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Relevance of Visitors' Personal Context for Learning Outcomes in a Science Museum

Visit Motivation, Text Comprehension and Attitude Change

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Voor jou, mam.

Abstract

This thesis is the result of a combination of studies that were carried out during the final two phases of a 5-year research project titled: user-specific presentation of knowledge with conflicting evidence in museums. The term ‘user-specific’ is a central theme in this thesis and refers to a focus on the visitor as active, self-determined user of the museum’s content and as individual learner. To understand this learner’s needs and guide or predict their learning outcomes an understanding of visitors’ personal context is pivotal. A fundamental aspect of a visitor’s personal context and a motivational starting point of the visit is their visit motivation. Two of the studies in this thesis deal with visit motivation, which can be seen as a situational reflection of a visitors’ various personal context elements that bring them to that particular museum on that particular day. The first study describes the development of a short scale that validly and reliably measures visit motivations within and across educational leisure settings. The second study applies this short scale in a nano- and biotechnology exhibition and investigates associations between visit motivation and a selection of visit attributes and visitor characteristics. Findings from these two studies provide insights into differences in visit motivation across three different sites and into the way visit motivation is embedded in visitors’ wider personal context. In addition to that, the developed short scale itself is a valuable result and useful tool for future research. A second term drawn from the title of the overarching research project above is ‘conflicting evidence’. This refers to the nature of many science and research topics that have found their way into contemporary science and technology exhibitions and forms the backdrop of this thesis. Conflicting information in the museum can be challenging for visitors to deal with and each visitor will deal with such information in their own way. Drawing on a risk–benefit interpretative text as an example of this type of information, studies two and three explore the relevance of visitors’ personal context for two different types of learning outcome. Study two investigates the way specific elements of a visitor’s personal, motivational background influence visitors’ text comprehension. Study three investigates if processing this information can lead visitors to change their attitude and to what extent visitors’ attitudinal background influences that change. Findings from studies two and three make a small but valuable contribution to our understanding of the relevance of visitors’ personal context when dealing with risk–benefit science information in the museum. Merits and limitations of the studies are discussed with regards to broader theories on museum learning and motivation, with regards to previous findings, implications for practice and recommendations for further research.

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Contents

1. Introduction

This thesis is the result of a combination of studies that were carried out during the final two phases of a 5-year DFG funded research project titled: user-specific presentation of knowledge with conflicting evidence in museums (SPP1409 - LE 1303/8-2 & -3). Keywords in this project title, besides the word museums of course, are ‘user-specific’ and ‘conflicting evidence’. The term user-specific refers to a visitor-centred approach when presenting museum content and, consequently, when researching museum learning. The individual visitor and the role their personal context plays in museum learning forms a central theme in this dissertation. The term ‘conflicting evidence’ refers to the nature of many science and research topics that have found their way into contemporary science and technology exhibitions and forms the backdrop of this thesis. Conflicting information in the museum can be challenging for visitors to deal with as I will describe below. In this introduction, I will start by describing different models of museum learning as a broader theoretical framework for the studies described in this thesis. As part of the section on museum learning, I will take a closer look at text comprehension and attitude formation as they are directly relevant to the studies in this thesis. I will then move on to motivation, which is central to museum learning and describe visit motivation and how it forms a fundamental situational part of visitors’ personal context. As the studies discussed in this thesis took place in a contemporary science exhibition, I will proceed by discussing some of the themes addressed in such exhibitions and why these inevitably involve ‘conflicting’ information. This term merges with the term ‘user-specific’ when I describe how (parts of a) visitors’ personal, motivational background can play a role when dealing with conflicting science topics in the museum. The introduction ends with a brief summary and six main research questions that are drawn from and addressed in the three studies included in this thesis. With the studies described in this thesis, their findings and the individual and overarching discussion, I hope to make a small contribution to our understanding of visit motivation on the one hand and the relevance of visitors’ personal context for learning outcomes in a science museum on the other.

1.1. Learning in the museum

In the classical sense, a museum is a “building in which objects of historical, scientific, artistic, or cultural interest are stored and exhibited” (Oxford Dictionaries, 2018). This, however, is a narrow and outdated description of museums today. The international council of museums currently offers the following definition:

"A museum is a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment" (ICOM, n.d.).

The first mentioned purpose of museums in this definition is education. This purpose is reflected in the museum research literature, where museums are also known as educational leisure settings, informal learning settings, or free-choice learning settings (Falk & Dierking, 1998, 2013). The term 'educational leisure setting' emphasises the museum as a place of teaching and learning that one can attend in one's leisure time. The term 'informal learning' serves to separate museum learning from learning that takes place in formal learning settings, such as schools. The term 'free-choice learning' serves a similar purpose but additionally hints at what museum learning entails, namely something that is done voluntarily. This aspect of free-choice is one of the key elements that make museum learning fascinatingly difficult to grasp. To comprehensively describe museum learning is an enormous challenge and ongoing endeavour of museum researchers and practitioners everywhere (Hohenstein & Moussouri, 2018). Thankfully, there are some theories and models that have helped frame museum studies and have greatly increased our understanding of museum learning. Possibly the most well-known of these is the contextual model of learning (CML; Falk & Dierking, 2013). The CML is a framework aimed at uncovering and organising the complexity of the museum learning experience. It describes this experience as an interaction between three contexts: the personal context, the sociocultural context, and the physical context (Falk & Dierking, 2013). The personal context refers to visitors' background of prior experiences and knowledge for example, but also "individual interests, attitudes and motivations for visiting" (Falk & Dierking, 2013, p. 27). The sociocultural context includes the visitors' cultural background, the cultural setting of the museum as well as the social interactions taking place during the visit. Such social interactions include those between friends or family members that visit together, between (unfamiliar) visitors and between visitors and museum staff. The physical context describes the architectural and design features of the museum, its exhibitions, and exhibits (Falk & Dierking, 2013). Besides these three contexts, the CML also includes the element of 'time'. Falk and Dierking explain that a museum visit is essentially a "snapshot in time" (2103, p. 29). In order to understand and predict (parts of) the museum experience, we need to look at how the museum visit fits within the larger context of a person's life and within the shifting role of the museum in society. Time also serves to illustrate the dynamic interaction between the three contexts, where the influence of each of these on a visitor's experience fluctuates over time (Falk &

Dierking, 2013). Following the CML's element of time, museum learning does not only take place during the visit. It builds on the various learning experiences that took place before a visit and on the prior knowledge, the interests and attitudes that people bring with them to the visit. Museum learning also continues after the visit through additional learning experiences that together contribute to a life-long increase in knowledge and changes in attitudes or behaviours. Although the CML is a useful framework for understanding museum learning, it is, as the name indicates, a model rather than an actual theory of learning (Hohenstein & Moussouri, 2018). The CML is inspired by the educational theory of constructivism (Falk, 2007). Constructivism postulates that knowledge consists as constructs in the individual mind, rather than something that exists outside the learner (Schunk, 2012). Consequently, in constructivism, learning is seen as an active process requiring the learner to make sense of what is presented to their mind and leading to a restructuring of existing mental structures (Hein & Alexander, 1998; Schunk, 2012). This theory fits well with the reality of museum learning as it puts the learner in control of what will be learnt and does not expect learning to follow a specific curriculum (Allen, 2004; Hein & Alexander, 1998; Hohenstein & Moussouri, 2018). Besides being directly applied as theoretical framework in various museum studies (e.g. Allen, 2004), constructivism also gave rise to another model designed to capture museum learning: the generic learning outcomes (GLO; Hooper-Greenhill, 2004). The GLO were developed by the Research Centre for Museums and Galleries in an effort to measure the various possible outcomes of learning in cultural institutions (Hooper-Greenhill, 2004). The development of the GLO appears to be driven by the need for such institutions to convince policy makers and financiers of their educational impact (cf. Hooper-Greenhill, 2007). This led to a broad understanding of learning translated into five learning outcome categories: knowledge and understanding; skills; attitudes and values; enjoyment, inspiration and creativity; and activity, behaviour, and progression (Hooper-Greenhill, 2007). These five broad categories of museum learning each encompasses various subcategories. Skills for example, involve social, emotional and physical skills, but also cognitive or intellectual skills, such as critical and ethical thinking (Hooper-Greenhill, 2007). With its focus on outcomes as a framework to study museum learning the GLO approach clearly differs from the CML. While the CML attempts to unveil and classify the many aspects that contribute to museum learning, the GLO illustrate that these aspects yield many possibilities for learning. Each in their own way are helpful tools when studying museum learning, and I will refer back to these models when framing the studies described in this thesis and discussing their merits and limitations. I will now briefly describe two aspects of museum learning that are directly relevant for the studies described in this thesis, one being text comprehension, and the other attitude change.

1.1.1. Text comprehension

Although objects and visualisations have always played a central role in the museum, texts are still the main medium for conveying knowledge (Dawid & Schlesinger, 2002; Kanel & Tamir, 1991). Texts can be found throughout the museum and serve to provide information, explain or personalise objects, instruct, orient or guide visitors, question visitors' views and provoke visitors (Serrell, 2015). Interpretative text can be presented visually, e.g. on text panels, touch screens, or walls, or acoustically via audio installations or audio guides as well as via other media, such as tablets (Schwan, Dutz, & Dreger, 2018). Visual (written) and auditory presentation are two main presentation modalities used to present interpretative text in the museum (Serrell, 2015). Interpretive texts provide the necessary background information for visitors to connect with the objects on display, allowing the object to resonate in a way that cannot be achieved with objects alone (Screven, 1992; Serrell, 2015). They have recently been found to improve visitors' memory of the pictorial details of art works compared to a label with minimal information (Schwan et al., 2018). Texts also play an important role in the 'scaffolding' of information that most science museums rely on to cater to the information needs of a diverse audience (Allen, 2004). For those visitors that want to find out more, texts enable them to build knowledge structures by allowing for a comparison of conceptual structures (Kintsch, 1994; Schnotz, 2002) and fostering deeper understanding of the (initial) messages conveyed through the object. Just like any other text, museum text requires the reader to construct a mental representation based on a combination of their background knowledge and inferences drawn from the text (Schnotz, 2002). Text comprehension consists of different levels. The shallowest level of understanding is formed by the encoding of words and phrases (surface structure). A deeper level is understanding the semantic content, constituted by semantic units called propositions. The text base is the subset of the propositional representation, which is explicitly mentioned in the text. Successful comprehension culminates in the construction of a mental modal (also referred to as the situation model), which requires readers to combine textual information and background knowledge (Schnotz, 2002). It involves the ability to draw inferences and coherently link ideas (Graesser, León, & Otero, 2002). The two presentation modalities, visual and auditory text, each have their advantages and disadvantages for text processing (Kürschner, Schnotz, & Eid, 2007). Visual text, for example, is "permanently" available, allowing readers to determine their own pace, skip through or reread passages, and to have more control over which details to focus on. This generally does not apply to spoken text, which is of an ephemeral nature, has a fixed pace, and tends to result in a more general level of understanding (Kürschner et al., 2007). On the other hand, auditory information is known to draw people's attention more strongly and is less

susceptible to distractions than visual information, which can be particularly advantageous in an informal learning setting (Novey & Hall, 2006). Furthermore, spoken text can provide listeners with auxiliary information by means of pitch, prosody, speed, and pauses that can aid their understanding (Danks & End, 1987; Kürschner et al., 2007). Besides these differences, it is important to consider the effect of a combined presentation of text with objects or images, as is the case in the museum. When simultaneously processing text and pictures or objects, visual text can be expected to 'compete' with the visual image (Mayer & Moreno, 1998). Findings from a recent study indeed show auditory text compared to written text leads to better recollection of the text and of pictorial details of art works in a museum-like setting (Schwan et al., 2018).

1.1.2. Attitude formation and attitude change

Encouraging visitors to form or adjust their attitudes toward other people, themselves or a specific topic has become a common part of many museums' missions (Bell, 2008; Cameron, 2005; Hooper-Greenhil, 2007; Mazda, 2004; Pedretti, 2004; Serrell, 2015). To illustrate, the mission statement for the Deutsche Museum, one of the largest and well-known science museums in Europe and study setting for the studies described in chapter three, reads:

„The Deutsches Museum addresses controversial issues and acts as a venue where people can exchange ideas, form their own opinions, and participate in the world of science and technology" (Deutsches Museum, n.d.).

Opinions are synonymous for attitudes (Bergman, 1998), which refer to the "general and relatively enduring evaluations people have of other people, objects, or ideas" (Petty, Wheeler, & Tormala, 2003, p. 353). Attitudes have an affective and a cognitive component and are formed and changed by a mixture of prior knowledge, existing attitude and the more or less elaborate processing of new information (Dole & Sinatra, 1998; Petty et al., 2003). The elaboration likelihood model (ELM; Petty & Cacioppo, 1986) is a well-known theoretical model describing attitude change. The model can be seen as an elaboration continuum, with a mainly affective processing of information at the low end and a high degree of invested cognitive effort at the high end (Petty et al., 2003). Although it is mostly used in the field of persuasion, it has also been applied to informal learning settings such as museums (Brossard, Lewenstein, & Bonney, 2005; Webb, 1997). By offering an appealing, layered, affective and cognitive learning experience and by virtue of being a credible and trusted source of information, museums seem well equipped to influence visitors' attitudes. Information processing in a museum covers the entire spectrum of the elaboration continuum. Similar to the underlying principle of the ELM, visitors'

interests, motivation and abilities play an important role in the themes they choose to deal with and how deeply they process the information on display (Csikszentmihalyi & Hermanson, 1995; Falk & Dierking, 2013). Webb (1997, p. 276) suggests that exhibit designers attempt to activate the visitors' affective side, which "has its antennae up all the time," with the aim of subsequently provoking a cognitive response. An example of a cognitive response is a visitor turning to an accompanying interpretive text to find out more about a certain topic. Although both affective and cognitive information processing can lead to a change in attitude, the latter is known to lead to stronger attitudes (Petty et al., 2003). An attitude is considered strong when it is persistent, resistant to change, or has a strong impact on thoughts and behaviour (Krosnick & Petty, 1995). Attitude strength has several dimensions, all of which hold one or more of these qualities of attitude strength (Krosnick, Boninger, Chuang, Berent, & Carnot, 1993; Visser, Bizer, & Krosnick, 2006). Four of these dimensions of attitude strength (prior knowledge, attitudinal certainty, attitudinal importance and attitudinal ambivalence) are included in study three as part of visitors' prior attitude.

1.2. Motivation in museums

As free-choice learning settings, where learners are free to navigate and decide what to engage in and for how long, insight into what drives visitors can help us to understand and possibly predict some of their learning experiences (Falk & Dierking, 1998, 2013). Compared to other realms of educational research, research on museum learning therefore calls for a special focus on motivational factors (Falk, 2009).

1.2.1. Self-Determination Theory

Motivation is what *moves* people to act, i.e. what directs individuals' behaviour (Ryan & Deci, 2017a). One prominent theory that helps explain different types of motivation is self-determination theory (SDT; Ryan & Deci, 2017a). SDT provides a framework for making predictions about which aspects of a social context (in our case the museum) will support high-quality motivation and general well-being (Ryan & Deci, 2017a). Following SDT, "an understanding of human motivation requires a consideration of the innate psychological needs for competence, autonomy, and relatedness" (Deci & Ryan, 2000, p. 227). I will briefly describe these needs and how they relate to the museum as free-choice learning setting. First is the need for competence, which describes a person's desire to feel effective; that is, to master the given demands of a task or learning situation and to feel challenged but still up to the task at hand (Ryan & Deci, 2017a). In the context of learning, the need for competence is supported by providing a scaffolding of structure (Ryan & Deci, 2017a; Reeve, Ryan, Deci, & Jang, 2008). Museums meet this need by

offering information hierarchies of varying difficulty, allowing visitors to find their own optimal degree and level of information for each domain or topic they encounter during the visit (Falk & Dierking, 2013). Sue Allen describes the challenge of designing exhibits that are “effective as teaching tools" and yet “support a diverse visiting public in making their own personal choices about where to attend, what to do, and how to interpret their own actions” (2004, p. 17). Successful design, according to Allen, highlights easy and fun aspects of science learning, holds back on the more effortful aspects *and* offers consecutive steps of inquiry drawing on visitors’ curiosity to “scaffold them through the cycle [of inquiry]” (2004, p. 20). The second basic need in SDT is the need for autonomy. This need describes a person’s desire to be an independent actor with individual goals who acts in accordance with an integrated self (Ryan & Deci, 2017a; Ryan & Deci, 2017b). Museums are well suited to support this basic need. The need for autonomy is an integral part of museum visits by virtue of it, at least in most cases, being ‘free-choice’. Also, museums use different media to present a wide range of information that visitors can approach voluntarily and process in their own manner, at their own pace, and in their own chosen order (Rounds, 2004). Third is the need for relatedness, or the strong desire for satisfactory social contacts. Most museum visitors are accompanied by partners, friends or family members, thereby meeting their own need to feel connected. Museums anticipate this need by offering opportunities for social interaction in basic facilities as well as via multiplayer exhibits, for example. Furthermore, museum staff, such as tour guides or demonstrators, offer opportunities for social interaction for all visitors, including those who come to the museum on their own (Falk & Dierking, 2013). SDT proposes that these three basic psychological needs (for competence, autonomy and relatedness) promote high-quality forms of self-determined and intrinsic motivation for, and engagement in, activities (Ryan & Deci, 2017a) including learning (Reeve et al., 2008). Reflecting on the above, it seems that for museum visits, the innate psychological needs described in SDT are reflected in all three contexts described in the CML. The three basic needs are either met through a visitor’s personal context (e.g. their level of competence in the museum’s domain), the sociocultural context (e.g. their visit company) or the physical context (e.g. by the museum offering content for different learning needs and preferences). Taken together, from a motivational perspective it seems safe to assume that museums offer the ideal nursing ground for highly motivated and self-determined learning. Though approaching it from different angles and using different descriptions, most museum researchers agree that museums offer intrinsically motivated, curiosity-driven learning opportunities (Csikszentmihalyi & Hermanson, 1995; Falk & Dierking, 2013; Rounds, 2004; Packer, 2006). This is an affordance of museums that most museum visitors are aware

of and anticipate (Falk, 2009). It is however, not the only affordance of museum that moves visitors to a museum (Black, 2005; Falk, 2009), as will become clear next.

1.2.2. Visit motivation

The construct 'visit motivation' captures the various needs and drives that bring a visitor to a specific site on a specific day (Falk, 2009; Moussouri, 1997; Packer & Ballantyne, 2002). It is a fundamental motivational starting point of a museum visit and a central focus of this thesis. Visit motivation has been studied for several decades, with different researchers approaching and describing visit motivation in different ways. An early paper describing different motivations for visiting museums came from Marilyn Hood's (1983) research on why people choose *not* to visit. Hood studied sixty years of literature in different fields and "identified six major attributes underlying adults' choices in their use of leisure time" (p. 51). More than a decade later, Sharon Macdonald (1995) condensed findings from forty-two group interviews with science museum visitors into four broad visit motivation categories. She coined the term 'cultural itineraries' (1995, p. 16) to implicate visitors' own strategies as well as wider socio-cultural patterns in motivations for visiting museums. Theano Moussouri expanded on this work and established ten motivation categories (1997; Moussouri & Roussos, 2013). Moussouri (1997; Falk, Moussouri & Coulson, 1998) suggests that visit motivation forms part of a visitor's agenda, together with *visit strategy*. She distinguished between three types of strategies for experiencing a museum visit: unfocused, moderately focused and focused. "Visitors with an *unfocused* strategy are generally unaware of museum/exhibition opportunities and are open to experiencing whatever the museum has to offer" whereas "visitors with a *focused* agenda plan their visit before they go to the museum; usually with a specific goal in mind" (Falk et al., 1998, p. 108). The moderately focused visit strategy falls in between the two. However, Falk, Moussouri and Coulson (1998) did not find any significant correlations between visit strategy and their six visit motivation categories. Around the same time, Doering and Pekarik described what they called visitors' entrance narratives, which consist of "*a basic framework, i.e. the fundamental way that individuals construe and contemplate the world; information about a given topic, organized according to that basic framework; personal experiences, emotions and memories that verify and support this understanding*" (1996, p. 20). In their paper they explain that visitors' entrance narratives shape their visit experience and that exhibitions that echo these entrance narratives will be most satisfying. In a later study the authors presented list of fourteen satisfying experiences, categorised into four clusters that visitors look forward to in a visit (Pekarik, Doering, & Karns, 1999). John Falk's theoretical and empirical studies of identities and motivations for visiting led to development of an identity-related visitor motivation model

(2006, 2009; Falk et al., 1998; Falk, Heimlich, & Bronnenkant, 2008). Falk suggests that "most museum visitors "enact" a museum "identity" during their visit: an identity that characterizes their motivations for that visit" (Falk, 2006 p. 154). He explains: "The essence of the model is that each museum visit experience is the synthesis of the individual's identity-related needs and interests and the views of the individual and society of how the museum can satisfy those needs and interests" (2009, p. 36). In other words, Falk suggests that the various individual elements of a visitor's personal background yield a specific motivation (2006, 2009). Finally, Jan Packer (2004; Packer & Ballantyne, 2002) approached visit motivation from a personal goals perspective and combined a literature review with pilot studies to devise a questionnaire with forty "possible reasons for visiting an educational leisure setting, expressed in terms of the desired outcome of the visit" (Packer & Ballantyne, 2002, p. 188). Through factor analysis she established that visit motivation is a multidimensional construct consisting of five categories. However, other studies, including the ones mentioned above, resulted in different categories. Visit motivation has been studied by a variety of disciplines, varying from sociology and museology to marketing, which has resulted in an assortment of visit motivation categories. Interestingly, despite various divergences in methodologies and research settings, there is considerable overlap in the visit motivation categories found in the various studies. Frequently mentioned visit motivations include the motivation to learn, to socialise, to relax, to have fun, to introspect, and to have a new experience (for a brief overview, see Phelan, Bauer, & Lewalter, 2018). Although any one of these may be dominant motivations for visiting a particular museum on a particular day, visitors can have more motivations for visiting (Falk, Moussouri, & Coulson, 1998). Different studies have shown that visit motivations will direct the choices visitors make during the visit, that they can indicate which needs are or are not being met and that they will influence visitors' learning experiences (Doering & Pekarik, 1996; Falk, 2006; Falk, Moussouri, & Coulson, 1998; Falk & Storksdieck, 2005; Mason, Robinson, & Coffield, 2018; Leinhardt, Crowley, & Knutson, 2002; Packer & Ballantyne, 2002) and long-term recollections of visits (Falk, 2009; Falk & Storksdieck, 2010).

1.3. Dealing with contemporary, conflicting science topics

Science museums play a unique and important educational role in society by covering a wide range of historical and contemporary topics, reaching a relatively wide audience, and having the distinct capacity to make scientific and technological concepts tangible (Allen, 2004; Bell, Lewenstein, Shouse, & Feder, 2009; Falk & Dierking, 2013). Science museums traditionally focus on established knowledge, such as science history and the achievements of science in terms of facts, figures, principles and products (Delicado,

2009). However, nowadays science museums also incorporate contemporary, ongoing ('unfinished') science and socio-scientific content into their exhibitions, bringing with them a range of conflicting or controversial science and technology topics (Bell, 2008; Cameron, 2005; Dorfman, 2018; Meyer, 2010; Yaneva, Rabesandratana, & Greiner, 2009). Rightfully so, because ongoing research, conflicts and controversies belong to the normal course of science (Bell, 2008; Bromme & Kienhues, 2014; Dascal, 1998) and presenting such topics is pertinent to any institution that aims to inform the public and provide a comprehensive portrayal of science and its role in society. Two of the studies presented in this thesis deal with a current science topic that is presented in a way that highlights the (potentially) conflicting nature of the subject. 'Conflicting' in this sense, is used broadly, encompassing 'incompatible', 'opposing' or 'discrepant' views or positions, which does not rule out the possibility of resolving the conflict (Bråten & Braasch, 2018). Scientific conflicts can arise in various ways. For example, conflicts can stem from scientists approaching a question from different theoretical perspectives or by using different methods (Dumanoski, Farland, & Krimsky, 1999), both of which can lead to contradictory results or opposing statements from different scientific experts. Conflicting information can also come about when scientific findings are translated into practice (e.g. in the form of recommended actions), especially when the topic mixes science with politics or ethics (Bromme & Kienhues, 2014). Finally, scientific research that is still ongoing is by definition open-ended, and likely to have a range of possible and potentially contradictory outcomes that surface when listing risks and benefits, for example (Bromme & Kienhues, 2014; Durant, 2004; Field & Powell, 2001). In museums, controversial and open-ended science topics tend to be presented in the form of different positions, pros and cons or risks and benefits, as this can help curators to present a balanced view (Cameron, 2005; cf. Mazda, 2004). Exhibitions dealing with such topics are thought-provoking sites. They are designed to encourage visitors to reflect upon the different sides of a story, increase their understanding and form or adjust their attitudes toward the topics on display (Chittenden, 2011; Mazda, 2004; Meyer, 2010; Pedretti, 2004). However, dealing with such information can be challenging and different visitors deal with these challenges in different ways. In sections 1.1.1 and 1.2.1 I described text comprehension and attitude change as concrete examples of on-site museum learning. I will now expand on these descriptions for the specific situation of dealing with conflicting science topics.

1.3.1. Processing conflicting science texts

Museum texts containing controversial or (seemingly) contradictory information require extra effort on the part of the visitor (Britt, Richter, & Rouet, 2014). Visitors reading text containing opposing positions on a topic do not only need to understand the surface

structure and text base of each position separately and construct separate mental models, they also need to interrelate these by integrating information across both positions (Britt et al., 2014; Stadtler, Scharrer, & Bromme, 2011). The reader has to engage in elaborate cognitive processing and draw inferences between conflicting statements to evaluate if and how the presented positions are compatible and different readers deal with such information in different ways (Britt, Richter, & Rouet, 2014; Specht, Phelan, & Lewalter, 2015).

1.3.2. Prior attitude and attitude change when dealing with conflicting science

Information containing different viewpoints, pros and cons or risks and benefits do not only increase visitors' general understanding, they also form an important basis for the development of evidence-based public attitudes toward, for example, emerging technologies (Fischer, Van Dijk, De Jonge, Rowe, & Frewer, 2013). As Beverly Serrell states, exhibit developers rely on interpretative text to "tell stories, contrast points of view, present challenging issues or strive to change people's attitudes" (2015, p. 19). As with other types of learning outcome in the museum, to understand attitude change in the museum requires some knowledge of visitors' personal background, in this case their prior attitudes. One specific part of a person's prior attitude that seems particularly relevant to dealing with risk–benefit information, is attitudinal ambivalence. A person with an ambivalent attitude has simultaneously positive and negative associations with an attitude object, as opposed to an association that is negative, positive, or neutral (Conner & Armitage, 2008; De Liver, Van der Pligt, & Wigboldus, 2007; Visser et al., 2006). Attitudinal ambivalence is an attribute of the attitude itself, is one of several dimensions of attitude strength, and has been linked to resistance to attitude change (Krosnick et al., 1993; Visser et al., 2006). Risk–benefit text can be considered ambiguous information, which forms an antecedent of attitudinal ambivalence from a theoretical perspective (Conner & Armitage, 2008). Of course, this does not mean a risk–benefit text will always lead to an ambivalent attitude; rather, studies such as Fischer et al. (2013) and Jonas, Diehl, and Brömer (1997) have indicated that ambiguous information can influence attitudes in a number of different ways. Considering the broad museum audience, with divergent levels of prior knowledge and a wide range of prior attitudes, it is interesting to find out if risk–benefit information can lead museum visitors to change their attitudes and whether attitudinal ambivalence can influence that change.

1.3.3. Personal characteristics central to dealing with conflicting science

From sections 1.1 and 1.2 it becomes clear that the free choice nature of a museum visit leads to very individual and intrinsically motivated learning experiences. Finding out more

about visitors' personal background is key to understanding and predicting how individual visitors deal with complex, conflicting science topics in the museum. Of course, there are numerous personal characteristics that vary from person to person or from situation to situation and that together play a role in how visitors deal with the information encountered during their visit (Falk, 2007; Mason, Robinson, & Coffield, 2018; Leinhardt, Crowley, & Knutson, 2002). In this section I will describe a handful of personal characteristics with expected relevance for museum learning in general and processing conflicting science topics in particular. The first one of these and a central personal characteristic from a motivational viewpoint is interest. Interest is a very strong motivator for behaviour. Interest in an object or activity can lead people to become absorbed in it, which in turn can foster or expand interest (Csikszentmihalyi & Hermanson, 1995; Nakamura & Csikszentmihalyi, 2002; Rounds, 2004). Following Rounds (2004) interest can be seen as the intrinsic reward of satisfying our curiosities while visiting the museum (Rounds, 2004). He suggests "the curiosity-driven visitor seeks interest as an end in itself, and is not concerned with whether the knowledge gained is relevant to some extrinsic benefit" (Rounds, 2004, p. 394). As part of a persons' visit motivation, interest developed in the past can move someone to visit a particular museum and direct their attention during the visit (Csikszentmihalyi & Hermanson, 1995; Hooper-Greenhill, 1999; Nakamura & Csikszentmihalyi, 2002). When visiting a science museum, this past or 'existing' interest can encompass both the broad domain of natural science as well as various topic-specific interests. Interest is known to influence many aspects relevant to formal and informal (i.e. free-choice) learning, varying from attention and concentration to text comprehension and joy when engaging with the topic (Hidi, 2000; Hidi, Renninger & Krapp, 2004; Fox, 2009). Besides interest, visitors' self-efficacy beliefs are an essential part of a visitors' personal context from a motivational viewpoint. Self-efficacy is a person's own judgement of their ability to deal with a certain situation (Bandura, 1977). Self-efficacy beliefs are closely related to the need for competence (Ryan & Deci, 2017b). Like competence, self-efficacy beliefs differ according to the topic or task they refer to. For the challenge of dealing with conflicting, contemporary science topics, this would include visitors' ability to deal with science topics as well as with contradictory information or opposing views. In a previous study, self-efficacy beliefs concerning science reading emerged as relevant predictor for multiple-text comprehension (Bråten, Ferguson, Anmarkrud, & Strømsø, 2013). Also, self-efficacy had an impact on visitors' knowledge increase in two different science museum studies (Lewalter, Geyer, & Neubauer, 2014; Waltner & Wiesner, 2009). Apart from interest and self-efficacy, a third personal characteristic should be mentioned. As processing conflicting science information requires some degree of cognitive effort, visitors' need for cognition needs to be considered

(Cacioppo & Petty, 1982; Petty, Briñol, Loersch, & McCaslin, 2009). Need for cognition is „a stable individual difference in people's tendency to engage in and enjoy effortful cognitive activity" (Cacioppo, Petty, Feinstein, & Jarvis, 1996, p. 198). A multitude of studies have shown that people that are high in need for cognition engage in greater information-processing activity than those that are low in need for cognition, with one study showing museum visitors with high need for cognition to be significantly more satisfied with cognitive exhibit displays than visitors low in need for cognition (Cacioppo et al., 1996; Yalowitz, 2002). This suggests that the need for cognition may be a predictor of an individual's information processing efforts and experiences in a museum. A final personal characteristic that needs to be introduced due its potential influence on dealing with complex, contradictory science topics are a visitor's epistemic beliefs. Epistemic beliefs are beliefs about the nature of knowledge and knowing (Muis, 2007). They include assumptions regarding the source of knowledge, the construction of knowledge and the certainty of knowledge, and have been linked to science learning in out of school learning settings (Conley, Pintrich, Vekiri, & Harrison, 2004; Price & Lee, 2013; Schommer-Aikins, 2002). They have also been found to influence the processing of dual-positional text (Kardash & Howell, 2000) and are therefore a potential predictor of how a visitor deals with the complexities of a museum text on a current, conflicting science topic. Finally, I'd like to add at this stage that although visit motivation has been studied in the context of the science museum, it has not specifically been linked to dealing with conflicting science topics, which is a gap that this thesis helps to close.

1.4. Summary and research questions

As described in the introduction above, a central theme in this thesis is 'user-specific' i.e. a focus on the visitors as individual, self-determined users of the museum's content and on what they bring with them to the visit. Knowledge of visitors' personal context is crucial to understand and predict (aspects of) museum learning. Two of the studies in this thesis, studies one and two, deal with visit motivation, which is a fundamental aspect of a visitor's personal context and a motivational starting point of the visit. Additionally, study two as well as study three investigate to what extent specific aspects of visitors' personal context affects different examples of learning outcomes. Both studies are set in a contemporary science exhibition and focus on the way visitors deal with 'conflicting' information. As explained in section 1.3, this term describes a specific type of information often encountered in science museums, which in our studies takes the form of a text presenting risks and benefits of biomimetics. From the three studies presented in this thesis, I have drawn a selection of six research questions that together form a thread that starts with what motivates people to visit educational leisure settings in general and

science museums in particular, followed by a closer look at science museum visitors' wider personal context and how these may influence visitors' on-site learning. While study two looks at the way a visitor's personal, motivational background may influence text comprehension, study three investigates if processing this information can lead visitors to change their attitude and if certain dimension of attitude strength influence that change. Together these studies aim to contribute to a better understanding of a small but central part of a visitor's personal and motivational context and an increased insight in the way visitors' personal context can affect (on-site) museum learning. The research questions addressed in this thesis are:

1. Is there a common core of visit motivations across educational leisure settings? (Study 1)
2. Do science museum visitors' average (latent mean) motivation scores differ from those for visitors to an art museum and a zoo? (Study 1)
3. What are associations between our six visit motivation categories (see section 3.1.) and visit company, visit strategy, visit frequency, interest in natural science, need for cognition, cognitive self-efficacy and scientific self-efficacy? (Study 2)
4. To what extent do the personal characteristics listed under 3, together with topic-specific interest and epistemic beliefs predict visitors' text comprehension when processing a risk–benefit museum text? (Study 2)
5. Can processing this risk–benefit museum text lead to an average attitude change in visitors toward the topic being presented? (Study 3)
6. To what extent do the different dimensions of attitude strength (prior knowledge, attitudinal certainty, attitudinal importance, and attitudinal ambivalence) predict visitors' average attitude change after processing a risk–benefit museum text? (Study 3)

These questions are addressed in the study summaries in chapter three and discussed, both individually and together, in chapter four. The following chapter describes the methods used in the three studies.

2. Methods

This dissertation is based on three studies described in two published papers and one submitted manuscript:

1. Phelan, S., Bauer, J., & Lewalter, D. (2018). Visit motivations: development of a short scale for comparison across sites. *Museum Management and Curatorship, 33*(1), 25–41.

2. Phelan, S., Specht, I., & Lewalter, D. (2018). Visit motivation, visitor characteristics and text comprehension in a science museum. Manuscript submitted for publication.

3. Phelan, S., Specht, I., Schnotz, W., & Lewalter, D. (2017). Attitude change when presenting science museum visitors with risk–benefit information. *Science Education, 101*(6), 873–886.

2.1. Study settings and participants

Study one was carried out in three different, well-known educational leisure settings in Munich: the Deutsches Museum (a science museum), the Lenbachhaus (an art museum) and Tierpark Hellabrunn (a zoo). Studies two and three were both carried out in a nano- and biotechnology exhibition that is part of the centre for new technologies in the Deutsches Museum. All participants were visitors that agreed to participate in our studies while visiting. All combinations of visitors were able to join, from individual visitors to groups of friends and families. However, for groups of visitors in study one only one person filled out the questionnaire. For family groups, we requested that the person filling out the questionnaire was at least twelve years old, and underage children (<18) were only allowed to participate with a parent's consent. For studies two and three participants had to be at least fifteen years old, and here too underage participants required consent from an accompanying adult. For study one, visitors were approached as they were entering the site and were asked to participate in our survey. For the studies two and three, visitors to the Deutsches Museum who were browsing the nano- and biotechnology exhibition in the centre for new technologies, were approached and asked to take part in our pre/post survey. Participation was voluntary in all three studies and in studies two and three, as an incentive for participating, visitors' entrance fees were reimbursed. Or-

ganised groups such as school groups were excluded in all three studies. Detailed sample descriptions can be found in the original papers. An overview of the study designs, locations and sample sizes can be found in table one.

Table 1. Study design, study settings and participants

	Study design	**Locations**	**Participants (*N*)**
Study 1	Cross-sectional field survey with entrance samples	Science museum Art museum Zoo	199 190 216
Study 2	Pre/post quasi-experimental field survey	Science museum (nano- and biotechnology exhibition)	108
Study 3	Pre/post quasi-experimental field survey	Science museum (nano- and biotechnology exhibition)	225

2.2. Treatment (studies 2 and 3)

Studies two and three involved a treatment in the shape of an interpretative text describing two opposing positions on the topic of biomimetics. This text was integrated into an existing exhibition with a fitting theme and content. In addition to a written or 'visual' version of the text, study three also involved an audio version. The visual version of the text in studies one and two was displayed on a touchscreen, whereas the audio version in study three was provided via an MP3 player with circumaural headphones. Participants in study three were assigned to either of the two information conditions. The text contained a balanced view of the potential risks and benefits of biomimetics and its products. After a short general introduction explaining biomimetics, the first part of the text highlights benefits, which are challenged by the second part of the text describing (potential) risks. To ensure balance, the number, length, and difficulty of words and sentences used in each part of the text (risks/benefits) was comparable (text length: 234 words). The text drew on information from a publication by the German Office of Technology Assessment (Oertel & Grunwald, 2006) and was developed with the help of two curators. All participants were facing the same nanotechnology and biotechnology products showcase. Contrary to the typical object-centred museum situation, the objects did not play a crucial role in this study. The showcase contained a collection of available products that rely on biomimetical principles or design, and mainly served the purpose of drawing the visitors' attention without evoking conflicting thoughts about the topic. In

other words, the objects served as neutral anchors for the topic of biomimetics but did not match the text in terms of a depiction of risks and benefits. A direct translation of the text can be found in the appendix of study three.

2.3. Instruments and variables

In all three studies the survey instrumentation consisted of a questionnaire containing various scales and items, most of them closed questions, some open-ended questions. To measure participants' visit motivation in study two, we applied our own visit motivation short scale that was developed and described in study one. The scale contains 17 items, which fall into six categories (see table two, section 3.1). The reliabilities we found when applying the scale in study two (in a nano- and biotechnology exhibition) are described in manuscript two[1]. Study two further included the variables visit strategy, visit company, visit frequency, interest in natural science, interest in biomimetics, cognitive and scientific self-efficacy, need for cognition and epistemic beliefs. Study three included the variables prior knowledge, attitude toward biomimetics, attitudinal certainty, attitudinal importance and attitudinal ambivalence. For a more detailed description of the scales used in the studies two and three and their reliabilities, I refer to the original papers. Unless stated otherwise, answers were given on a Likert-type scale from 1 (not at all) to 5 (very). Original items as used in the studies were in German.

2.4. Data analysis

Different strategies and research questions called for different statistical methods to be applied in the three studies. As the first manuscript concerned itself first and foremost with the development of a short scale, the statistical method included a series of exploratory factor analyses (EFA) with robust maximum likelihood (ML) estimation and oblique geomin rotation and the optimal shortening procedure following Raykov, Rodenberg and Narayanan (2015). To test if the scale allows for valid comparisons across sites, the scale's measurement invariance and scalar invariance was investigated using multi-group confirmatory factor analysis with stepwise imposing invariance restrictions. Finally, to test latent mean differences across the three sites, we used the multiple-group factor analysis alignment procedure. A more detailed description of the statistical approach can be found in the original paper (study one).

[1] The wording of one of the (German) PS Items used in study two ('*because I wanted to be able to say I'd been there*') slightly deviated from that in study one.

The second study had two aims. The first was to look for associations between six visit motivation categories and a variety of other personal characteristics. For correlations between visit motivation and the ordinal variables (visit strategy and visit frequency), we calculated a Spearman's rank correlation (two-tailed). For the interval variables (interest in natural science, need for cognition and cognitive and scientific self-efficacy) we calculated a Pearson product-moment correlation (two-tailed). We drew on Cohen's standard for social sciences to classify correlation results into small, medium and large (Cohen, 1992). For the nominal variable visit company, we calculated independent t-tests to look for differences in the visit motivation category means based on company. The second aim of the study was to calculate the extent to which a selection of personal context variables can predict visitors' level of text processing in the museum. For this, we carried out a multiple linear regression analysis with three models. The first model served as a 'base line' and only contained sociodemographic variables. The second additionally included a combination of other personal characteristics and the third added visit motivation. Following Field (2005), we deliberately added the personal characteristics before visit motivation, as we had more reason to assume these to be relevant predictors of participants' text comprehension when processing a risk–benefit science text in the museum. For the third study we compared participants' average attitude levels before and after reading that same museum text. We calculated a dependent t-test and Cohen's *d* for effect size (Cohen, 1992). Additionally, a multiple linear regression analysis was used to calculate whether text modality (visual and auditory text) in combination with prior knowledge, certainty, attitudinal importance and attitudinal ambivalence significantly predicted participants' attitude change.

3. Study summaries

This section provides summaries of the two papers and the one manuscript this thesis is based on, with an emphasis on findings relating to this thesis' research questions.

3.1. Study 1: Phelan, S., Bauer, J., & Lewalter, D. (2018). Visit motivations: development of a short scale for comparison across sites. *Museum Management and Curatorship, 33*(1), 25–41.

Research questions:

1. *Is there a common core of visit motivations across educational leisure settings?*
2. *Do science museum visitors' average (latent mean) motivation scores differ from those for visitors to an art museum and a zoo?*

This paper describes the development of an instrument to measure and compare people's motivations for visiting different educational leisure settings (ELS). Visit motivations are a long-lasting research focus and have been linked to various aspects of visit experience and learning outcome (Falk, 2009; Falk, Moussouri, & Coulson 1998; Hood, 1983; Packer & Ballantyne, 2002; Pekarik & Schreiber, 2012). Previous visit motivation studies conducted in different settings and based on different theoretical frameworks have led to different models and instruments. Perhaps not surprisingly, they have resulted in a variety of visit motivation categorisations. Nevertheless, when taking a closer look, there is substantial overlap in the visit motivation categories found in these studies. This suggests that there may be a common core of visit motivation dimensions across ELS. However, the lack of an instrument offering a reasonable degree of measurement invariance to use across sites has challenged attempts to make valid comparisons across different types of ELS. For this reason we set out to develop a short visit motivation scale that captures main visit motivation categories and enables quick and valid comparisons of visit motivations across ELS. In order to achieve this, we collected data in a science museum, an art museum and a zoo, all located in Munich. As a basis for our instrument, we drew on items from Falk's identity-related visitor motivation model (Falk, 2006, 2009) and Packer's motivational factors (Packer, 2004; Packer & Ballantyne, 2002) as they cover a wide range of motivational aspects and have already been used to study and compare visit motivations over different types of ELS. Following statistical strategies described in the methods section above, we succeeded in developing a 17-item short scale that captures six theoretically important visit motivation dimensions with sufficient reliability (ρ .65 < .85). Further analysis of this final short scale shows configural, metric and

approximate scalar invariance, indicating that the dimensions of visit motivation can be interpreted as virtually equivalent and that latent means of the visit motivation dimensions can be meaningfully compared across different ELS. The common core of visit motivation dimensions we found in the different ELS are: *learning and pursuing interests* (LI), *relaxation and recuperation* (RR), *social learning* (SL), *social enjoyment* (SE), *establishing social contacts* (SC) and *popularity of the site* (PS). Table two shows the items belonging to each of these categories. Descriptive item statistics and standardised factor loadings can be found in the original paper (see appendix).

When comparing latent factor means for the science museum with the two other sites, we found a number of statistically significant differences. First of all, LI was rated as more important in the science museum than in the zoo. Furthermore, RR and two of the social visit motivation categories, SL and SE, were more pronounced in the zoo than in science and the art museum. Additionally, SL and SC were more pronounced in the science museum compared to the art museum. For PS we did not find any statistically significant differences. In the discussion we suggest that the instrument offers new opportunities by allowing researchers and museum practitioners to quickly, validly and reliably measure visit motivations within and across ELS. As each site has its own affordances, combining data across different ELS can provide valuable insights into the broader workings of visit motivation.

Table 2: Items belonging to the six visit motivation categories

Item	**VM category**
1. to broaden my horizons	LI
2. to be better informed	LI
3. to deepen my areas of interest	LI
4. to learn something new	LI
5. to relax	RR
6. to switch off for a while	RR
7. to recuperate	RR
8. because I like to support my child(ren) / companion(s) with their learning	SL
9. because my family/friends learn things here they can't learn elsewhere	SL
10. to do something nice together	SE
11. to spend time with my companion(s)	SE
12. to have a nice time	SE

13. to connect with others	SC
14. to meet new people	SC
15. because I wanted to be able to say I'd been there	PS
16. because I heard this is a great museum / zoo /…	PS
17. because this museum/zoo/… is a tourist attraction	PS

Note: LI = learning and pursuing interests, RR = relaxation and recuperation, SL = social learning, SE = social enjoyment, SC = establishing social contacts and PS = popularity of the site

3.2. Study 2: Phelan, S., Specht, I., & Lewalter, D. (2018). Visit motivation, visitor characteristics and text comprehension in a science museum. Manuscript submitted for publication.

Research questions:

3. *What are associations between our six visit motivation categories (LI, RR, SL, SE, SC and PS) and visit company, visit strategy, visit frequency, interest in natural science, need for cognition, cognitive self-efficacy and scientific self-efficacy?*
4. *To what extent do the personal characteristics listed under 3, together with topic-specific interest and epistemic beliefs, predict how well visitors process a risk–benefit museum text?*

The second paper applies the visit motivation short scale described in study one in a nano– and biotechnology exhibition. A first aim of the study was to explore how visit motivation is embedded into visitors' broader background. We concentrated on a small and specific part of visitors' personal context based on existing studies, and focusing on motivation and museum learning. We included the visit attributes visit company, visit strategy and visit frequency, as well as the personal characteristics interest in natural science, cognitive self-efficacy, scientific self-efficacy and need for cognition. In our study, visit company tells us whether the museum visitor was visiting alone or accompanied by one or more adults or children. Visit strategy, following Falk, Moussouri, and Coulson (1998), captures the degree to which the visit was 'focused' or planned, while visit frequency tells us how often the visitor has previously visited the Deutsches Museum (never, 'once or twice', 'several times' or 'often'). Visit strategy and visit company were included based on findings in previous studies (Falk et al., 1998; Packer & Ballantyne, 2005). The variables interest, self-efficacy and need for cognition were chosen as (comparatively) stable personal characteristics that may be related to one or more of the situational visit motivation categories. Results regarding visit company show that solitary

visitors scored the visit motivation category *learning and pursuing interests* (LI) significantly higher and both *social learning* (SL) and *social enjoyment* (SE) significantly lower than those with company. When comparing visitors accompanied by one or more children (regardless of whether they were visiting alone or with other adults) to those without children company, we find that visitors with accompanying children scored *SL* significantly higher. For visit strategy we found a small positive correlation with the visit motivation *LI*, whereas visit frequency was positively correlated with social learning and negatively correlated with *popularity of the site* (PS). For the personal characteristics, we only found correlations with two of our six visit motivation categories. For SL we found a small positive correlation with interest in natural science, suggesting one's own enthusiasm for a topic coincides with a motivation to foster science learning in others. For LI we found small to medium positive correlations with participants' interest in natural science, their cognitive self-efficacy and their scientific self-efficacy. The various correlations we found confirm previous findings and also provide new insights, as will be discussed in section 4.2. Of special interest are the correlations we found with the visit motivation category *LI*.

A second aim of the study was to explore the potential influence of visitors' personal context on museum learning, using the example of on-site processing of a risk–benefit museum text on the topic of biomimetics. For this analysis, we included the four personal characteristics mentioned above and two additional characteristics: topic-specific interest and epistemic beliefs. Topic-specific interest was included because our initial interest scale (interest in the domain of natural science) was not accurate enough for the specific example of a text on biomimetics. We included epistemic beliefs as we assumed these could play a role in processing this particular text as described in section 1.3. We also added the sociodemographic variables age, gender and level of education as they are central to the visitor's personal context and to most visitor studies. Whether visit motivation itself can also influence such a specific example of museum learning is unknown and formed a question we hoped to shed some light on in this study. We found that the regression model involving all variables explained respectively 27% and 29% of the variance of the two types of coherence formation measured in our study (see study two for more detail). For the more basic coherence formation *within* each position (risk or benefits), level of education and need for cognition were the only two significant predictors with respective increases of .24 and .62 in participants' coherence formation. For coherence formation *between* the two positions, interest in natural science, cognitive self-efficacy and SL were significant predictors with a decrease of .64, an increase of .52 and a decrease of .23, respectively. The results are discussed in chapter four.

3.3. Study 3: Phelan, S., Specht, I., Schnotz, W., & Lewalter, D. (2017). Attitude change when presenting science museum visitors with risk–benefit information. *Science Education, 101*(6), 873–886.

Research questions:

5. *Can processing a risk–benefit museum text lead to an average attitude change in visitors toward the topic being presented?*
6. *To what extent do the different dimensions of attitude strength (prior knowledge, attitudinal certainty, attitudinal importance, and attitudinal ambivalence) predict visitors' average attitude change after processing risk–benefit museum text?*

Although many contemporary science museums actively aim to support visitors' attitude formation and change (Bell, 2008; Cameron, 2005; Deutsches Museum, n.d.; Hooper-Greenhil, 2007; Mazda, 2004; Serrell, 2015), there is very little empirical evidence of museum visits influencing visitors' attitudes. Drawing on a dual-positional museum text presenting risks and benefits of biomimetics with visual and auditory text as information conditions, this third paper investigated if risk–benefit information can on average lead museum visitors to change their attitudes. The study also explored whether participants' attitude change can be predicted based on presentation modality on the one hand and visitors' personal attitudinal background on the other. To measure visitors' initial attitude, four dimensions of their initial attitude strength were measured: prior topic-specific knowledge, attitudinal certainty, attitudinal importance, and attitudinal ambivalence. These four dimensions of prior attitude are all known to play a role in attitude change, and we postulated ambivalence to be particularly relevant for the focus of the paper (see section 1.3.2). When looking at visitors' attitude change, descriptively we found that of a total of 113 participants who read the text, 49 (43%) reported a less positive attitude after reading, 32 (28%) reported a more positive attitude, and 32 (28%) showed no change in attitude. Of the 112 participants who listened to the text via an audio guide, 43 (38%) reported a less positive attitude after listening, 26 (23%) reported a more positive attitude, and 43 (38%) demonstrated no attitude change. On average, before information, participants showed a very positive average attitude toward biomimetics. After information, we find a small but significantly less positive average attitude toward biomimetics as compared to before, albeit with a small effect size. When looking at each presentation modality separately, a significant average attitude change was found for visitors reading the text, but not for those listening to the text (see study three for more detail). This

suggests that the visual presentation modality had a more pronounced influence on attitude. To answer the second research question, results indicate that the different dimensions of attitude strength together explained 8% of the variance, but only ambivalence added statistically significantly to the prediction. Overall, our findings suggest that risk–benefit information can on average change visitors' attitudes and that prior attitudinal ambivalence can influence that change. The study and analyses presented in this paper are preliminary and have some important limitations, as discussed in the original manuscript and in chapter four, below.

4. Discussion

In this final section I will discuss some of the findings and limitations of each of the studies presented in this thesis, first separately and then together. The first part of the discussion is by no means exhaustive, but instead serves to highlight findings in each article that fit with the focus of this dissertation. For a more extensive discussion of the findings, limitations and implications for each of the individual studies, I refer to the original papers. In the second part of this discussion, I take a step back and discuss the three studies on a metalevel, referring back to the theoretical framework presented in the introduction, critically reviewing our methodology and suggesting future study focuses.

4.1. Study 1

The rationale behind study one was both pragmatic and theoretical. We decided to study visit motivation as part of the larger research project briefly described at the very start of this thesis. For that purpose, I vainly searched for a German visit motivation instrument and soon realised we had to develop our own based on foreign instruments. During my review of the visit motivation literature, I noticed a considerable overlap in the many visit motivation categories described in various studies. Interestingly, some researchers suggested their categories should hold for different settings, whereas other indicated that theirs are likely site-specific. This led me to wonder if there is a common core of visit motivations across educational leisure settings. Findings in study one suggest that there is indeed. We found a common core of six visit motivation dimensions that can be interpreted equally across three very different educational leisure settings. I'd like to stress here that the description 'a common core' does not exclude additional categories that may be found in specific settings and not in others. It does, however, give us a set of visit motivations that are (apparently) central to most educational leisure settings, which warrants comparisons of visit motivation means across sites. The visit motivation short scale we were able to develop showed sufficient reliability and measurement invariance to validly make such comparisons. In our paper we express our wish to share our instrument and describe how the field can benefit from opportunities the instrument offers. Conversely, there are ways in which the instrument can benefit from future studies. A personal point of criticism in study one is the fact that we based our short scale solely on existing instruments. We would have liked to have complemented our instrument development process with our own qualitative research, but time and resource constraints of the larger research project did not allow for it. So, although we started our study with a

very large and broad item-base, we cannot rule out that there are further core visit motivation dimensions that our instrument does not capture. We therefore welcome any future research that can confirm, complement or contradict our result of a common core of six visit motivation dimensions across educational leisure settings. That being said, the six visit motivation categories we found and the visit motivation short scale we were able to develop, offer exciting prospects for future studies on visit motivation, both across and within sites. Applying the instrument in studies across sites will contribute to a more comprehensive understanding of the role visit motivation plays in educational leisure settings such as museums. When we compared latent means for science museum visitors with those visiting an art museum and a zoo, we found several significant differences in visit motivation means between the science museum and the other two educational leisure settings (see section 3.1). One of these differences is the observation that science museum visitors score the visit motivation category 'learning and pursuing interests' higher than visitors to an art museum and significantly higher than visitors to a zoo, which brings us to the following study.

4.2. Study 2

In study two we applied the visit motivation short scale in a specific (contemporary) science and technology exhibition to investigate how visit motivation is embedded into visitors' broader personal context and how visitors' broader personal, motivational context influences on-site text processing. Results found when looking at differences in visit motivation based on visit company, substantiates some of our social visit motivation categories. For example, we found that visitors accompanied by one or more children scored social learning significantly higher than those who did not have children with them. That social learning and social enjoyment received significantly lower scores from solitary visitors compared to visitors with company, is similarly plausible and is in line with earlier findings (Packer & Ballantyne, 2005). Interestingly, solitary visitors also scored learning and pursuing interests (LI) higher than those with company. This slightly deviates from Packer and Ballantyne's (2005) previous findings. They found that solitary visitors score higher on their visit motivation category 'Understanding', but not on 'Learning and Discovery', which is closer to our LI category. Taken together however, these findings suggest that solitary visitors are more inclined to have a 'cognitive' visit motivation than those with company. Results in study two unveil more interesting insights into the visit motivation category LI. For example, we found a positive correlation with the degree to which the visit was planned (i.e. *focused*, cf. Falk et al., 1998). As it has been suggested that visit strategy and visit motivation are two dimensions of visitor agenda (Falk et al., 1998) it is exciting to find a correlation, albeit for only one of our visit motivation categories (LI).

Staying with the category LI, study two also shows small to moderate positive correlations with participants' interest in natural science, their cognitive self-efficacy and their scientific self-efficacy. In other words, the higher visitors' interest in natural science and the more confident they are in their ability to deal with scientific topics and incorporate new information into existing knowledge structures, the higher they rated learning and pursuing interest as their motivation for visiting. As described in section 1.2, various researchers describe visit motivation as something (e.g. an 'itinerary' or 'framework') reflecting a compilation of personal and socio-cultural background variables (Doering & Pekarik, 1996; MacDonald, 1995). Falk (2006, 2009) suggests that the various individual elements of a visitor's personal background yield a specific motivation. Although our findings don't disclose causality, we do find that personal interest in science and feeling capable of dealing with science topics and of rethinking existing notions based on new information, are some of the more stable elements of a personal background positively linked to the situational motivation LI when visiting a science museum. This is a first step in linking visit motivation to underlying elements of the personal context. Interestingly, we did not find a significant correlation between LI and need for cognition. However, Jan Packer (2004) did not find a correlation between need for cognition and her visit motivation subscale learning and discovery goals either. She argues that need for cognition plays an important role in cognitively demanding tasks, "thus limiting its relevance in educational learning settings, where visitors seek tasks that are perceived to be effortless" (Packer, 2004, p. 189; Packer, 2006). Following that, it is not surprising that in this same study need for cognition did turn out to be a significant predictor for the cognitively rather demanding task of processing a risk–benefit science text. As described in section 3.2, apart from looking at the embeddedness of visit motivation in a wider personal context, we also examined how well our selection of personal context variables can predict visitors' text comprehension when processing a risk–benefit science text. Although these variables together explained a relatively large amount of variance, we found little to no influence of visit motivation on visitors' text comprehension. Besides need for cognition, we found level of education to be a significant positive predictor for the more 'basic' text comprehension task of drawing inferences within each position (risk and benefit) presented in the text. For the more specific task of integrating information across both positions, visitors' cognitive self-efficacy (in our case focussing on one's ability to adjust one's own position on a topic when presented with good alternatives) proved to be a significant predictor. In addition to that, interest in natural science and the visit motivation category social learning turned out to be significant *negative* predictors. That interest in natural science turned out to be a negative predictor for inter-positional coherence formation is unexpected. The topic of the text may have been too specific and may not have formed

part of most visitors' general interest in science. Although we only approached visitors who were browsing the 'relevant' part of the exhibition, our participants were asked to look at the small section directly pertaining to our study. In other words, we don't know if all participants would have read the text on their own account, which is why we included topic specific interest in this part of our analysis. However, we did not find a negative influence for topic interest, nor a positive one for that matter, so these findings remain difficult to interpret. Another somewhat unexpected finding is social learning being a negative predictor for text comprehension. Although we can speculate on underlying reasons, additional research is need to confirm or reject this finding, as I will explain in section 4.4. Nevertheless, results in study two do give a tentative insight into the way a set of situational and more stable personal variables come together and suggest that the interplay between such variables can help predict a visitor's text comprehension in a science museum. Study three takes our analysis a step further by investigating if the same risk–benefit museum text can lead to a change in visitors' attitude towards the topic of the text.

4.3. Study 3

Staying with the example of processing a risk–benefit museum text, study three tentatively explores attitude change in a science museum in a quantitative way. With our study, we hoped to find empirical evidence of a museum visit influencing visitors' attitudes. Somewhat to our surprise, we found that more than two-thirds of the visitors participating in our study indeed showed some change in their attitude on a specific topic after processing a risk-benefit museum text. We also found an average change to a significantly less positive attitude toward biomimetics after to processing the text. Visitors' positive prior attitude fits with the general way the specific topic had been covered in the German media (Oertel & Grunwald, 2006). An explanation for the average change towards a more negative attitude could be a dominant influence of the attitude-incongruent information within our risk–benefit text (i.e. for the majority of participants, the risks) on visitors' attitudes (Van Dijk, Fischer, De Jonge, Rowe, & Frewer, 2012). However, future studies are needed to support this and to further explore how various museum contents touch different ends of the elaboration continuum and affect different aspects of visitors' attitudes. Further research is also needed to establish which (additional) variables can have a significant and meaningful influence on attitude change in the museum. However, results do hint toward the potential influence even a single museum text can have on visitors' attitudes and on the role a visitors' background in terms of the strength of their initial attitude can play when dealing with risk–benefit information. On a general note, a

better understanding of how visitors' prior attitude influences their perception of controversial, conflicting information in the museum should help explain some of the 'unexpected' visitor feedback (cf. Mazda, 2004). Mazda discusses some of the struggles he encountered during seven years of experience in engagement with controversy in the science museum in London. He describes different attempts at achieving a neutral exhibition and argues: "It is not surprising that visitors almost always view an exhibition on controversy to be biased. If the topic covered in the exhibition is truly controversial, visitors will color their perception of the exhibition by their personal views" (Mazda, 2004, p. 141). Of course, personal views will generally colour visitors' information processing, even for less controversial topics, as our results suggest. However, for the challenge curators face when presenting controversial topics in an objective or persuasive (e.g. deliberately biased) way, understanding their visitors' prior attitudes towards the topic at hand would indeed be a crucial starting point. This would ideally involve a broader look at different elements of visitors' prior attitudes, in particular attitudinal ambivalence as our results suggest.

4.4. General discussion

With the studies described in this thesis I explore the relevance of visitors' personal context for learning outcomes in a science museum. The personal context in this case is captured by a small selection of visitors' characteristics with a main focus on visit motivation. Learning outcomes are exemplified by text comprehension and attitude change, which serve as concrete examples of aspects of museum learning. Although these are only two examples out of the wide array of generic learning outcomes (GLO; Hooper-Greenhill, 2007), they were carefully chosen. Firstly, interpretive texts play a crucial role in museum learning by providing context and background information and thus enabling or increasing visitors' understanding of the objects on display (Screven, 1992; Serrell, 2015; Schwan et al., 2018). And, as mentioned in the theoretical section of this thesis (see 1.3), processing conflicting science information is not an uncommon task for visitors to a contemporary science exhibition (Cameron, 2005; Dorfman, 2018; Mazda, 2004). Mazda (2004) argues that museums present different positions in an attempt to present a more balanced view, in line with their aim to 'objectively' support visitors' opinion formation. Encouraging visitors to form or adjust their opinion is a central aim for many museums, especially for exhibitions dealing with contemporary science and research, as explained in section 1.1.2.

Attempting to understand and describe any form of learning in museums requires a broad view (and lots of time and energy). As described in section 1.1, the Contextual Model of

Learning (Falk & Dierking, 2013), which is based on the educational theory of constructivism, attempts to capture the complexity of museum learning. When placing this thesis in the framework of the CML, it is clear the three studies only cover a small slice of the three contexts. With visit motivation in studies one and two, interest, self-efficacy, need for cognition, epistemic beliefs in study two and attitude in study three, I explore small sections of the personal context. In a way, with visitors' average attitude towards the specific topic of biomimetics, which has a certain positive association in German media, as Oertel and Grunwald (2006) suggest, as well as with visit company in study two, we also touch upon the sociocultural context (Falk & Dierking, 2013; Oertel & Grunwald, 2006; Packer & Ballantyne, 2005). And our comparison of two presentation modalities in study three fall under the physical context. However, the main focus is on (part of the) personal context and properly investigating all three contexts belonging to the CML reached beyond the aim and scope of the individual studies. Another element of the CML that our studies were not designed to capture is its aspect of time. The CML poses that true 'learning' begins before and continues after the visit. Two of the studies presented in this thesis include aspects of museum learning that were only measured on-site. In study two we measured visitors' text comprehension and in study three attitude change, in both cases immediately after processing a museum text. We should be careful in labelling these learning *outcomes* as a visit outcome implies something that extends beyond the actual visit, and outcome in the longer term may differ from short-term outcome (Rennie & Johnston, 2007). However, short-term learning is at the very least a prerequisite, and in many cases a good indicator, for longer-term outcomes (Ballantyne, Packer, & Falk, 2011). Participants in study two read a specific museum text and filled out an inference recognition test after reading. Although this test may be too linear and reductionist for museum learning from a constructivist perspective (Falk & Storksdieck, 2005; Hein & Alexander, 1998), it did enable us to measure individual visitors' levels of text comprehension. This is a pragmatic and necessary approach when studying learning empirically. Also, our approach and choice of treatment in studies two and three allowed us to control certain situational factors and limit the number of confounding variables. Moreover, we believe our inference recognition test is a valid way of measuring learning. As Kintsch stated in his award address on text comprehension, memory and learning: "A typical case of learning from a text would be […] a subject answering inference questions after reading a text" (Kintsch, 1994, p. 294), which is how our test was designed (see study two). Additionally, by investigating attitude change in study three, we show that understanding this text led to some form of change in their attitude for more than two-thirds of our participants and to a small but significant positive average change in attitude after processing the text compared to before. So, although we did not include longer-

term outcomes in our studies, we can say that our findings on on-site learning show some surprising and promising indications of (short-term and potential longer-term) learning. On a different critical note though, our focus on text can be seen as a 'reverse' way of approaching museum learning. In the museum, objects and images take centre stage, with accompanying texts serving to support interpretation (Glaser & Schwan, 2015). From a museum learning perspective, measuring how well the object is remembered is at least as important as visitors' memory of the accompanying text (Schwan et al., 2018) and future studies should take this into consideration.

Studies two and three explore the extent to which a specific part of visitors' personal context can predict their comprehension of the text and their attitude change respectively. Study three focused on the personal context variables prior topic-specific knowledge, attitudinal certainty, attitudinal importance, and attitudinal ambivalence and found that only the latter formed a significant predictor for attitude change. In study two our main focus was on visit motivation, but we also explored interest, self-efficacy, need for cognition and epistemic beliefs because of to their expected influence on processing a risk–benefit science text. Prior studies have shown that visit motivation can shape the course of museum visits (Falk & Dierking, 2013) and influence visit outcome from an educational perspective (Packer & Ballantyne, 2002). However, that we find little to no influence of visit motivation on visitors' text comprehension is not surprising. To find an influence of visit motivation on such a small and extremely specific aspect of a visitor's learning experience is unlikely. One could argue that the motivation *learning and pursuing interests* may be a positive predictor for museum learning in general and that this would include text comprehension. However, our study only involved one specific text in one specific exhibition and one specific measure. Obviously, for most visitors, regardless of their visit motivation, processing this one particular text will not capture their museum learning experience. As Falk (2007) suggests, a longitudinal, more holistic approach is needed to investigate the influence of visit motivation on museum learning. The same holds for measuring attitude change in the museum. Due to the fact that we only included one text on one specific topic, our regression models in studies two and three do not lend themselves for further generalisation on text comprehension and attitude change in the museum. Additional studies are needed to further explore if and how different types of museum content influence visitors' attitudes and to determine the impact of visit motivation on text comprehension and other aspects of museum learning.

Our arguably 'narrow' perspective on learning is another point of personal criticism. All three manuscripts take an educational perspective, either by approaching the museum as an educational leisure setting or by directly investigating museum learning. Looking

at the GLO, learning outcomes encompass more than text comprehension and attitude change (Hooper-Greenhill, 2007). Somewhat ironically, the thesis starts with a description of a common core of visitors' own motivations for visiting, only two of which directly include learning. By focusing on learning as information processing in studies one and two we lose track of other motivations and potential outcomes, such as (social) enjoyment for example, which is also one of the generic learning outcomes (Hooper-Greenhill, 2007).[2] According to Black (2005), a focus on learning is a limited view on visit motivation that is often seen in museum research as opposed to the field of leisure and tourism, which takes a wider perspective. The personal characteristics included in study two were chosen based on broader motivational theories and because of their expected relevance for processing a (risk–benefit) science text. Conceivably because of this focus on learning, we found several correlations between these personal characteristics and the visit motivation *learning and pursuing interests*, and one between interest and *social learning*, but none with the other visit motivation categories. In other words, we did not gain much insight into some of our less 'cognitively' oriented visit motivation categories, which are likely to relate to a very different set of personal characteristics. Visit motivations revolving around social interaction, having fun, or recuperation for example, are just as central to museum visits. A better understanding of how visit motivation is embedded in a visitor's wider personal context therefore calls for an investigation of a wider range of personal and situational characteristics. As for attitudes, our educational focus led us to embrace the cognitive and neglect the affective component of attitudes. The Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1986) posits that both affective and cognitive information processing can lead to a change in attitude, and information processing in the museum indeed covers the entire spectrum of the elaboration continuum (Webb, 1997). Exhibitions with truly controversial themes often contain powerful images, leading to strong affective responses in visitors, which we necessarily missed out on in study three due to its focus on text. Future studies are needed to further explore how a wider array of museum content touches different ends of the elaboration continuum and affects different aspects of visitors' attitudes.

Our study's strong focus on text, though leading to certain limitations from a museum research perspective, does pave the way for a transfer of our findings to other areas of research. Short texts dealing with opposing positions or risk–benefit information are not limited to the museum context. On the internet for example, people regularly encounter such texts, and here too such texts are read because people are interested in the topic

[2] Note: considering 'enjoyment' a separate part of museum learning is disputed by Packer (2006), who argues that it in the museum context, enjoyment or 'fun' is inseparable from learning.

or because the information or an accompanying image drew their attention. Especially for socially relevant topics such as nano- and biotechnology, which are key technologies of the 21st century and often publicly discussed, it is important to find out more about how the general public forms and changes their attitudes (Fischer et al., 2013). Furthermore, our findings also have merit beyond *informal* learning. SDT "differentiates types of motivation along a continuum from controlled to autonomous" (Ryan & Deci, 2017a, p. 3). As high-quality (i.e. more intrinsic) motivation has clear benefits for school settings (Reeve et al., 2008), studying peoples text comprehension in a free-choice setting and looking at the role a broader motivational context can play in this, offer valuable insights for formal learning settings too. Taken together, our findings from studies two and three therefore make a small but valuable contribution to a more general understanding of the role of personal characteristics when dealing with risk–benefit information, and on the development of public attitudes toward nanotechnology-related topics that reaches beyond the field of museum research.

Finally, it is worth noting that the three studies offer some useful implications for the museum practice and suggestions for further research. For example, results in study two on differences in visit motivation categories based on visit company confirm and directly add to previous findings. The same goes for the relationships between visit motivation and visit strategy. To my knowledge, the theoretical link between these two has thus far not been corroborated by empirical evidence. Also in study two, by finding out about the relationship between the situational visit motivation categories such as LI with some of its stable 'counterparts' such as interest in science (in the case of a science museum) and need for cognition, we take a first tentative step towards identifying potential antecedents and consequences in the personal context. To investigate these relationships in a more ecologically valid way, future studies could take a combined look at these personal context variables in the shape of visitor profiles (Lewalter et al., 2015; Falk & Storksdieck, 2005). The correlations we found already give some insight into the complexity of a system with the "abundance of factors that influence learning in and from the museum." (Falk, 2007, p. 6). Knowing that texts play an important role in museum learning and that different visitors process information in different ways, study two further contributes by identifying a handful of personal and motivational characteristics that can positively and negatively influence text comprehension. While there are undoubtedly countless other aspects of a visitor's personal background involved in text processing in the museum, our small selection of personal characteristics in study two was able to explain over a quarter of the variance in visitors' text comprehension, suggesting these are indeed important elements for text–based learning in the museum. Although we need to be cautious in generalising our findings, our results at the very least offer a starting point

for future visitor studies. A more concrete implication for practice can be found in study three. Against expectations based on previous studies (Mayer & Moreno, 1998; Schwan et al., 2018) the third study tentatively suggest that written text (as opposed to the audio version) may be more suitable in the specific case of conveying complex, conflicting science topics. A possible explanation is the fact that this modality allows for self-paced learning and rereading of complicated or confusing passages (cf. Kürschner, Schnotz, & Eid, 2007). Finally, it is certainly interesting and perhaps reassuring for museum professionals to find that even a single museum text on a mildly controversial topic can lead to changes in visitors' attitudes as results in study three indicate. Considering that even such a small and concrete part of a visit experience can have a measurable effect on short-term outcome, we can only imagine the vast array of (measurable) learning outcomes resulting from all the encounters and interactions with objects, texts and other people during a museum visit. With this in mind, the findings presented in this thesis will hopefully inspire others to continue where we left off. The visit motivation short scale we developed and presented in study one should contribute to that by facilitating a quick and valid measurement of visit motivation within and across museums.

In conclusion, the choices and limitations discussed in this section are of course challenges many museum researchers are confronted with. Thankfully our individual publications, each with their own specific focus, together form pieces of a larger puzzle of an ongoing, joint, international research effort (Hohenstein & Moussouri, 2018). In a current long-term visitor study, my colleagues and I are already building upon previous findings and conclusions, developing new instruments and continuing to contribute small pieces to the larger puzzle of museum learning.

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