Making Sense of Digital Innovations: The Role of the Material Artefact

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Short Paper

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Abstract

Users' perceptions of a material artefact hold important implications of how they make sense of a digital innovation, expressed in their technological frames about the innovation. Yet, research on sensemaking offers little insights on the role of the material artefact for shaping users' technological frames. This paper proposes a 2x2 experiment to investigate how newness as a crucial aspect of the material artefact influences users' frames. Based on theories of resonance, we assume that this effect is mediated by cognitive and emotional resonance. We manipulate the technical and design newness of smart speakers to investigate our research model. Our findings contribute to research on technology sensemaking by illuminating the role of the newness of the material artefact. For developers, our results indicate how users' understanding can be shaped by embodying familiar and non-familiar cues in digital innovations.

Keywords: Sensemaking, technological frames, resonance, material artefact, digital innovations

Introduction

A social construction perspective on technology implies that technological artefacts are characterized by interpretative flexibility in terms of how individuals make sense of a new technology (Rindova and Petkova 2007). Technologies can be interpreted differently, depending on, e.g., users' hopes and anxieties (Prasad 1993). For companies developing innovations, this makes it difficult to anticipate the meaning users ascribe these innovations and to predict their success (Mesgari and Okoli 2018). Consequently, it is of paramount importance to better understand how individuals make sense of new technologies.

While there is a large body of research on technology sensemaking and related topics, most studies focus on social and cognitive explanations and neglect the role of the material artefact (Mesgari and Okoli 2018). They concentrate on the meaning invented in the human mind guided by social interactions, but do not grasp how users' understanding of a technology is influenced by the meaning embedded in the material artefact. Yet, this meaning is highly relevant, as the newness of an artefact demonstrates. Literature shows that technical newness and design newness of the material artefact impact how users perceive a technology (e.g. Mugge and Dahl 2013). For example, the design of the TiVo digital video recorder reminded users of the well-known VCR and thus enabled them to quickly understand the value of the new technology (Hargadon and Douglas 2001). However, the high visual similarity to the VCR dampened users' emotional excitement about the technology (Rindova and Petkova 2007).

This example shows that the artefact and especially its newness have a crucial role in sensemaking. To better understand this role, we investigate newness as a characteristic of the material artefact and its effect on sensemaking. Based on theories of resonance (Giorgi 2017), i.e. explanations of how users connect to an object, we postulate that this effect is mediated through cognitive and emotional resonance towards the material artefact. Cognitive resonance refers to a technology's compatibility with users' values and experiences. Emotional resonance focuses on users' emotional attachment to a technology (Giorgi 2017). The outcome of the sensemaking process can be assessed through technological frames, i.e. users' mental models of a technology (Orlikowski and Gash 1994).

To sum up, our aim is to show how the newness of the material artefact influences user's emotional and cognitive resonance, which in turn affect how users make sense of the artefact, captured through users' technological frames. Our first research question refers to the impact of the material artefact and users' cognitive and emotional resonance (e.g. Giorgi 2017), while our second research question refers to the effect of cognitive and emotional resonance on technological frames (e.g. Orlikowski and Gash 1994).

RQ1: How does the newness of the material artefact influence users' cognitive and emotional resonance?

RQ2: How does cognitive and emotional resonance influence users' technological frames?

To examine these questions, we investigate how users make sense of smart speakers. With their revolutionary voice-based control and the fast introduction of new designs, most recently the addition of touchscreens, smart speakers represent an interesting object of investigation. This is especially true because the idea of smart speakers raises conflicting opinions about the potential benefits and threats of the technology (Kowalczuk 2018) and, thus, the technological frames users have about the technology.

In an experiment we manipulate the technical newness and the design newness of a smart speaker and investigate how this affects participants' sensemaking processes. We focus on initial sensemaking, i.e. users' early exposure to a technology, as sensemaking at this stage is particularly influential (Orlikowski and Gash 1994; Mesgari and Okoli 2018). The findings of our study extend literature on sensemaking and technological frames by emphasizing the role of the material artefact and its effect in sensemaking. We especially show that individuals make sense of digital innovations through intertwined cognitive and emotional processes. These findings are also relevant for IS research streams that deal with technological frames, new product development, resonance, and framing effectiveness. Furthermore, our findings have important implications for technology developers regarding the development of digital innovations to elicit cognitive and emotional resonance to positively influence users' technological frames.

Theoretical Background

Sensemaking and technological frames

Sensemaking can be defined as the "processes of meaning construction whereby people interpret events and issues […] that are somehow surprising, complex, or confusing to them" (Cornelissen 2012, p. 118). Technology sensemaking focuses on the process through which individuals and groups form understandings of a new technology and attach an appropriate meaning to it (Mesgari and Okoli 2018). This includes forming assumptions, expectations, and knowledge of an information system which then serve as a basis for interacting with the system (Orlikowski and Gash 1994).

Cognitive research on technology sensemaking states that sensemaking is implicitly guided by mental models, which comprise individuals' understandings and interpretations of a technology. Orlikowski and Gash (1994) refer to those mental models as technological frames, which encompass assumptions, expectations, and knowledge about a technology. Consequently, technologies are equivocal and can be interpreted in many ways (Weick 1990). Different people can have different technological frames, reflecting these peoples' hopes, anxieties, dreams, and deficiencies (Prasad 1993). When members of a group have similar frames, we speak of congruent frames, while differences in frames are addressed as incongruent frames (Orlikowski and Gash 1994). The latter occur when technology users have different understandings of the same system. Different technological frames lead to diverging attitudes towards a technology and differences in whether users accept or reject the technology (Savoli and Barki 2013).

Several studies on technology sensemaking show that users hold either benefit frames of a technology, emphasizing the possible gains associated with the technology, or threat frames, focusing on possible negative implications of the technology (Mishra and Agarwal 2010). Thus, we refer to technological frames as mental models of a technology, encompassing the perceived benefits as well as the perceived threats of a technology. For example, Treem et al. (2015) identified employees' conflicting understandings of an enterprise social media system. While some employees focused on benefits and saw the system as an opportunity, e.g., to facilitate knowledge sharing, other employees emphasised negative aspects, which lead them to perceive the system as a threat that distracts from other tasks. Similar findings have occurred in other contexts (e.g., Savoli and Barki 2013), also showing that users' evaluation of the benefits and threats associated with a technology and the resulting technological frames determine use behaviour.

Newness of the material artefact

Users' sensemaking about a new technology is influenced by how they perceive the material artefact (Mesgari and Okoli 2018). Materiality is defined as the fixed properties intrinsic to technological artefacts, which comprise the physical and the digital material of a technology (Leonardi 2012). Such artefacts are socially constructed, which suggests that there is not just one way to design a technology, but that developers can design the artefact in different ways, depending on the meaning they want to assign the technology (Pinch and Bijker 1984). By embodying novel technologies with specific technical and design features, innovating firms can equip the material artefact with cues that guide users' understanding of the technology towards the desired outcome (Rindova and Petkova 2007). Likewise, users understand and interpret the material artefact in multiple ways (Pinch and Bijker 1984). When individuals are confronted with a new technology for the first time, they seek analogies to existing products to reduce the uncertainty associated with the new technology and to assess its value (Rindova and Petkova 2007). By transferring knowledge from a familiar product category to the new one, individuals try to understand and interpret the novel technology through drawing on familiar mental schemas. These guide users' perception of cues embedded in the material artefact (Rindova and Petkova 2007).

Consequently, technology developers can reduce a technology's interpretative flexibility by incorporating familiar stimuli in the material artefact (Rindova and Petkova 2007) and determine how they want to frame a technological product (Benner and Tripsas 2012). The chosen features determine the technical newness of an innovation (Rindova and Petkova 2007). The more the technical features of an innovation differ from features of other existing products, the higher is the innovation's degree of newness (Talke et al. 2009). In other words, products that are characterized by a high technical newness imply a large deviation from users' existing mental schemas (Mugge and Dahl 2013), which is often associated with high uncertainty (Rindova and Petkova 2007). In contrast, a technology that matches existing mental schemas is more likely to trigger familiarity and perceived safety. Besides varying the degree of technical newness, users' perception of a technology can also be influenced by its design (Talke et al. 2009). The design of a product refers to its observable exterior features including colours, materials, shapes, and proportions that characterise its physical appearance (Rindova and Petkova 2007; Talke et al. 2009). Similar to technological features, developers can use a product's design to shape the perception of a technology by providing cues that guide users' sensemaking (Rindova and Petkova 2007). For example, when the TiVo digital video recorder was introduced, its design provided visual cues that highlighted its similarity with a VCR (Hargadon and Douglas 2001). Exploiting the well-established understanding of the VCR enabled TiVo to create a quick understanding and gain rapid acceptance among potential customers by presenting itself as an advanced generation of VCRs. Thus, the similarity of visual attributes of a technology with other products affects how a product is categorized and understood (Mugge and Dahl 2013). The degree to which a product's visual appearance matches that of other products in its category determines the design newness of a technology (Talke et al. 2009). The less visual features a product shares with other competing products, i.e. the higher its design newness, the more it is perceived as atypical and unfamiliar (Mugge and Dahl 2013).

Cognitive and emotional resonance

In the context of influencing the sensemaking process, framing can be seen as a tool for shaping others' understandings by directing their attention through inclusion and exclusion of certain information (Giorgi 2017). In order to determine the success of the framing effort in achieving a certain outcome, scholars propose the concept of resonance (Snow et al. 1986). Giorgi (2017) defines resonance as "an audience's experienced personal connection with a frame" (p. 716). Two main pathways determine framing effectiveness: the personal connection with the audience can be experienced at the cognitive level, as an alignment with the audience's beliefs and values, or at the emotional level, as an alignment with the audience's feelings and desires (Giorgi 2017). Therefore, eliciting resonance can be seen as a tool for generating support for a new technology through either an appeal to users' cognition or emotions.

The first pathway for achieving resonance is through an appeal to the audience's cognition. In other words, a framing effort is successful when it is perceived as compatible with the understandings and beliefs that are central to the target audience (Giorgi 2017). The framing literature stresses the importance of addressing individuals' experiences and most salient values to convince them to support an idea (Snow et al. 1986). If an individual perceives an innovation as compatible with his or her past experiences and existing values, uncertainty can be reduced by evoking a sense of familiarity (Rogers 1995). Scholars differentiate between compatibility with prior experiences and compatibility with values (Tornatzky and Klein 1982). First, as individuals use previously introduced ideas as mental tools to ascribe a meaning to new ideas, an innovations' compatibility with prior experiences is crucial for its success (Rogers 1995). A famous example of an innovation that resonated with the general public because of its compatibility with previous experiences is Edison's electric lighting, which established a sense of familiarity through its similarity with the well-known gas lighting (Hargadon and Douglas 2001). Second, new ideas should align with individuals' values (Rogers 1995). An example of an innovation which failed to resonate with the values of its time is the Audi A2. When the Audi A2 was introduced in 2000, its advanced, lightweight body structure couldn't convince potential customers because it was "too early" to build a car around values such as sustainability and environmental consciousness. To sum up, we refer to cognitive resonance as achieving compatibility with both users' prior experiences as well as their values.

The second pathway to resonance is by evoking an emotional reaction. Organizational and management literature suggests that emotions have a strong influence on sensemaking. Therefore, emotional arousal can serve as a powerful tool to guide sensemaking and support the development of strong beliefs (Weick et al. 2005). Giorgi (2017) argues that the main mechanism for achieving emotional resonance is identification. In other words, if an individual identifies with a product, i.e. her individual beliefs about the product become self-defining, this identification triggers emotional attachment. Emotions can thus influence the sensemaking process through entangling a product with individuals' identity and thereby influence their behaviour through evoking passionate identification (Giorgi 2017). Therefore, emotional resonance can be used as a powerful tool for differentiating from competitors by enhancing customers' emotional attachment to products and ideas (Giorgi 2017). A popular example of a company that sets itself apart from its competitors by encouraging emotional attachment to its products and ideas is Apple. When presenting new products, Apple always embraces passion and emphasizes how the new product will change customers' lives (Gallo 2010). As a consequence, Apple has succeeded in creating passionate identification with its products, both within and outside organizational boundaries (Giorgi 2017). In summary, we define emotional resonance as users' emotional attachment to an innovation, which encompasses feelings of passion, referring to intense and aroused positive feelings, as well as feelings of connection with the innovation (Thomson et al. 2005).

In conclusion, framing effectiveness can be achieved through cognitive resonance based on compatibility with the target audiences' values and experiences as well as through emotional resonance based on identification with the audiences' feelings and desires. But cognition and emotion should not only be seen as mutually exclusive ways to achieve resonance. Often, they are deeply intertwined in shaping the meaning the audience ascribes to a particular product (Giorgi 2017).

Hypotheses

Our research model (see Figure 1) depicts how users' sensemaking of a technological artefact is influenced by emotional and cognitive resonance. In the first part, we investigate how the newness of the material artefact influences users' cognitive and emotional resonance. In the second part, we examine the influence of cognitive and emotional resonance on users' technological frames.

Individuals' perception of novel technologies is based on cognitive and emotional evaluations of the artefact. This assumption of a "holistic, cognitive-emotional nature of perception" (Rindova and Petkova 2007, p. 227) is grounded in Piaget's theory of schemas. Piaget and Cook (1952) refer to schemas as mental structures that help to understand the world based on existing knowledge. Through their mental schemas, individuals compare new situations with their knowledge about past experiences. Congruity triggers cognitive evaluation and incongruity evokes emotional evaluation (Mandler 1981). Accordingly, we argue that users' sensemaking about technologies depends on (in)congruity with existing mental schemas, i.e. the perceived newness, which affects the cognitive and emotional evaluation of a technology.

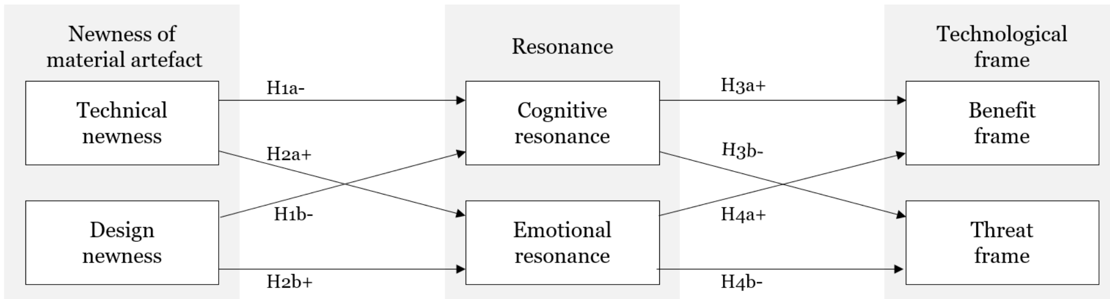

Figure 1. Research Model

In the case of congruity, i.e. the novel situation is similar to an existing schema, no important changes in mental schemas are necessary, and the situation is evaluated positively due to experienced familiarity (Mandler 1981). If a technology is characterized by low newness, users can apply analogical reasoning and transfer knowledge from mental schemas of familiar products to the new technology (Rindova and Petkova 2007). Therefore, they might experience high compatibility with their values and experiences. In contrast, products that are characterized by high technical newness, i.e. substantial changes in technology features, imply a large deviation from users' existing schemas (Mugge and Dahl 2013). Because of the incongruity with existing schemas, users are not able to apply analogical reasoning to make sense of the new technology features (Rindova and Petkova 2007). Therefore, we argue that technical newness negatively influences cognitive resonance, i.e. the compatibility with users' values and prior experiences.

H1a: Technical newness of the material artefact negatively influences cognitive resonance.

Besides low technical newness, another way to elicit cognitive resonance is by providing visual cues that facilitate the sensemaking process through activating available schemas (Rindova and Petkova 2007). By embodying technologies in familiar forms that resemble existing products, designers can support users by transferring knowledge from available schemas to the new technology (Rindova and Petkova 2007). The example of Edison's electric lighting shows that high visual similarity with the well-known gas lighting positively affected its compatibility with prior experiences (Hargadon and Douglas 2001). Consequently, we suggest that high design newness of the material artefact decreases users' cognitive resonance.

H1b: Design newness of the material artefact negatively influences cognitive resonance.

In the case of incongruity, i.e. a novel situation does not fit existing schemas, a modification of schemas is necessary, and this interruption of expectations evokes emotional arousal, also referred to as passionate emotional evaluation (Mandler 1981). Likewise, Rindova and Petkova (2007) suggest that perception of novelty elicits emotional reactions. A low newness, on the other hand, might decrease users' emotional excitement (Rindova and Petkova 2007). Furthermore, as radical innovations, i.e. technologies with high technical newness, are characterized by improving the fulfilment of customer needs (Chandy and Tellis 1998), Chaudhuri et al. (2010) suggest that radical innovations elicit positive emotions by evoking positive disconfirmation with available schemes. In a study they show that radical innovations evoke arousal, whereby the positive emotions associated with the innovation outweigh the negative emotions. Thus, we hypothesize that technical newness of the material artefact has a positive effect on emotional resonance.

H2a: Technical newness of the material artefact positively influences emotional resonance.

In addition, technologies with high design newness evoke emotional excitement. Yalch and Brunel (1996) show that a unique product design elicits psychological arousal and enables users to enhance their self-identity by expressing their "sophisticated" taste. For example, when Apple's iMac was introduced, its innovative design expressed a distinctive personality and thus evoked emotional excitement among the general public (Barlow and Maul 2000). By contrast, the TiVo digital recorder, which was designed to visually resemble the VCR, failed to evoke emotional excitement due to its high visual similarity with existing mental schemas (Rindova and Petkova 2007). Following these insights, we hypothesize that design newness of the material artefact positively influences emotional resonance.

H2b: Design newness of the material artefact positively influences emotional resonance.

Giorgi (2017) suggests that cognitive resonance, i.e. compatibility with experiences and values, encourages individuals to positively evaluate ideas and products. A tendency to positively evaluate the familiar is also demonstrated by the exposure effect (Zajonc 1968), which states that "mere repeated exposure of an individual to a stimulus object enhances his attitude toward it" (p. 23). In other words, the exposure effect indicates that repeated exposure to a stimulus increases the probability of positively evaluating this stimulus. The example of Edison's electric lightning also shows that familiarity resulting from high compatibility with experiences enables users to quickly understand the benefits of a technology and elicits a positive evaluation (Hargadon and Douglas 2001). Thus, we suggest that users are more likely to develop benefit frames of a new technology when it is compatible with their prior experiences and values.

H3a: Cognitive resonance positively influences benefit frame.

Unfamiliar situations with low compatibility, on the other hand, elicit rather negative evaluations because they are associated with uncertainty and conflict (Zajonc 1968). Similarly, Mugge and Dahl (2013) argue that low compatibility entails great uncertainty as the limited knowledge transfer from existing schemas makes it more difficult to make effective use of the technology and detect its benefits. Consequently, we suggest that low compatibility with users' prior experiences and values increases the threats associated with the technology, while high compatibility decreases users' threat frames.

H3b: Cognitive resonance negatively influences threat frame.

Besides cognitive resonance, Rindova and Petkova (2007) suggest that users' perception of the potential value of an innovation is influenced by their emotional response towards the product, i.e. by intense and aroused positive feelings as well as feelings of connection with the innovation. Likewise, Giorgi (2017) states that individuals positively evaluate a product when they feel emotionally attached to it. This positive relationship between emotional resonance and evaluation of a product can be explained by the affect-as-information theory (Schwarz and Clore 1983). It states that people often ask themselves "How do I feel about it?" when making judgements. Therefore, emotional reactions serve as important information when making evaluative judgements (Schwarz 1988). Positive feelings associated with the object of evaluation generally lead to positive judgements (Storbeck and Clore 2008). Thus, we hypothesize that emotional resonance positively influences users' benefit frames.

H4a: Emotional resonance positively influences benefit frame.

Furthermore, we suggest that emotional resonance reduces users' threat frames. By investigating the undoing effect of positive emotions, Fredrickson et al. (2000) show that positive emotions help individuals to manage threating situations and reduce anxiety. When people have intense and aroused positive emotions and feel a connection to a product, it is unlikely that they put emphasis on threats. Instead, even positive illusions can occur, leading to distortions of negative feelings in favour of positive ones (Biggane et al. 2016). Therefore, we suggest that positive emotions decrease the threats associated with a new technology.

H4b: Emotional resonance negatively influences threat frame.

Taken together, these hypotheses indicate that cognitive and emotional resonance help to positively shape users' technological frames, as both enhance benefit frames and reduce threat frames. However, the material artefact has a controversial role: On the one hand, its newness decreases cognitive resonance, on the other hand, this newness increases emotional resonance. This highlights that the meaning embedded in the material artefact is indeed crucial to understand sensemaking. Our results will show which kind of resonance overweighs the other, allowing for interesting insights as well for academics as practitioners.

Method

To test the hypotheses, we conduct a quantitative experiment investigating how individuals make sense of smart speakers. Such speakers can play music similar to conventional loudspeakers but are digitally connected to allow for added functionality. In advanced forms, they react to users' voice commands and have a camera for video calls as well as a touchscreen to display content. With a current market diffusion of less than 25% of households even in technologically advanced countries like the US (Kinsella 2019), smart speakers are sufficiently new to provide meaningful results.

We conduct an experiment with at least 120 participants in a 2 × 2 full factorial design using all four combinations of the two independent variables: (1) technical newness and (2) design newness. Low design newness refers to smart speakers that resemble smartphones that stand upright, such as the Amazon Echo Show. High design newness refers to smart speakers with unusual appearance, such as the Amazon Echo Spot. In the low technical newness condition, participants receive one of these devices without voice and video call functionality, i.e. they can use the smart speaker similar to a smartphone, but with restricted capabilities. In the high technical newness condition, both features are available, i.e. interaction through voice commands and video calls are possible. Participants get one of these devices for home use and have to fill out a questionnaire after the initial sensemaking period is over.

Figure 2. Experimental Design (© Amazon.com, Inc.)

To verify whether these stimuli are perceived as intended we conduct a pretest measuring design newness and technical newness. For measuring design newness, a scale from Mugge and Dahl (2013) is adapted and anchored by "old/novel," "not original/original," and "not (as) innovative/ innovative". For assessing technical newness, also a scale from Mugge and Dahl (2013) is used. In the actual experiment, participants are asked to evaluate the treatment stimulus through several multi-item measures. Cognitive resonance is assessed using a scale adapted from Karahanna et al. (2006) that encompasses compatibility with prior experiences and compatibility with values. To assess emotional resonance, we cover feelings of passion towards the technology as well as feelings of connection by adapting a scale of Thomson et al. (2005), which covers both connection as well as passion towards the technology. Finally, users' technological frames are assessed through benefit frame and threat frame. To measure the benefit frame, we adapt the relative-advantage scale from Moore and Benbasat (1991) as the relative advantage of an innovation refers to its benefits compared to previous technologies. The threat frame is assessed using a scale adapted from Peacock and Wong (1990) anchored by "threating situation", "feel anxious", "negative outcome", and "negative impact". As control variables, we use different personality traits, because risk-averse or conservative participants could react substantially different from innovative participants; previous experience with different kinds of smart speakers, because this might influence the level of newness participants perceive; previous negative or positive experiences with similar artefacts, because especially negative experiences related to artefacts with a small level of newness have the potential to affect results; and aesthetic appeal of the design, as this could affect results besides design newness.

The subsequent data analysis is performed using IBM SPSS Statistics 23 to evaluate component structure and to conduct a between-subject analysis via ANOVA. Relationships in the model are further investigated using partial least squares structural equation modelling with SmartPLS 3, also employing multi-group analyses to compare path coefficients (Ringle et al. 2015).

Outlook and Implications

The findings of our study will provide important implications. First, they extend existing literature on technological frames by investigating how the material artefact influences individuals' sensemaking process. According to our model, this influence differs depending on whether individuals' respond cognitively or emotionally to the artefact's newness. Second, our findings contribute to existing technology sensemaking literature by examining the previously mainly qualitatively explained genesis of technological frames in a quantitative experiment, thus providing generalizable evidence on the influence of the material artefact as well as on the influence of cognitive and emotional resonance. Third, our findings provide practical implications for technology developers on how to design a technology to elicit cognitive and emotional resonance and thus positively influence users' technological frames.

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