics that include visual signals are perceived as more appealing, compared to non-signaled infographics."*

(H5) *"Infographics that include visual signals are perceived as more persuasive, compared to non-signaled infographics."*

(H6) *"The effect of signaling on persuasiveness is mediated by appealingness: infographics with visual signals are more appealing than infographics without visual signals, which in turn makes them more persuasive."*

2.4.4. Interaction effects. Since the present study investigates animation and signaling as two types of peripheral cues, it is expected that they may enhance each other. Not only because they are two types of peripheral cues, but also because both design elements have been argued to enhance the ease of processing. Furthermore, although being investigated in a different context, previous research already concluded that animations are more effective when essential information is cued (Ayres & Paas, 2007; Betrancourt, 2005; De Koning, Tabbers, Rikers & Paas, 2007).

Therefore, in addition to the current literature, the present study will investigate the combined effects of animation and signaling on the appealingness and persuasiveness of infographics. With regards to animation and signaling as peripheral cues, it is expected that

including both in an infographic will positively influence the perceived appealingness and persuasiveness of its design.

Hence, the following hypotheses are formulated:

(H7) *"Infographics that include both animation and visual signals will be perceived as most appealing, compared to infographics that include only animation, only signaling, or none of them."*

(H8) *"Infographics that include both animation and visual signals will be perceived as most persuasive, compared to infographics that include only animation, only signaling, or none of them."*

(H9) *"The interaction effect between animation and signaling on persuasiveness is mediated by appealingness: animated infographics that include visual signals are most appealing, compared to infographics that include only animation, only signaling, or none of them, which in turn makes them most persuasive."*

2.5. Conceptual model

Figure 2 includes a schematic overview of the conceptual model of the present study. Both the independent, dependent and mediating variables are displayed down below. Additionally, the overview includes the expected results of the above formulated hypotheses.

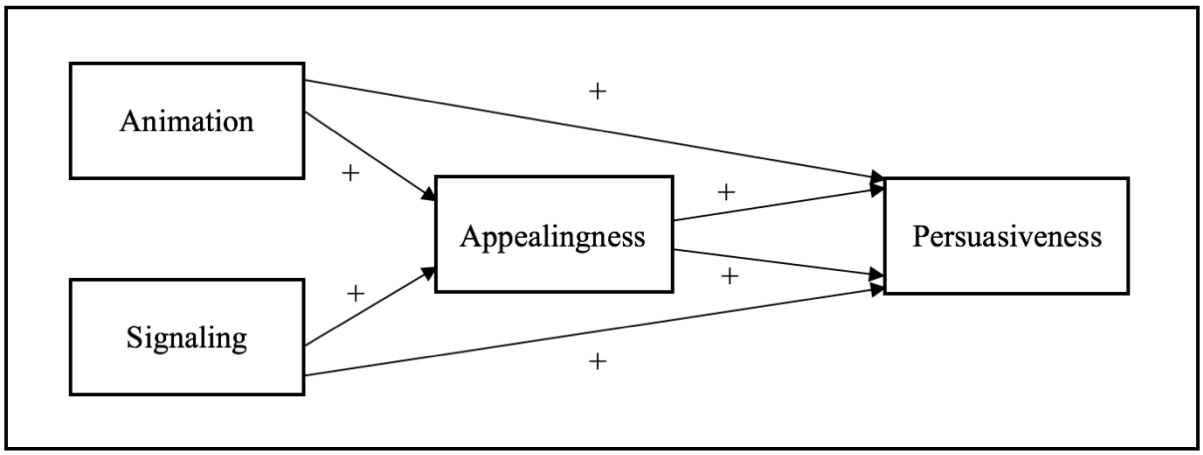


Figure 2. Schematic overview that represents the conceptual model of the present study.

3. Method

3.1. Design

In order to investigate the effects of peripheral cues within infographics, a quantitative study with a 2 x 2 between-subjects design was conducted. The experiment took place in a controlled environment on the campus of Tilburg University and included *animation* (levels: static and animated) and *signaling* (levels: without visual signals and with visual signals) as independent variables. Validated scales were used for the measurement of the dependent variable *persuasiveness* and the mediating variable *appealingness.*

3.2. Participants

Tilburg University's participant pool was consulted for the sampling of the participants in the present study. In total, 91 responses were collected over a period of two days. The sample consisted of 31 male (34.1%) and 60 (65.9%) female individuals who were on average 21.15 years old (*SD*= 2.86). Their most prevalent highest level of education was a Bachelor's degree on a University of Applied Science (43.8%). Two respondents who indicated that they did not watch the infographics on full-screen were excluded from the analysis. After excluding these two participants, the final sample consisted of 89 eligible responses.

3.3. Stimuli

Two existing Dutch infographics were used to create the stimuli for the present study. The first infographic was a visualization of market developments within the design branch[1] and the second infographic was a visualization of cybercrime statistics[2]. These infographics

[1] http://docplayer.nl/70144135-Bno-branchemonitor-de-nederlandse-ontwerpsector-in-beeld-en-getal.html

[2]https://magazine.dnb.nl/cybercrime_van_verdediging_naar_veerkracht/online_oplichting_haalt_fietsdiefstal_in

were chosen because of two reasons. Firstly, to minimize the influence of participants' attitude towards an infographic's topic, infographics about social problems were avoided and less common topics were chosen. Secondly, the infographics contained similar design elements that kept the overall design of both infographics consistent. That is, they were made out of "boxes" that presented facts or information regarding the topic.

All manipulated conditions were an alteration on the condition that contained neither animation or signaling. This baseline condition, condition one, contained the infographic as a still image. Before the infographics were manipulated, the designers were contacted in advance to inform them about the present study and to ask them for permission. From there on, the infographics were replicated, modified and manipulated into four conditions: (1) static and without signaling, (2) animated without signaling, (3) static with signaling and (4) animated with signaling. Every participant was presented with two infographics manipulated in the same condition. Exposing participants to two infographics enhanced the generalizability of the potential effects of the independent variables. The four conditions of both infographics can be found within Appendix A. This appendix includes the original infographics and per infographic four unique hyperlinks that are linked to each condition.

For the conditions that contained animation (condition 2 and 4), infographics were animated in terms of using animation as a cosmetic function. Incorporating animation in infographics with a cosmetic function was chosen for the current study, because Weiss et al. (2002) mentioned that cosmetic animations are used to make content more attractive. This is important for the current study, since attractiveness is an important variable that eventually may lead to persuasion. The infographics were animated in a way such that the order in which the content was presented, significantly changed compared to the static infographics. To achieve this, each infographic included several animations that made the infographic more dynamic. The backgrounds of the infographics were animated, and specific elements were moved or faded into the frame to "introduce" them to the viewer. For example, the six boxes

that are part of both infographics, see Figure 3, appeared one by one so that they could be processed separately. The reveal of those boxes appeared at a rather slow pace, that provided participants sufficient time to process the information before the next box appeared. Within the conditions that contained animation, it took 80 seconds for infographic 1 and 75 seconds for infographic 2 to be unfolded completely. In addition, secondary design elements (the graphs, figures, numbers and boxes) were animated such that they were displayed as more dynamic by incorporating movement and scaling.

Figure 3. Overview of the baseline condition for infographic 1 (left) and infographic 2 (right).

The second independent variable, signaling, was manipulated in the infographics by cueing (design) elements within the infographics. To accomplish this, the boxes that are part of the infographics were made more salient by increasing them in size for a short amount of time, and by isolating them from the background. It took 70 seconds for both infographics to isolate each box individually within the conditions that contained signaling. Figure 4 includes an example of the signaled infographics, where one of the six boxes is made more salient and isolated from the background.

Figure 4. Example of the signaled infographics for one of the six boxes. Infographic 1 is displayed on the left, whereas infographic 2 is displayed on the right.

In order to keep the changes between conditions as close to the manipulations as possible, all conditions were presented in video format (within a video player). This was also done in the first condition, although the infographics there neither contained animation nor signaling. However, displaying these infographics as a still image was still avoided, since this might have influenced the perception of the participants: a still image may have a different appearance compared to a video player. Furthermore, the video player was customized in a way that only the full screen button and play/pause button were visible, and that auto play was enabled. Other elements such as the video title, the video player timeline and the share button were removed. A 10 second countdown was included before each infographic started. This gave participants sufficient time to enable full screen mode.

3.4. Instrumentation

In order to measure both the appealingness and persuasiveness of the manipulated infographics, existing scales from previous studies were adopted. Since the present study used a Dutch sample, all statements were translated into Dutch (see Appendix B).

The appealingness of the infographics was measured with a semantic differential scale that consisted of eight bipolar verbal answers. These answers were adapted from Hassenzahl et al's. (2000) product quality scale that consisted of 23 items, divided over three constructs (ergonomic quality, hedonic quality and appeal). Although Hassenzahl et al. (2000) measured three constructs to evaluate the overall product quality, the present study only used items from the appeal construct to assess the appealingness score of infographics. The appeal measurement consisted out of eight bipolar verbal answers (e.g., good – bad) that were answered on a seven-point scale. This scale had an excellent reliability for both infographics (a= .90). Table 1 provides all items that were used for the appealingness scale.

Table 1.
Appealingness scale

Measurement	**7-point scale**	
	1 =	7 =
APPEAL1	Unpleasant	Pleasant
APPEAL2	Bad	Good
APPEAL3	Unaesthetic	Aesthetic
APPEAL4	Rejecting	Inviting
APPEAL5	Unattractive	Attractive
APPEAL6	Unsympathetic	Sympathetic
APPEAL7	Discouraging	Motivating
APPEAL8	Undesirable	Desirable

As the present study was interested in the persuasiveness of the design of an infographic, and not specifically the topic, persuasiveness was operationalized as an individual's attitude towards the design of the infographic. In order to measure these attitudes, an 8-item semantic differential scale was adapted from Olney, Holbrook and Batra's (1991) attitude towards an ad scale. Although the present study did not specifically investigate ads, the infographics are the same type of visual format (video) as the ads used in Olney et al's. (1991) study. Again, this scale consisted of bipolar answers (e.g., useful – not useful), divided over three constructs (e.g., hedonism) that required answers on a seven-point scale. This scale had an acceptable reliability (a= .77) for both infographics. All items that were used for the persuasiveness scale are provided within Table 2.

In addition to the scale questions, an open-ended question was added which asked participants to write down their first impression of the infographics. This question was included to collect the overall thoughts of the participants regarding the infographics. Finally, two control variables were added. Firstly, participants were asked to indicate their level of

involvement to the topic for both infographics. This was measured with one statement "I am involved with the topic of the infographic", on a 5-point Likert scale (1= Strongly disagree, 5= Strongly agree). Finally, participants were asked whether they watched the infographics on full screen or not.

Table 2.
Persuasiveness scale

Measurement	**7-point scale**	
	1 =	7 =
ATT1	Unpleasant	Pleasant
ATT2 (R)	Fun to watch	Not fun to watch
ATT3	Not entertaining	Entertaining
ATT4 (R)	Enjoyable	Not enjoyable
ATT5	Not important	Important
ATT6	Uninformative	Informative
ATT7	Not helpful	Helpful
ATT8	Not useful	Useful
ATT9	Does not make me curious	Makes me curious
ATT10	Boring	Not boring
ATT11	Does not keep my attention	Keeps my attention

3.5. Procedure

The experiment was conducted in collaboration with a fellow researcher at Tilburg University, who also conducted an experiment about infographics. Both experiments had completely different manipulations of an infographic's design, although they had "infographics" as a topic in common. To avoid order effects, the order in which the

experiments were completed by the participants was varied to minimize the influence of the depletion of participants. Both experiments were reviewed in advance and approved by the Ethical Committee of the School of Humanities and Digital Sciences of Tilburg University.

Participants were expected to show up in a computer room at Tilburg University. A group of maximum 10 participants were able to participate at the same time. After participants showed up at the location, the experiment was conducted with the help of the survey tool Qualtrics. Before both studies started, participants were exposed to an introduction that included a brief explanation of the study and an informed consent. Participants were ensured that their data was treated confidentially, that the expected time of completion is 10 minutes and that they could end the study whenever they wanted. On average, participants completed the experiment in 8.52 minutes (*SD*= 6.65). After the participants agreed to the informed consent, the first part of the experiment provided them with instructions and information about what to expect. This included information about the structure of the survey, the type of questions that would be asked and instructions about how to watch the infographics on full screen.

The second part of the experiment displayed the first infographic from one of the four randomly assigned conditions. In total, condition one, three and four were exposed to 23 participants each, whereas condition two was exposed to 22 participants. To ensure that participants viewed the infographics on full screen resolution, again instructions were provided. Participants were asked to inspect the infographic and to proceed when the “next” button appeared, or when they felt they had completely inspected the infographic. After the participants had inspected the first infographic, they were instructed to fill out the attractiveness scale in part three and the persuasiveness scale in part four. In part five, participants were asked to indicate their involvement with the topic of the infographic.

The actions performed in part two, three, four and five were repeated for the second infographic in part six, seven, eight and nine. Although participants were exposed to a

different infographic, the condition of the second infographic was kept the same as the first infographic. Furthermore, there was the ambition to keep the minimum viewing duration across all conditions the same. Due to the duration of certain manipulations, the minimum viewing duration ended up ranging between 60 and 80 seconds. However, participants were able to inspect the infographics longer if they preferred to. The maximum duration of an infographic was four times the time it took to complete one full round of manipulation. Including with the countdown timer in the beginning, the maximum duration ranged between 4.15 and 4.52 minutes. After this, the video automatically stopped playing.

In part ten, participants were asked to fill in their age, gender and educational level as demographic information. Part ten also included the full-screen control variable and open-ended question. Finally, the eleventh part provided the participants with a debriefing of the current study, where participants could also indicate if they wanted to receive the results of the current study, or not.

4. Results

To examine the effects of *animation* and *signaling* within infographics, multiple statistical analyses have been performed. This Results section consists of a main analysis and a secondary analysis. Within the main analysis, two factorial ANOVAs were performed to test the direct effects of the independent variables. Both outcome variables, *appealingness* and *persuasiveness* have been tested separately. The secondary analysis focused on the mediating effect of *appealingness.* Two simple mediation analyses (model 4) and a moderated mediation analysis (model 7) were conducted with the PROCESS macro, developed by Hayes (2017).

Before the analyses were performed, insights were gained in topic influence, which was a control variable. For infographic 1, participants indicated their level of involvement with the design branch on average as 2.43 (*SD*= 1.18), while participants reported for infographic 2 that they were involved on average 3.36 (*SD*= 0.99) with the topic cybercrime. These results were considered as rather neutral, and it was therefore expected that the topic of the infographics did not influence their perceived appealingness and persuasiveness. Table 3 provides an overview of these descriptives.

Table 3.
Descriptive statistics for topic influence control variables.

	N	Mean	SD	Minimum	Maximum
Control variable					
Topic influence infographic 1	89	2.43	1.18	1	5
Topic influence infographic 2	89	3.36	0.99	1	5

4.1. Main analysis

4.1.1. Appealingness. To test whether infographics are perceived as more appealing if they include *animation* or *signaling*, a two-way ANOVA was performed. The appealingness scores were not normally distributed. There were issues with the z-scores for the static infographics (*z-skewness* = -4.00, *z-kurtosis* = 7.03) and non-signaled infographics (*z-skewness* = -4.57, *z-kurtosis* = 9.25). The assumption of homogeneity of variances was met, as the Levene's test was not significant, $F(3, 85) = 0.97$, $p = .413$. Since the data was not normally distributed, bootstrapping was enabled.

The ANOVA showed a non-significant main effect of animation, $F(1, 85) = 1.59$, $p = .211$. Animated infographics ($M = 5.47$, $SD = 0.63$) were not perceived as more appealing than static infographics ($M = 5.27$, $SD = 0.84$). Furthermore, there was no main effect of signaling, $F(1, 85) = 0.68$, $p = .411$. Infographics with visual signals ($M = 5.44$, $SD = 0.68$) were not perceived as more appealing compared to non-signaled infographics ($M = 5.30$, $SD = 0.81$). There was also no significant interaction effect between animation and signaling, $F(1, 85) = 1.42$, $p = .237$.

Given these results, the following can be concluded. Animated infographics were not perceived as more appealing, compared to static infographics. Therefore, hypothesis 1 is rejected. In a similar vein, the results also showed that infographics that included visual signals were not perceived as more appealing, compared to non-signaled infographics. Therefore, also hypothesis 4 is rejected. Furthermore, the results of the ANOVA showed that infographics that included both animation and signaling were not perceived as most appealing, compared to infographics that included either animation, signaling, or none of them. Again, this result is in contrast with the predicted effect and therefore rejects hypothesis 7.

4.1.2. Persuasiveness. To test whether infographics are perceived as more persuasive if they include *animation* or *signaling*, again a two-way ANOVA was performed. The persuasiveness scores were not normally distributed because there were issues with the static (*z-skewness* = -3.85, *z-kurtosis* = 5.85) and non-signaled (*z-skewness* = -3.38, *z-kurtosis* = 5.68) infographics. The assumption of homogeneity of variances was met, as the Levene's test was not significant, $F(3, 85) = 0.52$, $p = .672$. Since the data was not normally distributed, again bootstrapping was enabled.

The ANOVA showed a non-significant main effect of animation, $F(1, 85) = 0.50$, $p = .480$. Animated infographics ($M = 5.16$, $SD = 0.58$) were perceived as equally persuasive as static infographics ($M = 5.06$, $SD = 0.73$). In addition, there was no significant main effect of signaling $F(1, 85) = 1.11$, $p = .295$. Signaled infographics ($M = 5.18$, $SD = 0.56$) were not perceived as more persuasive compared to non-signaled infographics ($M = 5.03$, $SD = 0.74$). Furthermore, no significant interaction effect between animation and signaling was found, $F(1, 85) = 2.53$, $p = .115$.

With regards to the postulated hypotheses in the Literature Review section, the following can be concluded. Hypothesis 2 is rejected because animated infographics were not perceived as more persuasive, compared to static infographic. In addition, hypothesis 5 is rejected as well because the results indicated that infographics with visual signals were not perceived as more persuasive, compared to non-signaled infographics. Furthermore, infographics that included both animation and signaling were not perceived as most persuasive, compared to infographics that included either animation, signaling, or none of them. Therefore, hypothesis 8 is rejected as well.

4.2. Appealingness as a mediator for persuasiveness

Notwithstanding the fact that the main analysis did not reveal significant effects, a secondary analysis tested if and how appealingness mediated persuasiveness. Although significant mediation effects were not expected based on the outcomes of the main analyses, additional mediation analyses were performed for the sake of completeness. The analyses presented below tested hypotheses 3, 6 and 9 directly. Model 4 of the PROCESS macro (Hayes, 2017) was used to test the individual effects of the independent variables, while model 7 was used to test the interaction effects between both independent variables.

Before the simple mediation analyses and moderated mediation analysis were performed, insights were gained in the descriptive statistics (e.g., mean scores) to get a better understanding of the data. These statistics are provided in Table 4. To assess possible violations of normality, z-scores for the skewness and kurtosis of all groups were calculated. Table 5 presents the z-scores separated by appealingness and persuasiveness. Since the z-scores for the static and non-signaled conditions are outside the -1.96 and 1.96 margins, normality cannot be assumed. Furthermore, a Pearson Correlation analysis was performed. There appears to be a strong positive correlation (b= .74, p < .001) between the appealingness and persuasiveness of infographics. This indicates that when an infographic is perceived as more appealing, the design of the infographic is perceived as more persuasive as well.

Table 4.

Descriptive statistics for the outcome variables.

Outcome variables	N	Mean	SD	Minimum	Maximum
Appealingness	89	5.37	0.75	1.88	7
Persuasiveness	89	5.11	0.66	2.19	6.63

Table 5.
Z-scores for each experimental condition, separated by appealingness and persuasiveness.

	Appealingness		Persuasiveness	
Experimental condition	Skewness	Kurtosis	Skewness	Kurtosis
Static	**-4.00**	**7.03**	**-3.85**	**5.85**
Animated	-0.63	0.59	-0.60	0.35
Non-signaled	**-4.57**	**9.25**	**-3.38**	**5.68**
Signaled	-0.75	-0.81	-0.97	-0.97

*Not*e. Significant z-scores are marked as **bold.**

4.2.1. Simple mediation – Animation. To investigate whether the relationship between *animation* and the *persuasiveness* of infographics can be explained by the *appealingness* of infographics, a simple mediation analysis was performed using PROCESS (Hayes, 2017).

Before the mediation analysis was performed, assumptions were checked. A visual inspection of the scatterplots indicated problems with the assumption of linearity and assumption of homoscedasticity. The dots in the scatterplots were not randomly distributed, see Appendix C. Furthermore, the assumption of normality was not met either. The z-scores of the standardized residuals were outside the -1.96 and 1.96 safe range (*z-skewness* = -3.84, *z-kurtosis* = 5.94). There was also one case with a studentized deleted residual higher than 3. The remaining assumptions were met. The largest Cook's distance was 0.22, there was no indication of multicollinearity (VIF = 1), and the highest Centered Leverage Value (0.01) was below 0.09. Finally, there were no cases with a significant Mahalanobis distance as all cases scored below 5.99, and the Durbin Watson value (1.45) was acceptable. Although it is recommended to enable bootstrapping for the violated assumptions, it required no additional

actions from the researcher. PROCESS (Hayes, 2017) automatically enables bootstrapping, irrespective of whether assumptions are violated or not.

In the mediation analysis, *animation* was entered as the predictor to persuasive infographics, and the infographics' *appealingness* was entered as a mediator. The model is displayed in Figure 5. As can be seen, *animation* is not related to appealingness, but appealingness is significantly related to the persuasiveness of infographics. There was a non-significant total effect of *animation* on *persuasiveness (b*= 0.10, *SE* = 0.14, *p*= .473), indicating that animated infographics are not more likely to be more persuasive, compared to static infographics.

This non-significant effect remained the same when appealingness was added as mediator; in that case, the direct effect was *b*= -0.03, *SE*= 0.10, *p*= .746. Furthermore, the indirect effect was not significant either (*b*= 0.13, *SE*= 0.11, BCa CI [-0.06, 0.36]). Given these non-significant results, the size of the effects is irrelevant and left out of the result section. The results of this simple mediation analysis are in line with the findings of both factorial ANOVAs, performed in the main analysis. Animated infographics are not perceived as most persuasive, and the appealingness of the infographics does not explain the link between animation and persuasiveness within infographics. Therefore, hypothesis 3 is rejected.

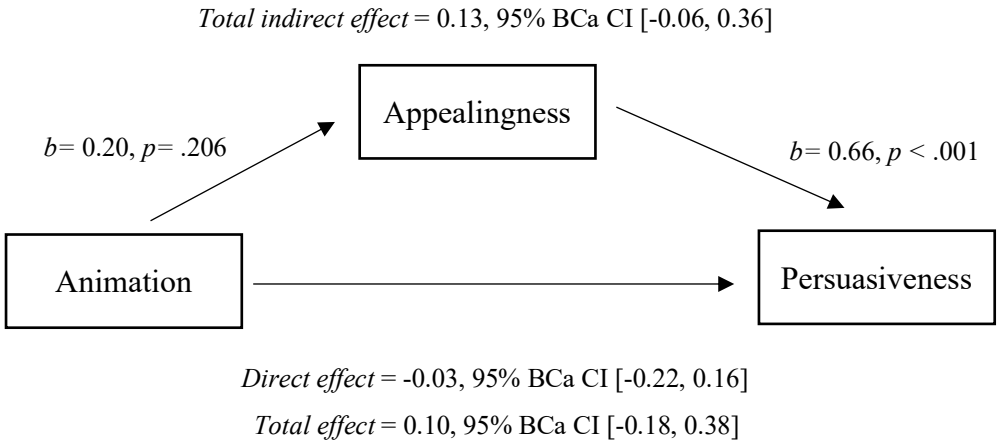


Figure 5. Simple mediation model with animation as a predictor of the persuasiveness of infographics, mediated by their appealingness.

4.2.2. Simple mediation – Signaling. To investigate whether the relationship between *signaling* and the *persuasiveness* of infographics can be explained by the *appealingness* of infographics, a second simple mediation analysis was performed using PROCESS (Hayes, 2017).

Before the mediation analysis was performed, assumptions were checked. A visual inspection of the scatterplots indicated problems with the assumption of linearity and assumption of homoscedasticity (Appendix D). The dots in the scatterplots were not randomly distributed. Furthermore, the assumption of normality was not met either. The z-scores of the standardized residuals were outside the -1.96 and 1.96 safe range (*z-skewness* = -3.71, *z-kurtosis* = 5.85). There was also one case with a studentized deleted residual higher than 3. The remaining assumptions were met. The largest Cook's distance was 0.22, there was no indication of multicollinearity (VIF = 1), and the highest Centered Leverage Value (0.01) was below 0.09. Finally, there were no cases with a significant Mahalanobis distance as all cases scored below 5.99, and the Durbin Watson value (1.53) was acceptable. Again, despite Hayes (2017) recommends enabling bootstrapping for the violated assumptions, the PROCESS macro required no addition actions from the researcher.

In the mediation analysis, *signaling* was entered as the predictor to persuasive infographics, and the infographics' *appealingness* was entered as a mediator. The model is displayed in Figure 6. As can be seen, *signaling* is not related to appealingness, but appealingness is significantly related to the persuasiveness of infographics. There was a non-significant total effect of *signaling* on *persuasiveness (b*= 0.15, *SE* = 0.14, *p*= .278), indicating that signaled infographics are not more likely to be more persuasive, compared to non-signaled infographics.

This non-significant effect remained the same when appealingness was added as mediator; in that case, the direct effect was *b*= 0.06, *SE*= 0.10, *p*= .518. Furthermore, the

indirect effect was not significant either (*b*= 0.09, *SE*= 0.11, BCa CI [-0.10, 0.32]). Given these non-significant results, the size of the effects is irrelevant and left out of the result section. The results of this simple mediation analysis are in line with the findings of both factorial ANOVAs, performed in the main analysis. Signaled infographics are not perceived as most persuasive, and the appealingness of the infographics does not explain the link between signaling and persuasiveness within infographics. Therefore, hypothesis 6 is rejected.

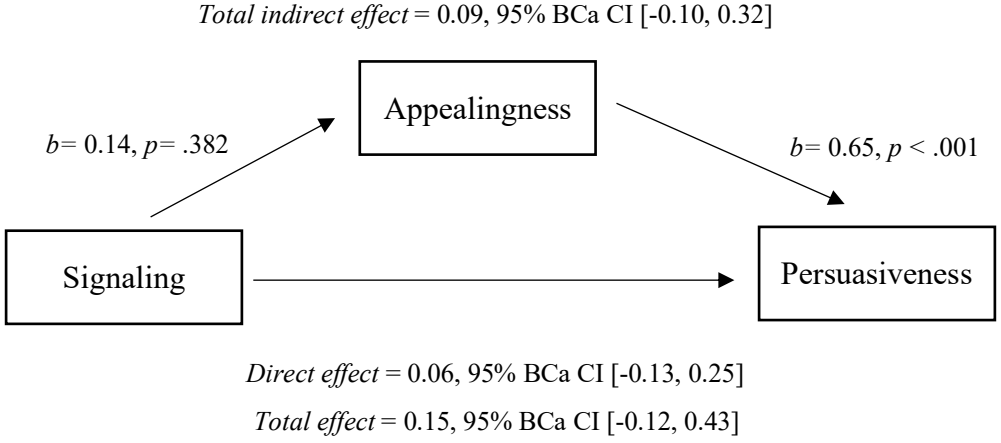


Figure 6. Simple mediation model with signaling as a predictor of the persuasiveness of infographics, mediated by their appealingness.

4.2.3. Moderated mediation – Interaction animation and signaling. To investigate whether there is an interaction effect between *animation* and *signaling* on the *persuasiveness* of infographics, and whether this can be explained by their *appealingness*, a moderated mediation analysis was performed using PROCESS (Hayes, 2017).

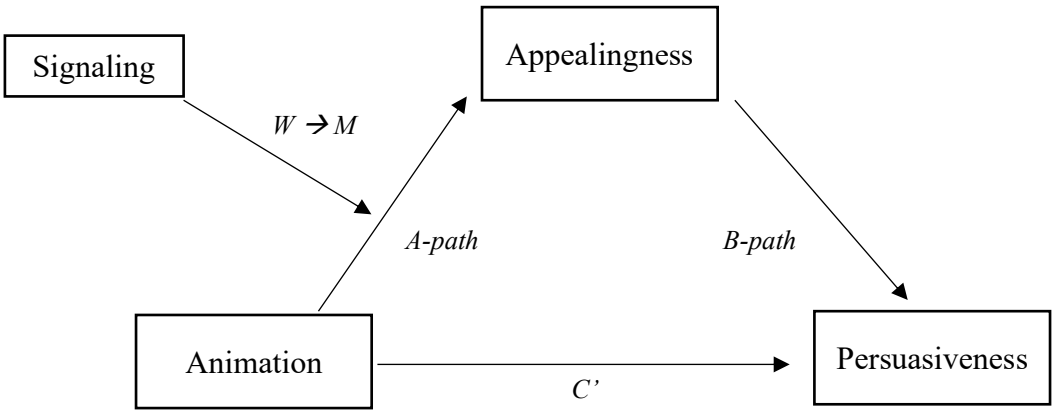
Before the moderated mediation analysis was performed, assumptions were checked. A visual inspection of the scatterplots indicated problems with the assumption of linearity and assumption of homoscedasticity. The dots in the scatterplots were not randomly distributed. Furthermore, the assumption of normality was not met either (see Appendix E). The z-scores of the standardized residuals were outside the -1.96 and 1.96 safe range (*z-skewness* = -3.59, *z-kurtosis* = 5.44). The remaining assumptions were met. The highest

Cook's distance was 0.22 and there were no cases with a studentized residual value higher than 3. Furthermore, all cases had a Mahalanobis distance below 5.99 and the highest Centered Leverage Value (0.02) was below 0.09. Finally, there were no issues with the multicollinearity (VIF= 1) and the Durbin Watson value (1.50) was acceptable. As mentioned before, there were no additional actions required as a result of the violated assumptions. The PROCESS macro, developed by Hayes (2017), always enables bootstrapping.

In the moderated mediation analysis, *animation* was entered as the predictor to persuasive infographics, appealingness as a mediator and *signaling* as a moderator. The model is demonstrated in Figure 7. Again, *animation* is not related to appealingness, but appealingness is significantly related to the persuasiveness of infographics. Furthermore, there was a non-significant total effect of *animation* on persuasiveness (b= -0.03, SE= 0.10, p= .746). This indicates that animated infographics are not more like to be more persuasive, compared to static infographics.

This non-significant effect remained the same when appealingness was added as a mediator, for both low levels of moderation (b= 0.25, 95% BCa CI [-0.03, 0.62]) and high levels of moderation (b= 0.01, 95% BCa CI [-0.26, 0.25]). Given these non-significant results, the size of the effects is irrelevant and left out of the result section.

Furthermore, the results of the analysis indicated a non-significant effect of signaling on appealingness (b= 0.13, SE= 0.16, p= .403*).* In addition, a non-significant interaction effect was found (b= -0.38, SE= 0.32, p= .237*).* These results are also confirmed by the fact that the bootstrapped confidence intervals of the moderated mediation index crossed zero (*index*= -0.25, SE= 0.22, 95% BCa CI [-0.70, 0.13]). Again, the results of this moderated mediation analysis are in line with the findings of both factorial ANOVAs, performed in the main analysis. Therefore, including both *animation* and *signaling* in infographics will not result in creating the most persuasive infographics and this interaction is not mediated by an infographic's appealingness. These results reject hypothesis 9.



A-path: $b = 0.20$, $p = .216$, 95% BCa CI [-0.12, 0.51]
B-path: $b = 0.66$, $p < .001$, 95% BCa CI [0.53, 0.78]
C': $b = -0.03$, $p = .746$, 95% BCa CI [-0.22, 0.16]
W → M: $b = 0.13$, $p = .403$, 95% BCa CI [-0.18, 0.45]
Interaction: $b = -0.38$, $p = .237$, 95% BCa CI [-1.00, 0.25]

Figure 7. Moderated mediation model with animation as a predictor of the persuasiveness of infographics, mediated by their appealingness, which is moderated by signaling.

5. Discussion

The current study investigated whether animation and signaling would influence the perceived attractiveness and persuasiveness of an infographic's design. This study reasoned that attractiveness and persuasiveness were linked to each other in a way that attractiveness mediates the persuasiveness of an infographic's design. Nine hypotheses were formulated, tested, and rejected based on the statistical results. The sections presented below will discuss the findings of the current study, as well as potential explanations. Furthermore, the limitations of the present study and directions for future research will be provided.

5.1. Animation and signaling as peripheral cues

An important finding of the current study was that animated infographics were not perceived as more attractive or persuasive compared to static infographics. At the same time, the effects of signaling were not borne out by the data either. As mentioned within the Results section, the hypotheses for both independent variables had to be rejected. These findings are in contrast with the main theoretical reasoning of the present study.

The current study argued that both animated and infographics with visual signals should lower one's cognitive load because they enable viewers to process the stimuli more passively (Mayer et al., 2005; Mayer & Moreno, 2003). Reducing one's cognitive load should enhance their ease of processing, what should have led to a higher perceived appealingness according to the Fluency Theory (Reber et al., 2004). In addition, it was reasoned that the appealingness of infographics is related to the persuasiveness of their design. Lima (2004) stated that the first step in persuasion is to create attention to the message, which appears to be one of the capabilities of an infographic. Infographics are able to attract and maintain one's attention through their visual attractiveness (Clark & Lyons, 2011; Locoro et al., 2017; Matrix & Hodson, 2014). Furthermore, the expected effects for both animation and signaling were in line with various empirical research (e.g., Flavián et al.,

2017; Ozcelik et al., 2010). Therefore, besides testing the direct effects of animation and signaling on appealingness and persuasiveness, a potential mediation effect where the persuasiveness of an infographic's design is mediated by its appealingness was investigated, but not found. Furthermore, there were no interactions between animation and signaling.

In general, the lack of effects might be grounded into three possible reasons. First of all, it might be that animation and signaling did not lower the participants' cognitive load. Although this would not be expected based on previous research (Mayer et al., 2005; Mayer & Moreno, 2003), animation and signaling may have failed to result in a more fluent processing experience. Therefore, animated infographics and infographics that contained visual signals might not have been perceived as more appealing. Another explanation for why there may have been no difference in cognitive load could be that participants were not able to change the timing of the presented stimuli. Although there was a minimum viewing duration for both infographics, participants could not speed up or speed down this process. It might have been that participants viewed the stimuli until they became "bored", what might have overruled any fluency effects. Furthermore, the stimuli used in the current study contained relatively large amounts of text. This might have negatively influenced the processing fluency because it takes more time to finish reading the texts completely.

Second, what might be possible is that participants did not process the stimuli via the peripheral path. Although this was not officially tested, there are indicators for central route processing. Instead of focusing on the design, participants might have considered the content within the infographics during their evaluation. Within the open-ended question, several participants commented about the content of the infographics. For example, one of the participants indicated the following: "It was interesting to see the facts and numbers about the crimes especially.". Another participant stated "I found the first one a bit boring, due to the topic, but the second one was more interesting. However, both infographics became boring after a while.". Finally, another participant answered "I found these infographics better than

the one about Tony's. This one had more facts and numbers, which made them clearer and more appealing.". These responses indicate that participants have read the infographics thoughtfully, which is related to central route processing. This might explain the current results because it appeared that participants did not focus on the design of the infographics. By not focusing on the design of the infographics, the manipulations might have failed to influence one's evaluation of the stimuli in terms of their appealingness and persuasiveness.

Finally, the way animation and signaling were implemented in the infographics might explain the results of the current study. Although animation was operationalized based on Weiss et al.'s (2002) cosmetic definition and signaling on Van Gog's (2014) bottom-up cues, there were no specific instructions provided about how to implement these cues. To implement visual signals in the infographics, some animation was required. For example, in order to isolate the "boxes" of the infographics, some scaling and movement needed to be performed by using animation. Therefore, both manipulations overlap in some way, which might have influenced the results.

5.2. Limitations and suggestions for future research

In order to investigate the effects of animation and signaling on the appealingness and persuasiveness of an infographic's design, a controlled experiment was conducted amongst 91 students of Tilburg University. Validated scales were used to assess participants' appealingness and persuasiveness scores. The experiment had a high internal validity because only the type of peripheral cue was manipulated between each condition, while the content was kept consistent. Additionally, the experiment was conducted in a lab environment. This reduced the influence of confounding variables, such as different screen sizes and distractions. However, although this study has its strengths, the section presented below discusses some limitations.

Regarding the cognitive load and processing fluency, no explicit measures were used in the current study. In order to gain more insights into one's cognitive processes, future studies could include validated measurements to access one's cognitive load and perceived processing fluency. One's perceived cognitive load can be measured based on Paas' (1992) self-reported scale question that ranges from "very low mental effort (1)" to "very high mental effort (7)". Processing fluency can be measured with scale questions like "How easy is it to see this object?" (Reber, 2012). Including these measurements might help to understand the underlying cognitive processes. Measuring one's cognitive load gives insight if the load actually changed after manipulation, or not. If not, other factors might explain the results.

Two other limitations come from the stimuli that are used in the current study. First, the speed in which the animations and visuals cues appeared in the infographics were limited to a predefined pace. This pace was not chosen on theoretical grounds but on a non-scientific pretest, that tested whether individuals were able to read the text within the given time frame completely. Different effects might be found when animation and signaling are implemented at a different pace. For example, it might be that when animation and signaling are implemented at a higher speed, one's ease of processing will be enhanced because it takes less time to process, which might lower the cognitive load. Furthermore, future research could also focus more on ensuring peripheral route processing by using different stimuli that includes less in-depth information to avoid central route processing. These stimuli might, for example, have little text, but larger amounts of visual symbols or illustrations. Furthermore, these stimuli might focus on telling a story, or provide instructions, rather than presenting just facts and numbers. Second, due to practical considerations, only animation was investigated in combination with signaling. However, within Mayer's (2005) Cognitive Theory of Multimedia Learning, animation is part of the Animation and Interactivity principle. Therefore, only one part of this principle was investigated. Future studies might explore this

principle further to find out whether there might be a relation between animation and interactivity, or that they still might be influential independently from each other.

Additionally, future studies might focus more on the initial aim of Mayer's (2005) CTML. Since the CTML is a set of principles designed for learning purposes, future research might combine this with the aim of the current study. This potential future study could examine the effects of animation and signaling in the context of an infographic's attractiveness and learnability. Although being investigated in a web application context, Ngadiman and Sulaiman (2017) already found support for the relationship between attractiveness and learnability. They found that the attractiveness of a web application contributes to the process of making the web application easy to understand and to reduce the time it takes to learn and complete a particular task. In the context of infographics, this might be an interesting study to find out whether infographics are efficient and successful educational resources.

5.3. Conclusion

The current study showed that creating animated or signaled infographics would not automatically lead to a more positive evaluation of their appealingness or persuasiveness. Therefore, designers should carefully consider whether the extra costs (e.g., time and resources) that come with creating such infographics are worth it. However, the lack of effects in the current study does not necessarily mean that there might be no potential effects in other future studies.

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Appendix A

An overview of the stimuli that is used for the present study, including their four conditions.

Infographic 1 | Condition 1: animation (static) | signaling (without visual signals):

https://vimeo.com/373005071/ebf63e84e0

Infographic 1 | Condition 2: animation (animated) | signaling (without visual signals):

https://vimeo.com/373004623/904738823d

Infographic 1 | Condition 3: animation (static) | signaling (with visual signals):

https://vimeo.com/373004224/8f1e04e5d9

Infographic 1 | Condition 4: animation (animated) | signaling (with visual signals):

https://vimeo.com/373003827/dc9139bbfc

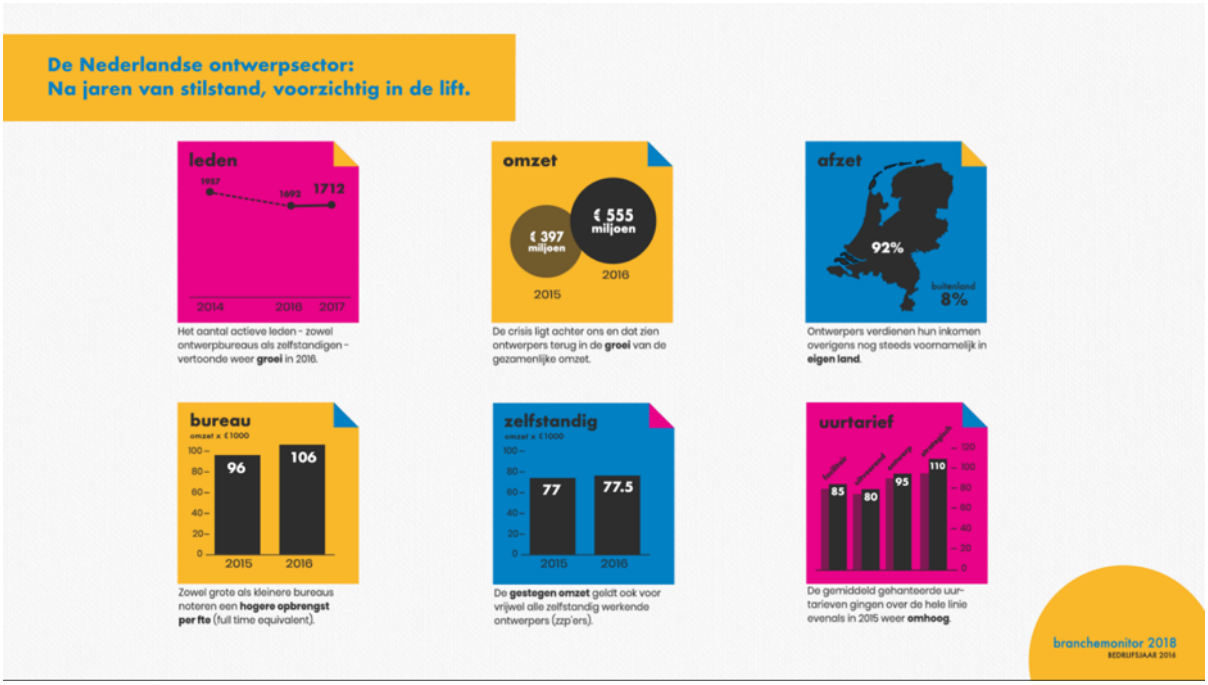

Figure 1. Original infographic 1, adapted from Ruys (2018)

Infographic 2 | Condition 1: animation (static) | signaling (without visual signals):

https://vimeo.com/373003611/cbf809953d

Infographic 2 | Condition 2: animation (animated) | signaling (without visual signals):

https://vimeo.com/373003366/72974f2185

Infographic 2 | Condition 3: animation (static) | signaling (with visual signals):

https://vimeo.com/375896665/2df674fd5f

Infographic 2 | Condition 4: animation (animated) | signaling (with visual signals):

https://vimeo.com/373149320/f0154c2b41

Figure 2. Original infographic 2, adopted from De Nederlandsche Bank (2019).

Appendix B

Table 1.
Appealingness scale (translated into Dutch)

Measurement	**7-point scale**	
	1 =	7 =
APPEAL1	Onaangenaam	Aangenaam
APPEAL2	Slecht	Goed
APPEAL3	Onesthetisch	Esthetisch
APPEAL4	Afstotend	Uitnodigend
APPEAL5	Onaantrekkelijk	Aantrekkelijk
APPEAL6	Onsympathiek	Sympathiek
APPEAL7	Ontmoedigend	Motiverend
APPEAL8	Ongewenst	Wenselijk

Table 2.
Persuasiveness scale (translated into Dutch)

Measurement	**7-point scale**	
	1 =	7 =
ATT1	Onaangenaam	Aangenaam
ATT2 (R)	Grappig om te zien	Niet grappig om te zien
ATT3	Niet vermakelijk	Vermakelijk
ATT4 (R)	Plezierig	Niet plezierig
ATT5	Niet belangrijk	Belangrijk
ATT6	Niet informatief	Informatief
ATT7	Niet nuttig	Nuttig
ATT8	Niet bruikbaar	Bruikbaar

Appendix C

Scatterplots for the simple mediation analysis with animation as independent variable.

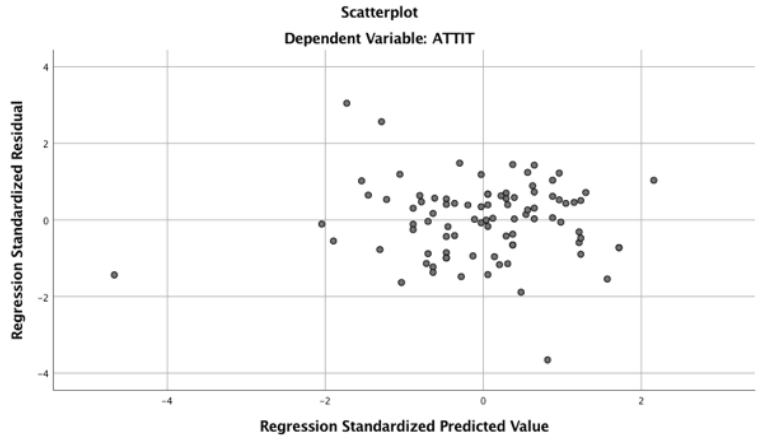

Figure 1. Scatterplot for the residuals.

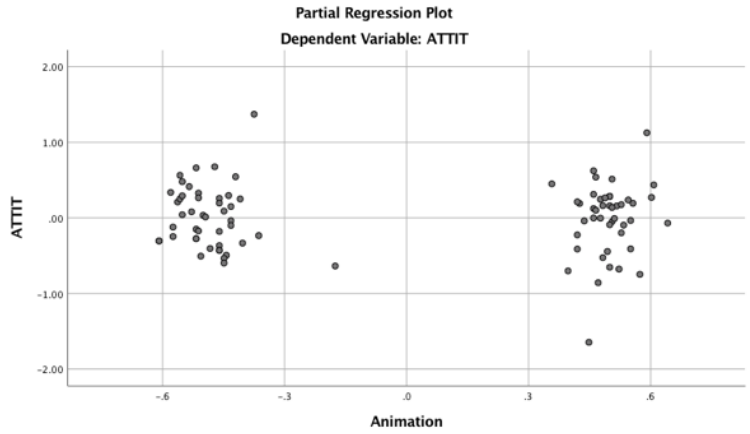

Figure 2. Scatterplot for animation and the dependent variable.

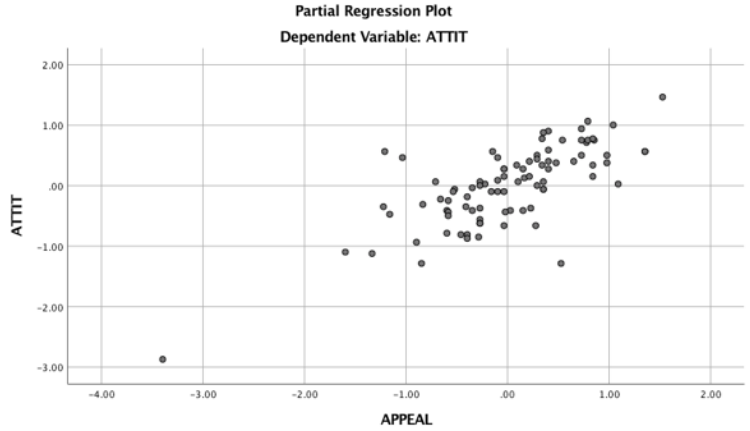

Figure 3. Scatterplot for the mediator and dependent variable.

Appendix D

Scatterplots for the simple mediation analysis with signaling as independent variable.

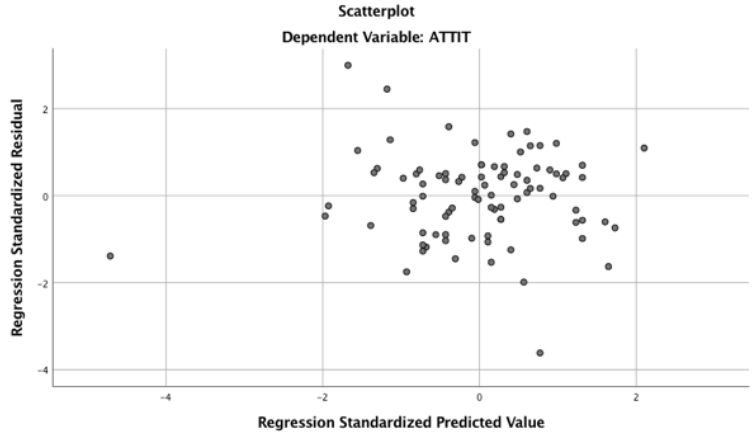

Figure 1. Scatterplot for the residuals.

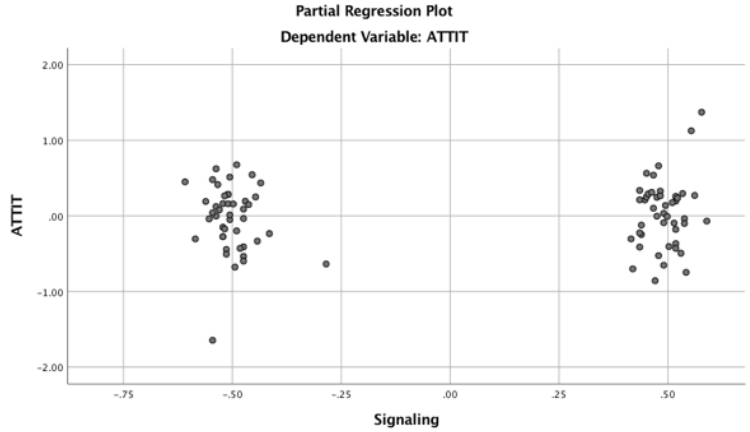

Figure 2. Scatterplot for signaling and the dependent variable.

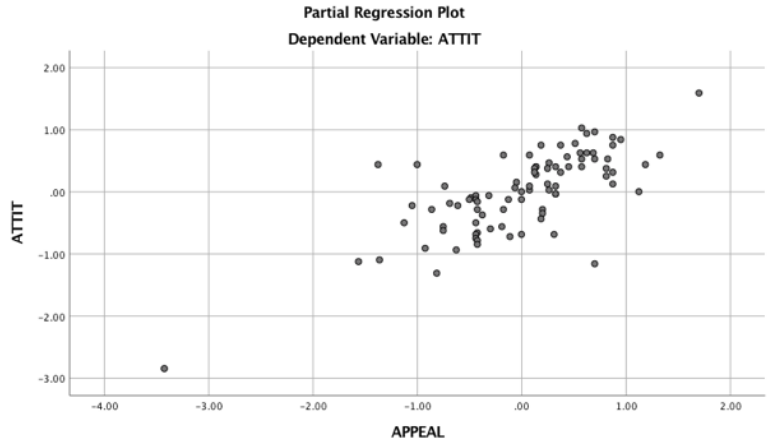

Figure 3. Scatterplot for the mediator and dependent variable.

Appendix E

Scatterplots for the moderated mediation analysis with animation as independent variable and signaling as moderator.

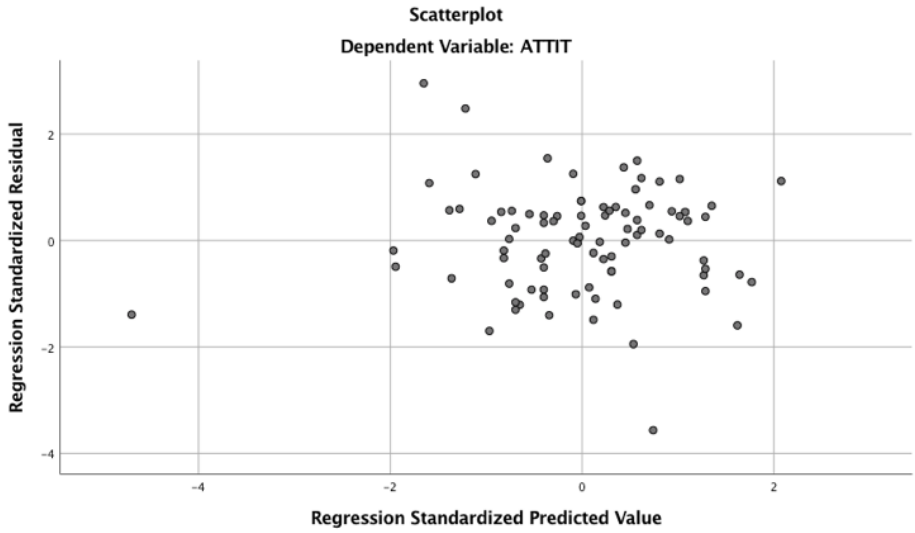

Figure 1. Scatterplot for the residuals.

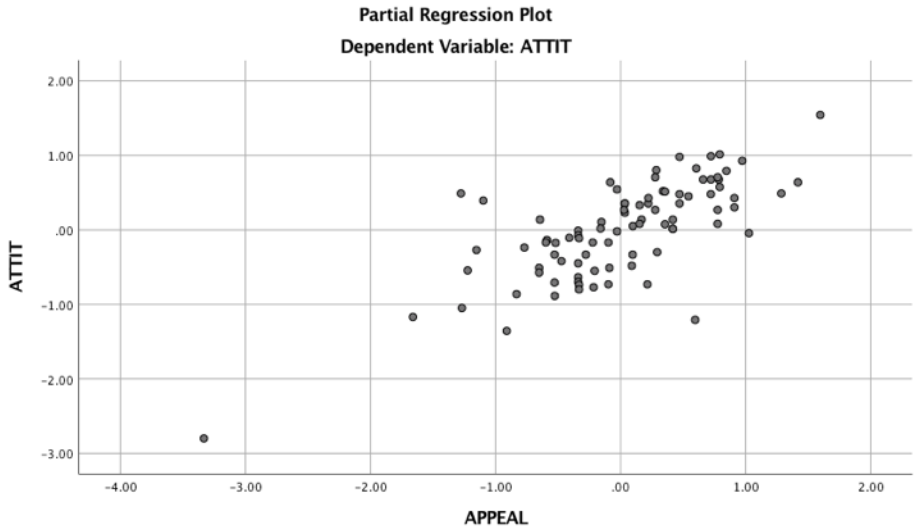

Figure 2. Scatterplot for the mediator and dependent variable.

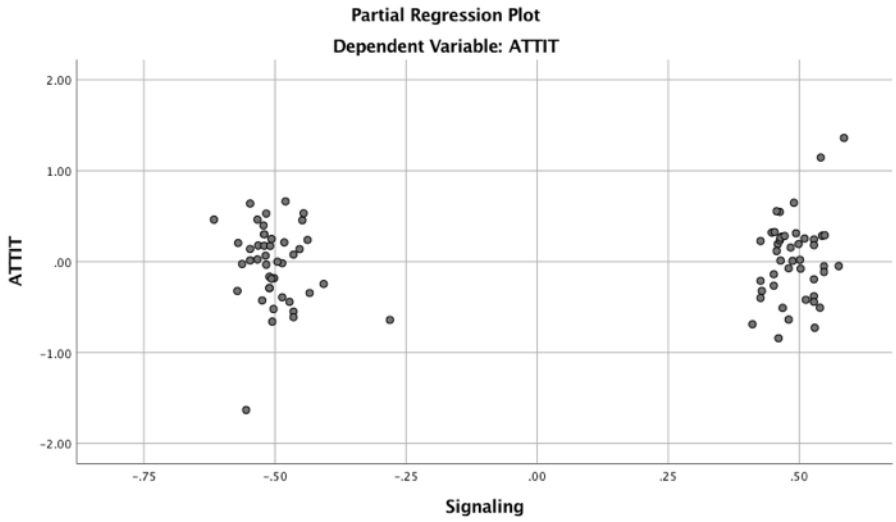

Figure 3. Scatterplot for signaling and the dependent variable.

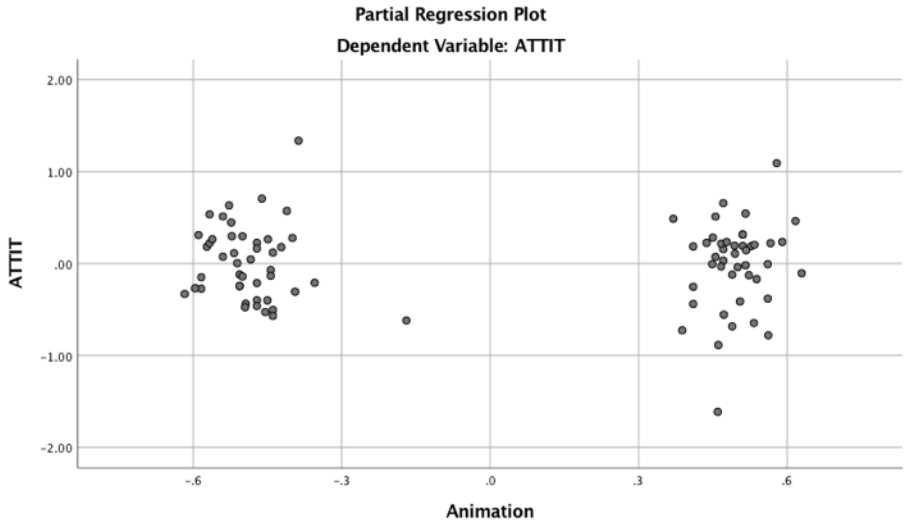

Figure 4. Scatterplot for animation and the dependent variable.