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An Experience Perspective on Intuitive Interaction: Central Components and the Special Effect of Domain Transfer Distance

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Research into intuitive interaction often builds on the development of a definition and clear-cut criteria. The present paper suggests an alternative, more phenomenological approach. In line with the User Experience perspective, we focus on the experiential phenomenon and subjective feelings related to intuitive interaction. Our analysis makes use of insights from psychological research on intuitive decision-making and user research in Human–Computer Interaction. As a result, we suggest four components of intuitive interaction (Gut Feeling, Verbalizability, Effortlessness, Magical Experience) and a research framework of relevant influencing factors. Given that intuitive interaction relies on the transfer of previously acquired knowledge, one suggested influencing factor is the domain transfer distance, i.e. the distance between the application domain and the source domain of transferred prior knowledge. Our theoretical model assumes a differential effect of the domain transfer distance on the four components of intuitive interaction. An empirical study ($n = 152$) substantiates the suggested components and theoretical considerations on the special effect of the domain transfer distance. As assumed, Gut Feeling, Verbalizability, Effortlessness and Magical Experience were all relevant for participants' subjective understanding of intuitive interaction. In line with our model of domain transfer distance, usage scenarios with higher transfer distance were perceived as better representatives of intuitive interaction and characterized by Gut Feeling/Magical Experience, whereas lower transfer distance scenarios were characterized by Verbalizability/Effortlessness. The present paper offers a number of contributions for research and design. Besides providing a better understanding of the phenomenon of intuitive interaction and underlying mechanisms, we discuss how design can profit from these insights (e.g. specification of the desired experience, design for innovation). Limitations of the present study and implications for future research are discussed.

RESEARCH HIGHLIGHTS

- Discusses the phenomenon of intuitive interaction from an interdisciplinary perspective, including HCI, psychology and design.
- Presents an experience-oriented perspective of intuitive interaction, including a model of four subjective components of intuitive interaction and a research framework of influencing factors.
- Suggests a model to explain subjective impressions of intuitiveness depending on the transfer distance between the source of previous knowledge and the application domain.
- Presents an empirical study that tests implications of an experience model of intuitive interaction with a special focus on the effect of domain transfer distance.
- Recommends a design approach based on key subjective factors of intuitive interaction.

Keywords: HCI design and evaluation methods; HCI theory, concepts, and models; Empirical studies in HCI; Interaction design theory, concepts and paradigms; Empirical studies in interaction design; intuitive interaction, User Experience, INTUI-components, domain transfer distance, design principles

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1. INTRODUCTION

Intuitive interaction has emerged as a specific field of research within Human–Computer Interaction (HCI) with a particular wave of interest within the last decade (e.g. Antle *et al.*, 2009; Blackler *et al.*, 2007, 2010; Kaltenbacher, 2009; Macaranas, 2013; Marsh and Setchi, 2008; Mohs *et al.*, 2006a; Naumann *et al.*, 2007; O'Brien *et al.*, 2008). This is not surprising, given the many benefits of uncovering the secret of intuitive interaction: Designing systems that are immediately usable, even without any prior experience or instructions, by almost each and every person. Instead of frustration (about the producer's or one's own incompetence) intuitive interaction goes along with feelings of ease and competence, possibly even fun, and, eventually, happy users.

Thus, many authors have engaged in clarifying the roots of intuitive interaction, defining its essential elements, and listing clear criteria for classifying system use as a case of intuitive interaction. Some typical components, reoccurring in many authors' definitions of intuitive interaction (or intuitive use), are the application of previously acquired knowledge (e.g. Blackler *et al.*, 2002; Naumann *et al.*, 2007; O'Brien *et al.*, 2008) as well as the unconsciousness of this process (e.g. Agor, 1986; Bærentsen, 2000; Blackler, 2006; Macaranas, 2013; Naumann *et al.*, 2007). Some definitions, like that of the Intuitive Use of User Interfaces (IUUI) group, also name classical usability criteria such as 'effectiveness', referring to the ISO standard series by DIN EN ISO 9241-11 (Mohs *et al.*, 2006a; Naumann *et al.*, 2007). When developing its definition, the IUUI group aimed to come up with a shared definition that everybody (at least within the IUUI group) was able to agree with (Naumann *et al.*, 2007, p. 129). Their search for a common denominator within different cases and personal conceptualizations of intuitive use finally resulted in the following definition: 'A technical system is, in the context of a certain task, intuitively usable while the particular user is able to interact effectively, not-consciously using previous knowledge' (Naumann *et al.*, 2007, p. 129). As also discussed by the IUUI research group members themselves, this kind of wide definition allows for a broad range of applications and agreement among many researchers, but, on the other hand, leaves many open questions (Hurtienne *et al.*, 2006). For example, the definition classifies interactions as intuitive that have become performable without conscious thinking only by repeated use and resulting automation of motor actions. As a result, any system could become intuitive at some point in time. Such broad definitions may serve as a helpful checklist but do not provide a picture of typical cases of intuitive interaction.

The INTUI-model suggested here explores an alternative, more phenomenological approach and suggests a novel, more subjective and interdisciplinary perspective on intuitive interaction. Rather than extracting essential characteristics of all cases of intuitive interaction, it searches for typical characteristics of the experience phenomenon, whose specification may vary from case to case. In line with the User Experience (UX) perspective (e.g. Hassenzahl and Tractinsky, 2006) the INTUI-approach is interested in the whole experience of interacting with a system. Instead of objective outcomes, it focuses on the individual feelings that typically go along with intuitive interaction. To explore this subjective side, the perspective is extended to other disciplines beyond HCI, with a particular focus on insights on intuitive decision-making from psychology and the decision-makers' own perceptions of that process (as further described in the next sections). Moreover, we also interviewed users about their first-hand experiences and their opinion about what constitutes intuitive interaction. Hence, a key characteristic of the present approach is the exploration of the phenomenon of intuitive interaction from a holistic perspective, including individual user statements as well as knowledge on intuition from different disciplines. As a result, the INTUI-model suggests four components of intuitive interaction: namely, Gut Feeling, Verbalizability, Effortlessness and Magical Experience (see the following sections for more information on the development of the INTUI-model; see also Ullrich, 2014).

Variations between the components' relative specification distinguish different types of intuitive interaction, so-called INTUI-pattern. The INTUI-pattern, in turn, depends on different factors related to product, person and context. For example, one's prior experience within a product domain (with similar user interfaces or even exactly the same product) affects the perceived degree of effort (Effortlessness) but also extraordinariness and magic (Magical Experience) while interacting with a product. Accordingly, the resulting INTUI-pattern changes over time (see also Ullrich and Diefenbach, 2010b). A similar effect might be triggered through the distance of required knowledge transfer, the so-called *domain transfer distance*. A central prerequisite for intuitive interaction is the transfer of previously acquired knowledge, which may stem from prior experience within the same or other product domains, or even just general sensorimotor knowledge through interaction with the world (e.g. Blackler and Hurtienne, 2007;

Naumann *et al.*, 2007). We think that the distance between application domain and the source of prior knowledge, whose (unconscious) transfer to the present domain enables intuitive interaction, may affect the UX and the resulting INTUI-pattern (see Ullrich and Diefenbach, 2011, p. 67 for a full discussion). High transfer distance may offer a higher specification of Magical Experience and Gut Feeling, whereas low transfer distance may lead to a higher specification of Effortlessness and Verbalizability. Such insights could provide a better understanding of the phenomenon of intuitive interaction and a useful basis for design. Depending on which components are considered as most important in a given usage scenario, designers may choose less or more distant sources of knowledge transfer to design for a specific experience of intuitive interaction. However, prior research rarely discussed the link between transfer distance and UX, and if so, only on a theoretical level (see Ullrich and Diefenbach, 2011).

The present paper further explores the representation of intuitive interaction through the four INTUI-components and tests the theoretical assumptions of the domain transfer model in an empirical study. In the following sections, we discuss existing definitions of intuitive interaction, highlighting the most distinct characteristics and differences as well as typical questions that pop up when aiming at a definition (Section 2). After this, we summarize the development and existing studies on the INTUI-model (Section 3). We then present an empirical study ($n = 152$) that tests whether model theoretical assumptions are also supported by participants' understanding of intuitive interaction (Section 4). Finally, we discuss implications for research and design (Section 5) as well as limitations and questions for future research (Section 6). Hence, this paper follows several aims: First, it discusses alternative views on intuitive interaction and highlights conceptual agreement and differences. Secondly, it introduces an experience perspective on the phenomenon of intuitive interaction and discusses implications for research and design. Thirdly, it presents an empirical test of our phenomenological understanding of intuitive interaction with a focus on one particular factor, namely domain transfer distance.

2. APPROACHES TO INTUITIVE INTERACTION

2.1. The IUUI position

The IUUI group started its activity in 2006. It is an interdisciplinary team of psychologists, computer scientists, engineers and designers, sharing the research interest in intuitive use. As already outlined above, one of its first endeavors was to come up with a shared definition of intuitive use. Based on several expert workshops, user interviews, analysis of attributes associated with the label 'intuitive' in product advertisement as well as internal discussions, the IUUI group suggests the following definition (Naumann *et al.*, 2007):

> A technical system is in the context of a certain task, intuitively usable while the particular user is able to interact effectively, not-consciously using previous knowledge' (e.g. Mohs *et al.*, 2006a; Naumann *et al.*, 2007).

The group further specifies this definition in several respects.

Regarding the criterion of effectiveness and goal accomplishment, the IUUI group refers to the ISO standard series, which describes effectiveness as 'the accuracy and completeness of users' tasks while using a system' (DIN EN ISO 9241-11). However, the claim for effectiveness does not imply that the users' interactions necessarily accord to the ideal interaction path (Mohs *et al.*, 2006b, p. 132; Naumann *et al.*, 2007, p.134). Moreover, effectiveness represents no dichotomous variable but rather forms a continuum (see also Hurtienne *et al.*, 2006, p. 38). Hence, the criterion of effectiveness does not necessarily imply fully precise and complete goal accomplishment.

Another component is the application of prior knowledge. The IUUI group emphasizes that prior knowledge may stem from different levels and that the number of potential users (people having that relevant knowledge) decreases with the degree of knowledge specialization (Mohs *et al.*, 2006b; Naumann *et al.*, 2007). Knowledge sources can be considered as a continuum, reaching from innate knowledge (e.g. instinctive behavior, reflexes, shared by all people) to expertise knowledge (shared by a few people), which also includes knowledge about using tools and technologies.

Finally, another component of the IUUI definition is that the application of prior knowledge happens unconsciously. In the work of Mohs and colleagues (2006b), the IUUI group discusses (un)consciousness under the aspect of selective attention and the threshold of consciousness. A process is defined as conscious if the user's attention is directed to that process, and defined as unconscious if direct attention is missing. According to the IUUI group, intuitive processes represent a third case, namely a process that (meanwhile) is not performed unconsciously but can retain consciousness, if attention is directed to it. Intuitive interaction, thus, is mainly achieved through practice and exercise.

Besides these criteria, the IUUI group also emphasizes that intuitiveness is no feature of a product but a label for human information processes. They argue that 'Intuitive use can only be used in the context of task, user, environment or technical system. More precisely, intuitive use can only be attributed to the human-machine interaction in a certain context, for the achievement of objectives, but not to a technical system per se' (Mohs *et al.*, 2006b, p. 130).

2.2. The position of Blackler and colleagues

Alethea Blackler and colleagues have been engaged in research on intuitive use for more than 10 years. They based their definition of intuitive use on extensive literature review in different fields (e.g. HCI, product design, psychology) and later

verified it through empirical research. Their first definition of intuitive use says that:

> Intuitive use of products involves utilising knowledge gained through other products or experience(s). Therefore, products that people use intuitively should be those with features they have encountered before (Blackler *et al.*, 2002, p. 1).

A later publication further complements that:

> Intuitive interaction is fast and generally non-conscious, so that people would often be unable to explain how they made decisions during intuitive interaction (e.g. Blackler, 2006, p.120).

Or, in slightly different wording:

> Intuition is a type of cognitive processing that utilises knowledge gained through prior experience (stored experiential knowledge). It is a process that is often fast and is non-conscious, or at least not recallable or verbalisable (Blackler *et al.*, 2010, pp. 74, 75).

While the IUUI group emphasizes the effectiveness of interaction, the definition by Blackler and colleagues includes no such reference. In general, however, the two groups' approaches are largely compatible as laid out in a joint publication (see Blackler and Hurtienne, 2007). For example, in accordance with the IUUI definition, Blackler and colleagues also emphasize the components of 'Prior knowledge' and 'Unconsciousness'.

Regarding the application of prior knowledge, they emphasize that the existence of relevant prior knowledge is a critical prerequisite for intuitive interaction (Blackler *et al.*, 2010, pp. 72, 73). If users do not hold any such knowledge, they have to make use of analytical processes. Design for intuitive use, thus, needs to rely on the fact that users will be in possession of the relevant knowledge to be triggered by design. Moreover, their definition includes two further specifications of the characteristics and consequences of the unconscious application of prior knowledge: First, prior knowledge is described as 'knowledge gained through other experience'. Though the definition does not explicitly inform what 'other experiences' adheres to, it suggests that relevant knowledge has been acquired in some other context and probably not within the same system. This is different from the IUUI view, which emphasizes the role of prior experience with exactly the same product, so that continued use of one same system will inevitably result in intuitive interaction. The definition by Blackler and colleagues (2010) thus adds 'Other context' as a new component. Secondly, they refer to the missing verbalizability of processes of intuitive use, describing it as 'non-conscious, or at least not recallable or verbalisable' (Blackler *et al.*, 2010, p. 75), concluding that 'people would often be unable to explain how they made decisions during intuitive interaction' (Blackler, 2006, p. 120). While the IUUI group argues that intuitive interactions can retain consciousness as soon as the user directs attention, Blackler and colleagues suggest that there may be cases of intuitive use where people are completely incapable of conscious reflection on their actions and decisions, even if they tried.

2.3. Further positions and summary

Some of the above extracted components of intuitive interaction also appear in other researchers' definitions. For example, Bærentsen (2000, p. 32) also refers to the aspect of 'Unconsciousness' when defining an intuitive interface as:

> An interface, which is immediately understandable to all users, without the need neither for special knowledge by the user nor for the initiation of special educational measures. Anybody can walk up to the system; see what kind of services it affords, and what should be done in order to operate it. While operating the device, navigation and manipulation of the system interface should proceed without the need for conscious awareness of the sensory- motor operational aspects of the interface.

O'Brien and colleagues (2008, p. 1647) focus on the cognitive processes underlying intuitive interaction and emphasize the interplay of prior knowledge and feed-forward processes, thereby sharing the reference to 'Prior knowledge':

> Interaction between humans and high technology in lenient learning environments that allow the human to use a combination of prior experience and feed-forward methods to achieve an individual's functional and abstract goals.

Antle and colleagues (2009, p. 240) focus on intuitive interaction in the field of embodied interaction. In line with previous definitions, their understanding of intuitive interaction also includes the components of 'Unconsciousness' and 'Effectiveness':

> One way in which intuitive interaction occurs is when, in a movement-based system, users enact appropriate input actions unconsciously or automatically, rather than consciously learning, step-by-step, how to interact with the system.

Macaranas and colleagues (2012a, 2012b, 2013) explore intuitive interaction in the context of movement schemas and their abstract representations. Their understanding of intuitive interaction (e.g. Macaranas, 2013, p. 10) refers to the already discussed components of 'Unconsciousness' and 'Other context':

> Interaction with an unfamiliar system where the user knows how to act quickly and automatically and with unconscious effort and attention.

In sum, definitions of intuitive interaction/intuitive use in HCI research provide the following central components:

(i) Effectiveness (e.g. Antle *et al.*, 2009; Mohs *et al.*, 2006a; Naumann *et al.*, 2007).
(ii) Prior knowledge (e.g. Blackler *et al.*, 2002; Naumann *et al.*, 2007; O'Brien *et al.*, 2008).

(iii) Unconsciousness (e.g. Antle *et al.*, 2009; Bærentsen, 2000; Blackler, 2006; Macaranas, 2013; Naumann *et al.*, 2007).
(iv) Other context (e.g. Blackler, 2006; Macaranas, 2013).
(v) Verbalizability (e.g. Blackler, 2006; Blackler *et al.*, 2010; Ullrich and Diefenbach, 2010a).

3. INTUI: AN EXPERIENCE-ORIENTED PERSPECTIVE OF INTUITIVE INTERACTION

The approaches discussed in the previous section already bring up valuable starting points for the research and design of intuitive interaction. For example, Blackler and colleagues (2010) emphasize the role of prior knowledge and present a technology familiarity questionnaire that has proved a relevant predictor of performance. The IUUI group (Naumann *et al.*, 2007) highlights that relevant prior knowledge may not only be acquired in the domain of technical products but even can go down to the level of sensorimotor knowledge, which is acquired early in childhood. However, when starting our investigation of intuitive interaction, we felt that these approaches did not yet cover all of the relevant elements that add to the experience of intuitive interaction. As a first trial, we dismissed the idea of listing criteria that necessarily must be present in each and every case of intuitive interaction. Instead, we decided to take a holistic look at the experiential phenomenon and its constituents. Our goal was not to supply a better or more concise definition. In contrast, we consciously expanded our view to include the whole variety of experiential characteristics of intuitive interaction. In a parallel process we consulted different sources such as literature on intuitive decision-making in psychology, literature from HCI and peoples' subjective reports on usage experiences collected in an interview study ($n = 41$, 32 female, mean age = 25; see also Ullrich and Diefenbach, 2011). Participants reported on a concrete experience of interacting with a product they found intuitive to use. Products covered a broad range (e.g. software, mobile phone, digital camera, music player, household appliances, gaming consoles, answering machine, printer, navigation system, copying machine, etc.). They reflected on how they operated the product as well as related feelings and thoughts. After describing the concrete event of interaction, they also gave their personal view on constituents and typical characteristics of intuitive interaction.

Based on these different sources (i.e. literature analysis, interview studies), we extracted relevant aspects of intuitive interaction as an experiential phenomenon, leading to the INTUI-model of four components. In the following, we give a short overview on the components' basis in research on intuitive decision-making and HCI-related user statements. Besides the INTUI-model, as a means for the systematic description and exploration of the experiential phenomenon of intuitive interaction, we also present different levels of relevant influencing factors within a larger framework.

3.1. Unconscious, non-analytical, feeling-guided

A central statement on the nature of intuitive decisions refers to the absence of conscious reason and analysis (e.g. Agor, 1986; Bastick, 1982, 2003; Fischbein, 1987; Hammond, 1993; Noddings and Shore, 1984; Vera and Simon, 1993). For example, Hammond (1993) describes intuition as a 'cognitive process that somehow produces an answer, solution, or idea without the use of a conscious, logically defensible step-by-step process'. Kaltenbacher (2009) refers to 'the emotional and supposedly non-purposeful elements in these processes'.

In consequence of the unconscious decision process, the insight gained through intuition is difficult to explain and can hardly be justified by logical steps behind the judgment process (Hammond, 1993). However, not all researchers imply that the absence of conscious logical cognitive process necessarily results in a total unawareness of the decision process as a whole. For example, Bastick (1982, 2003) argues that perceptions become connected to a particular emotional state, a so-called *emotional set*. Intuition builds on the activation of adjacent emotional sets and the creation of new linkages between previously unrelated concepts. The occurring 'drift' between such sets is what the subject perceives as an intuition, i.e. an affective impulse that is hardly explainable. Intuition, thus, is no all-or-nothing phenomenon, but, rather, builds a continuum between completely controlled and automatic processing (Isen and Diamond, 1989; Logan, 1985).

Researchers widely agree that the basic mechanism behind intuition is the (unconscious) access to previously stored memories of diverse origin (e.g. Agor, 1986; Bastick, 2003; Bowers *et al.*, 1990; Cappon, 1994; Dreyfuss and Dreyfuss, 1986; Fischbein, 1987; King and Clark, 2002; Laughlin, 1997; Noddings and Shore, 1984). Such memories could have been stored recently or long ago, and may not be consciously accessible. The strength of intuition thus lies in the holistic integration of all available cues (Hammond, 1996) through the parallel access to huge amounts of data, which conscious, sequential analysis could not have processed (Agor, 1986; Bastick, 2003; Salk, 1983). Bowers (1982) suggests that triggers of intuitive processing are particularly those aspects that do not receive conscious attention. In sum, intuition represents a highly efficient, quick and precise form of processing knowledge from different levels (Agor, 1986). Moreover, intuition performs a filter function, which permits a focus on the relevant part of the available information (Wilson and Schooler, 1991).

The aspect of being guided by feelings rather than thought was also discussed in many intuitive interaction reports in our interview study. A considerable portion of the participants (25 of 41, 61%) based their judgment on a product's intuitiveness (amongst other) on the fact that they used it without conscious thinking and just followed what felt right. Typical statements were 'just having a feeling for how to use the product', 'quickly getting a feeling for it', 'no explicit thoughts about it', 'just interacting spontaneously', 'no need to think about which button to press' or 'having an intuitive

feeling for what's the right thing to do'. Despite the complex mental processes underlying intuitive decisions, participants were not aware of this complexity, and the process of decision-making was perceived as rather vague, uncontrolled and guided by feelings rather than reason. According to their perception, the interaction was directed by 'gut feeling'. Thus, from an experience perspective, one central component of intuitive interaction is feeling-based decision-making.

3.2. Non-verbalizable

Many researchers state that intuitive decisions cannot be verbalized and propose different underlying mechanisms. For example, Wickens and colleagues (1998) argue that this is because intuitive decisions are based on stored memory associations rather than reasoning per se. Another factor is implicit learning. Gigerenzer (2013) argues that experts with vast experience in a specific subject, who make the *best* decisions, are nevertheless the most incapable of *explaining* their decisions. They apply a rule but are unaware of the rule they follow. This is because the rule was acquired by implicit rather than explicit learning. The missing insight into the process of knowledge acquisition implies that it is hardly memorable or verbalizable (Bastick, 1982, 2003; Fischbein, 1987; Hammond, 1993; Noddings and Shore, 1984). Besides, not only the decision-making process itself but also the relevant stored information may remain unconscious (Agor, 1986). This aspect of decision-making without explicit information also becomes visible in the position by Westcott (1968), stating that 'intuition can be said to occur when an individual reaches a conclusion on the basis of less explicit information that is ordinarily required to reach that conclusion'. Similarly, Vaughan (1979) describes the phenomenon of intuition as 'knowing without being able to explain how we know'. Klein (1998), however, sees the reasons for missing verbalizability of intuitive decisions in the nature of human decision-making by itself. He claims that people generally have difficulties with observing themselves and their inner processes and therefore have trouble explaining the sources of their judgments and decisions.

In our interview study, this was reflected by statements such as 'knowing how to operate the product but not knowing why', 'operating the product just happened', or, also, 'I don't remember the single steps but it must have been obvious. There was no need to read the manual'. Altogether, 33 of 41 (80%) participants mentioned non-verbalizable operating steps or a missing verbalizability of the knowledge source as a central characteristic of intuitive interaction. These statements reveal missing verbalizability as another characteristic of intuitive decisions and intuitive interaction.

3.3. Quick and effortless

Another characteristic discussed in relation to intuitive decisions is that they typically arise quickly and effortlessly. This closely relates to the already discussed aspect of missing consciousness. For example, Hogarth (2001, p. 14) claims that 'The essence of intuition or intuitive responses is that they are reached with little apparent effort, and typically without conscious awareness'. In general, intuition produces quick answers and tendencies of action, as it allows for the extraction of relevant information without making use of slower, analytical processes (e.g. Agor, 1986; Bastick, 1982, 2003; Hammond, 1993; Salk, 1983). Accordingly, intuitive decisions can appear as 'strict but strangely vague, revelation-like experience' (Piha, 2005). On a neuronal basis, the quick decision process may rely on the benefits of unconscious processing (Baars, 1988; Clarc and Boden, 1997). Also HCI researchers in the field of intuitive interaction discuss the relation between unconscious and efficient information processing. For example, Blackler and colleagues (2010) state that 'Because it is efficient, intuition is also generally faster than conscious forms of cognitive processing'. They describe intuition as 'a type of cognitive processing … that is often fast and is non-conscious'. Another suggested explanation for the speed and effortlessness of intuitive decisions is that affect is generally more accessible than cognition (Zajonc, 1980). This highlights the relationship between perceiving decisions as effortless as well as feeling-guided.

Users in our interview study emphasized that they handled the product without any strains, describing the interaction as 'quick', 'stress free', 'free from frustration', 'problem free', 'simple' and 'easy functioning', while some also mentioned 'usability', often accompanied by positive surprise. For example, one participant reported on his new Senseo coffee maker, stating that operating the machine was 'much easier than assumed'. In contrast to effortlessness, decision-making statements on effortless interaction could refer to a cognitive but also a motor level. However, user reports did not clearly distinguish between these two types: Reduced cognitive strains were often associated with reduced motoric strains, i.e. the interaction also 'felt' effortless. This finding is in line with research on motor learning, which argues that motor and cognitive learning are often intertwined processes and cannot be clearly separated (e.g. Striedter, 1998). Altogether, 26 of 41 (63%) participants referred to the aspect of effortlessness. However, some also further reflected on it and argued that 'intuitive interaction' and 'effortless interaction' are not synonyms. For example, one participant argued that 'effortless interaction may also result from many years of training, intuitive interaction means directly using the product without prior learning'. Another participant stated that 'intuitive interaction is always effortless but there are also products which are effortless to use but nevertheless not intuitive'. Similarly, one participant referred to the example of driving a car and argued that 'Driving is effortless but only due to automatization. I think that the concept per se is not that intuitive'. Nevertheless, the general tenor was that effortlessness is often a correlate of intuitive interaction. Hence, we consider effortlessness as

another typical characteristic of intuitive decision-making and intuitive interaction.

3.4. Magical experience

Finally, intuitive decisions often appear as magical. Even though not made by magic, a number of mechanisms seem to suggest so. First of all, most people are not aware of the cognitive processes and their prior knowledge underlying intuition so that intuition appears to be a supernatural gift (Cappon, 1994). They are not aware that they had previously acquired knowledge themselves rather than receiving it by magic or revelation. Even if one knows about intuitive processing and the role of prior knowledge, the intuition process is still not directly perceivable. As Klein (1998) argues, the access to previously stored memories usually does not activate single, specific elements but rather refers to sets of similar elements. This aggregated form of knowledge makes one's own contribution to intuition hard to grasp, and people possibly are unaware of the actual source of their intuition. Dreyfus and Dreyfus (1986) emphasize the difference between intuition and wild guessing. In contrast to just guessing, intuition relies on an actual basis rooted in prior experience. However, this difference may not be perceivable for people, so that an 'unlikely good guessing performance' (actually based on intuitive processing) might appear as the result of supernatural power. The mystique of intuition arises because people are unaware of the processes allowing for such insights. In consequence, magic forms another facet of intuition, at least from an experience perspective.

In the interview study, this was reflected by enthusiastic reactions where users emphasized that the interaction was something 'special', 'extraordinary', 'stunning', 'amazing', 'absolutely surprising'—or even 'magical'. Often, such statements referred to examples where participants discovered a new technology or interaction concept, at least not established in this product domain (e.g. a scroll wheel in the domain of mp3 players or digital cameras; touch interaction in the domain of stove tops). Participants further emphasized related emotions and feelings, like 'feeling good while interacting with the product', 'having fun' or reaching their goal 'in a playful manner'. Compared with the previously discussed components, less participants (18 of 41, 44%) mentioned the aspect of 'magical' interaction. However, we still felt that it was an essential component to consider. At least for those who mentioned it, 'magic' formed an essential part of their experience of intuitive interaction.

3.5. Integrative research framework

3.5.1. The INTUI-model: four components of intuitive interaction

Based on findings of our interview study and literature analysis, the INTUI-model suggests four components of intuitive interaction, i.e. Gut Feeling, Verbalizability, Effortlessness and Magical Experience. Note that these four components should not be regarded as a definite or exhaustive model. Although the extracted components provide a kind of definition, this is to be understood in an illustrative and not in a limited sense. When compared with previous approaches in the field of intuitive interaction (see Section 2), particularly the component of Magical Experience represents a novel aspect within the research landscape. Moreover, the model of four components represents a holistic perspective and emphasizes that there are different facets that may be part of intuitive interaction. However, these facets should be seen as options and not as definite requirements. Thus, another important characteristic of our approach is the rather illustrative definition—when compared with previous definitions, which could be seen as 'checklists'.

Among the four components, Effortlessness and Verbalizability are to some extent related to the classical usability concept and the aspects of goal achievement, effectiveness and efficiency (as defined by the DIN EN ISO 9241-11). In contrast, Gut Feeling and Magical Experience rather relate to the concept of UX, which goes beyond the instrumental and is particularly concerned with subjective feelings, emotions, and the positive and motivating qualities of interactive products (e.g. Hassenzahl and Tractinsky, 2006). Actually, a number of approaches to UX and positive experience in HCI, interaction design and psychology address aspects related to the concept of Magical Experience as raised by the participants in our interview study on intuitive interaction. For example, Landin (2005) names 'magical' as one characteristic expressional property of computational technology as a design material. DeJongh Hepworth (2007) suggests 'surprise', 'unordinary', 'unnatural' and 'exciting' as relevant ingredients of magical interaction. Desmet (2003) discusses the role of 'surprise emotions', while Christensen (2004) introduces the concept of 'excitability'. On a broader level, the Magical Experience component also relates to what Jordan (2002, p. 14) discusses as psycho-pleasure like 'relief from boredom and being stimulated', to the emotional experience of flow and immersion (e.g. Chen, 2007; Csikszentmihalyi, 1997; Nacke and Lindley, 2008), or to the combination of positive valence and arousal emotions in the circumplex model by Russell (1980).

After setting up the model of four components, we also developed a tool to survey these. The INTUI-questionnaire is a set of 16 seven-point semantic differential items, which allows the calculation of score values for each of the components (Ullrich and Diefenbach, 2010a). In line with our holistic perspective on intuitive interaction, the INTUI-questionnaire does not suggest the calculation of an overall average score across the four component values. Instead, it evaluates the four components' relative specifications in relation to each other, the so-called INTUI-pattern. Previous studies (Ullrich, 2013; Ullrich and Diefenbach, 2010a, 2010b, 2011) explored the INTUI-pattern with regard to first-level influencing factors (product, user, context) and intermediating, second-level factors (usage mode, judgment integration and domain transfer

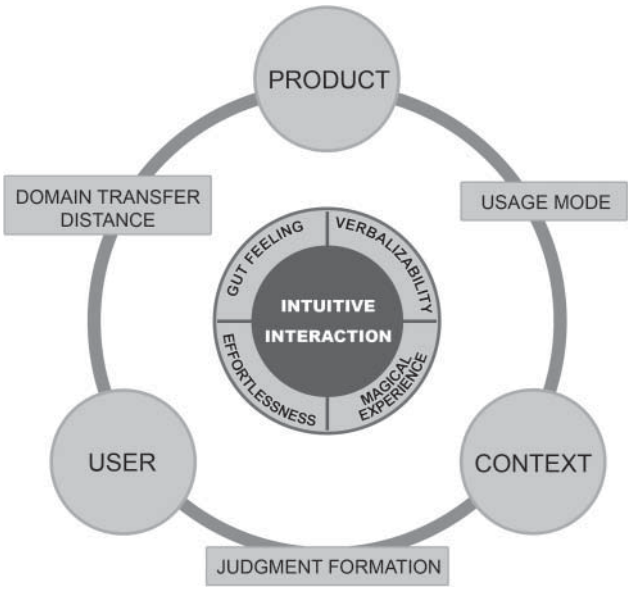

Figure 1. Integrative research framework. Four components of intuitive interaction and relevant influencing factors.

distance), which are summarized in the following paragraphs. Figure 1 shows an overview of the four components of intuitive interaction and relevant influencing factors.

3.5.2. First-level influencing factors

First, a central influencing factor for the experience of intuitive interaction is the product itself. Even small differences in the interaction concept can evoke significant differences in the overall evaluation and judgments on intuitiveness. For example, in one of our first studies we contrasted two mp3 players (see also Ullrich and Diefenbach, 2010a). Owing to slight differences in the operational controls, player A was rated as more intuitive than player B (see Fig. 2). With player A, the upper side of a button (marked with a '+') had to be pressed to raise the volume, and the lower side (marked with a '−') to reduce it. With player B, the function of the upper and the lower part of the button was reversed. While the former is a common solution, the latter is quite unusual and also deviates from the image schema of 'more is up, less is down' (e.g. Hurtienne and Blessing, 2007).

Another relevant product characteristic is its complexity; this particularly pertains to the Verbalizability component. Operating a product without thinking (and, thereby, accepting a high risk for mistakes) may work for reduced interaction concepts—such as the mp3 players in Fig. 2 whose functional range is limited to play, pause, skip forward, skip back, volume up and volume down. Even if one is listening to music on the train, half asleep, blindly grabbing the player, holding it the wrong way round and pressing back instead of forwards, one will not be lost but simply press the opposite button. In this case, intuitive interaction comes with *low* verbalizability and

Figure 2. Player A (left) was rated as more intuitive than player B (right).

no conscious reflection, as known from the field of intuitive decision-making.

However, entirely unreflective interaction cannot be an ultimate design goal for all kinds of products. Most products are more complex than mp3 players are. For example, websites, software or modern televisions offer a variety of functions in nested menus. Using such systems without any reflection bears a high risk of being stuck with no idea where to find the solution. Hence, the intended positioning on the continuum between completely controlled and automatic processing (Isen and Diamond, 1989; Logan, 1985) must depend on the product's complexity.

For complex products, intuitive interaction may represent reaching one's goal without cognitive effort while still reflecting one's doing: possibly not knowing *why* this is the right button (so this part is still not verbalizable) but being aware of what one is doing and one's different steps of action. Thus, intuitive interaction concepts should be easy to grasp and easy to make sense of but not necessarily remain indescribable or prevent reflection. This also parallels the position by other researchers (e.g. Bolter and Gromala, 2003; Hornecker, 2012) who emphasize the value of reflection in interaction. For example, Bolter and Gromala (2003) demystify the promises of transparency and even argue that perfect transparency would be a dangerous mistake. Instead, interfaces should allow the user to 'step back and contemplate'. Hornecker (2012) discusses the challenges of design strategies for intuitive use that rely on tangible interaction and affordances. She suggests a change of focus 'from support of intuitive use to the design of seamful mappings and the support of reflection and learning' (Hornecker, 2012, p. 175), and argues that 'interfaces should oscillate between transparency and reflection' (Hornecker, 2012, p. 180).

Another factor related to the emerging INTUI-pattern is the product domain. In a previous study (Ullrich and Diefenbach, 2010a) participants reported on products from their daily

life which they saw as particularly intuitive. They mentioned products from four broad categories, i.e. computers, mobile phones, home appliances and fun products (e.g. gaming consoles), with typical differences in the related INTUI-pattern. Home appliances, for example, typically got high values for Effortlessness and Verbalizability, whereas mobile phones got higher values for Gut Feeling and Magical Experience. Depending on the product type and typically related tasks, different components may be particularly relevant for an overall impression of intuitive interaction. These different requirements need to be addressed in design.

Besides the product itself, the emerging experience of intuitive interaction also depends on user characteristics and the particular context of use (cf. Fig. 1). As also argued by others (Mohs *et al.*, 2006b), intuitiveness is not a product feature but depends on the interplay between system and user in a given context. Probably the most relevant user characteristic for intuitive interaction is the user's prior knowledge. First of all, the transfer of relevant prior knowledge to the current use situation is a prerequisite for intuitive interaction to occur. Moreover, the degree of prior knowledge in a given product domain affects the specific type of resulting experience and different INTUI-components become more or less relevant for the global judgment of intuitiveness. For novice users, Magical Experience is the best statistical predictor of overall judgments of intuitiveness, whereas, for expert users, judgments on intuitiveness rather depend on Effortlessness (Ullrich and Diefenbach, 2010b, 2011).

3.5.3. Second-level influencing factors

Apart from the basic factors of product, user and context, there are relevant intermediating factors such as the usage mode (e.g. Hassenzahl and Ullrich, 2007) or the integration of judgments on intuitiveness over time. Goal-related usage modes focus on the achievement of single specific tasks (e.g. booking a train ticket, doing a data backup), whereas explorative usage modes are undirected and provide more room for experiential needs and actions (e.g. browsing a news site). Even in the interaction with the same product (e.g. mobile phone) we found a varying relevance of the INTUI-components depending on the task/usage mode. For example, the relevance of the Verbalizability component was more pronounced in goal modes (possibly evoking a need for reflection and control) than in explorative modes (Ullrich and Diefenbach, 2011).

Furthermore, interaction proceeds along time and consists of many single steps and impressions (of more or less intuitive interaction) that contribute to an overall judgment on the product's intuitiveness. However, in the process of judgment integration, some impressions can get a higher weight than others. In a previous study on photo-editing software, single 'non-intuitive' functions led to a significant and non-proportional downgrading of the products' overall intuitiveness (Ullrich and Diefenbach, 2011). Moreover, one's own subjective impression of being effective was even more important than objective task performance (e.g. level of task completion, time of task completion). Establishing an impression of intuitive interaction requires a consistent feeling of 'being on track'. Suboptimal solutions for single functions can already diminish one's confidence and destroy the flow of intuitive interaction. For developers, this finding highlights the risk of cluttering a product with too many functions at the expense of consistency and perceived intuitiveness.

Another factor that we assume relevant for users' experience is the *domain transfer distance*, i.e. the distance between the application domain and the origin of prior knowledge that enables intuitive interaction. For example, low transfer distance is demonstrated in a subject's intuitive use of a product (e.g. iPhone 5) when the subject had previous experience with a preceding model and basically the same interaction concept (e.g. iPhone4). The origin of prior knowledge and the application of knowledge both relate to the same product domain and technology (here: smartphones and touch display). In contrast to this, the shake to shuffle function introduced with the iPod nano (fourth generation) forms a case of higher domain transfer distance. Here, intuitive interaction builds on prior knowledge acquired in the domain of physical objects (e.g. shaking a drink to mix the ingredients). The origin of prior knowledge and the application of knowledge relate to different product domains (drinks and kitchen appliances vs. music player) and different materials (juice vs. digital data). This may apply to most concepts of so-called reality-based interaction, which rely on the transfer of pre-existing knowledge acquired in the everyday, non-digital world (e.g. Jacob *et al.*, 2008).

However, while other influencing factors have already been explored in empirical studies (see Ullrich, 2013; Ullrich and Diefenbach, 2010a, 2010b), the role of transfer distance has so far only been discussed theoretically (Ullrich and Diefenbach, 2011). Our domain transfer model assumes that the distance between the application domain and the source of transferred prior knowledge (which effectively enables intuitive interaction in the application domain) affects the specific experience of intuitive interaction and the resulting INTUI-pattern (see Fig. 3).

Figure 3 illustrates three core assumptions related to the concept of domain transfer distance: (1) At some point, there is a limit where the transfer distance is too high and no more knowledge transfer is possible. (2) The effect of transfer distance follows an asymptotic function until the transfer limit is reached. (3) There is a differential effect of rising transfer distance for the four components.

The first two assumptions, referring to the transfer limit, both highlight that transfer distance is not a limitless factor. If the distance between the application domain and relevant stored knowledge becomes too high, the cues in the present domain may not be powerful enough to activate the relevant prior knowledge. Then, knowledge transfer and, in turn, intuitive interaction are no longer possible. Possibly this was the case in the study by Gatsou and colleagues (2011), where older

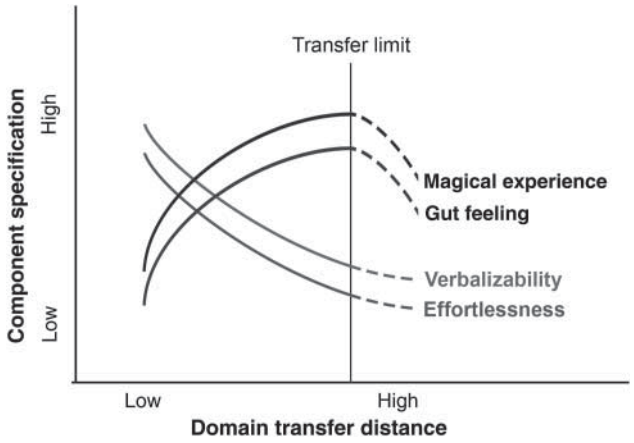

Figure 3. Domain transfer model.

users with little computer experience failed to understand the metaphor of a home icon (a house) to navigate back to the main menu. Discovering the parallel between a house as a point of start and return in real life and the main menu as a point of start and return in the domain of web navigation exceeded the transfer limit. Consequently, intuitive interaction failed. In contrast, younger users with higher computer experience explicitly knew the meaning of the home icon in the domain of websites and software. Understanding the home metaphor did not require knowledge transfer between different domains, making it a case of low domain transfer distance. From an experience perspective, the prime example of intuitive interaction might be positioned somewhere in between these two transfer distance extremes—higher than applying explicit knowledge from the same domain, however, just before reaching the transfer limit.

The present research focuses on the third assumption, i.e. the differential effect of transfer distance for the four components. As depicted in Fig. 3, we assume that the specification of Effortlessness (i.e. the degree of perceived effortlessness of the interaction) decreases with growing domain transfer distance. The more obvious the relation between the present scenario and the prior experience, which offers access to knowledge of relevance to the present case, the more effortless the interaction appears. The specification of Verbalizability follows the same direction. Given low transfer distance, it will be easier to reflect on and describe the interaction, possibly because one is aware of where one's knowledge for operating the system comes from. In contrast, Gut Feeling and Magical Experience will be rather low in cases of low transfer distance. When the source of 'intuition' is too obvious, interaction does not feel magical or guided by gut feeling but just guided by previously learnt principles. Thus, Gut Feeling and Magical Experience will increase with domain transfer distance. Let us use the example of reality-based interaction concepts (Jacob *et al.*, 2008), e.g. copying naïve physics and concepts like gravity or friction on touch displays. Such concepts pick up knowledge that is well learnt but has been acquired in another domain, namely, the non-digital world. This makes reality-based interaction a case of high domain transfer distance, which, in turn, implies a rather high specification of Magical Experience (surprising, or not expected in this domain) and Gut Feeling (acting based on feeling rather than thinking) but a lower specification of Verbalizability and Effortlessness. At least, this is what we would expect compared with cases of lower domain transfer distance, where the interaction concept is already established in the same domain and just copied from other products (e.g. a flip switch in the domain of lamps). Note, however, that the domain transfer model makes predictions about relative differences between the components and not exact score values.

4. STUDY

The previous section described our theoretical considerations about the concept of domain transfer distance and its relevance for the experience of intuitive interaction. As a next step, we ran an empirical study that checked our model-based hypotheses against peoples' understanding of intuitive interaction in different scenarios. Besides the concept of domain transfer distance, we also examined the support for the four INTUI-components as relevant constituents of intuitive interaction. In the following, we describe the research objectives and procedure in more detail.

4.1. Research objectives and procedure

The study was conducted online using SurveyMonkey (www.surveymonkey.com) in German. Invitations to the study were distributed via students' unions representatives of various universities in Germany, Austria and Switzerland. As an incentive, ten Ł10 gift vouchers were raffled among all participants who completed the survey. Of 226 individuals who started the study, 152 completed it (67% retention rate), whereby we allowed for single missing values. Those were included in the final sample ($n = 152$, 92 female, mean age = 24 years, SD = 5.62, min = 18, max = 59).

The study consisted of two parts, aimed at two independent research objectives:

(1) The objective of the first part was to validate the central components of intuitive interaction suggested in existing definitions against peoples' common understanding and experience. In fact, the INTUI-components have been primarily derived from the experience reports of users, and previous studies confirmed their general relevance for a product's perceived intuitiveness by significant correlations to the score values of the INTUI-questionnaire. However, none of these studies cross-validated the four-component model by explicitly asking participants whether the single components represent relevant

Table 1. Items to represent different components of intuitive interaction/intuitive use suggested in definitions in HCI.

Component of intuitive interaction	Sample definitions	Item
INTUI		
Gut Feeling: guided by gut feeling rather than reason	Kaltenbacher (2006) Ullrich and Diefenbach (2010b)	Intuitive interaction is guided by feelings rather than reason
Verbalizability: low verbalizability, people may not be able to explain their decision	Blackler (2006) Ullrich and Diefenbach (2010b)	Intuitive interaction means instantly being able to operate a product but you cannot tell why
Effortlessness: effortless interaction	Ullrich and Diefenbach (2010b)	Intuitive interaction means that users can accomplish their tasks effortlessly
Magical Experience	Ullrich and Diefenbach (2010b)	Intuitive interaction means that operating a product is surprisingly simple, almost magical
Other		
Effectiveness: effective interaction	Antle *et al.* (2009) Mohs *et al.* (2006a) Naumann *et al.* (2007)	Intuitive interaction means that users can accomplish their tasks effectively
Prior knowledge: application of prior knowledge	Blackler *et al.* (2002) Naumann *et al.* (2007) O'Brien *et al.* (2008)	Intuitive interaction relies on the application of already acquired knowledge
Unconsciousness: unconscious access to prior knowledge or decision process	Antle *et al.* (2009) Bærentsen (2000) Blackler (2006) Macaranas (2013) Naumann *et al.* (2007)	Intuitive interaction is performed unconsciously
Other context: prior knowledge acquired in another context/system	Blackler (2006), Macaranas (2013)	Intuitive interaction relies on prior knowledge gained in other contexts

constituents of intuitiveness. We were thus interested in whether the four components suggested in our INTUI-model provide a meaningful picture of intuitive interaction from the participants' point of view. This was operationalized by four different statements, each denoting one of the components as characteristic of intuitive interaction (see Table 1, subsection *INTUI*). Participants indicated their agreement to each of the statements on a four-point scale (1 = not at all agree, 4 = completely agree; see Appendix for exact instructions and items). In line with the INTUI-model we assumed

(H1) A significant degree of agreement to statements related to all four INTUI-components.

In addition to the INTUI-components, we also explored components suggested in definitions by other researchers (see Table 1, subsection *Other*). Altogether, we thus explored eight components of intuitive interaction/intuitive use (Column 1), as suggested within definitions by one or several researchers (Column 2), each represented by one item (Column 3). Items were presented in random order.

(2) The objective of the second part of our study was to test our domain transfer model, as specified in the previous section (also see Ullrich and Diefenbach, 2011). Our basic assumption was that

(H2) Use cases with higher transfer distance will be perceived as clearer cases of intuitive interaction compared with use cases with lower transfer distance.

Moreover, we hypothesized that

(H3) Differences in transfer distance will also affect the specification of the INTUI-components.

More specifically, in line with the domain transfer model, we assumed that

(H3a) Gut Feeling should be higher for use cases with higher transfer distance compared with use cases with lower transfer distance.

(H3b) Magical Experience should be higher for use cases with higher transfer distance compared with use cases with lower transfer distance.

In contrast

(H3c) Verbalizability should be higher for use cases with lower transfer distance compared with use cases with higher transfer distance.

(H3d) Effortlessness should be higher for use cases with lower transfer distance compared with use cases with higher transfer distance.

Differences in transfer distance were operationalized by presenting pairs of usage scenarios (a full list of all usage scenarios can be found in the Appendix). Within each pair, both scenarios described examples of intuitive interaction with the same product in the same application domain. The only difference between the two scenarios was the indicated source of prior, transferred knowledge, resulting in higher transfer distance for one of the scenarios. For example, one of the scenario pairs read:

> Lisa instantly knows how to operate her new mp3-player. She is somehow already familiar with the scroll wheel. **This is because of her stereo system** (*medium transfer distance*). / **This is because she knows the preceding model** (*low transfer distance*). Intuitively she knows which direction to scroll to pick the next song.

Altogether, participants were confronted with a total of nine scenario pairs, presented in random order on separate pages (see Appendix for all nine scenario pairs). To differentiate contrasted scenarios within one pair, one was labelled 'Scenario 1' and the other 'Scenario 2'. The matching of labels to the scenario with higher or lower transfer distance was balanced across the nine pairs. To control for potential effects of the concrete level of transfer distance, application domain and relevant user interface parts, we explored three different specifications for each of these. Thus, the scenarios covered three different domains of application (mp3-player, bread machine, photo-editing software), whereby intuitive interaction applied to different parts of the user interface (concrete operational elements, icons, menu structure). Moreover, we contrasted scenarios indicating three different levels of transfer distance (low, medium, high) within each domain. Scenario pairs thus covered extreme contrasts of transfer distance (low versus high) and moderate contrasts (low versus medium, medium versus high). Note that all usage scenarios were described as cases below the critical limit of transfer distance, implying that intuitive interaction was still possible.

For each of the scenario pairs, participants were asked for five ratings, indicating their view on which of the two represented the clearer case of intuitive interaction (ref. H2), was experienced as more feeling-guided (ref. H3a), more magical (ref. H3b), easier to verbalize and describe (ref. H3c) and more effortless (ref. H3d). All ratings were assessed as four-point semantic differential items (Scenario 1 vs. Scenario 2; see Appendix for exact instructions and items).

In preparation for analysis of the scenario ratings, we performed several data-processing steps. First, we re-coded scenario ratings so that across all nine scenario pairs, a high rating indicated a rating in favor of the scenario with higher transfer distance. Secondly, we calculated overall means across the nine scenario pairs for the five different scenario ratings (i.e. Intuitive Interaction, Gut Feeling, Verbalizability, Effortlessness and Magical Experience), irrespective of the domain of application and the type of contrast. Thirdly, we calculated means of the scenario ratings for the different domains of application (i.e. mp3 player, photo-editing software and bread machine). Fourthly, we calculated means of the scenario ratings across extreme contrasts as well as moderate contrasts.

4.2. Results and discussion

4.2.1. Picture of intuitive interaction

In accordance with H1, agreement to statements on all four INTUI-components significantly exceeded the (theoretical) scale midpoint of 2.5. The same applied to the components of intuitive interaction suggested within definitions by other researchers (see Table 2, section *Agreement scores*). As a more convenient measure, we also calculated the ratio of 3 and 4 ratings for each component, indicating the percentage of participants that either agreed or fully agreed with the according statement. Figure 4 shows the ratio of agreement for all eight components analyzed. The four INTUI-components gained the highest ratios of agreement, ranging from 69% for Effortlessness to 78% for Gut Feeling. The difference between ratios of agreement (3 and 4 ratings) versus disagreement (1 and 2 ratings) was significant for all four INTUI-components (χ^2 tests for uniform distribution; see Table 2, section *Ratios of agreement* for components section *INTUI*). For the non-INTUI-components, the ratios of agreement were lower and only significant for Unconsciousness and Other Context (63% each, χ^2 tests for uniform distribution; see Table 2, section *Ratios of agreement* for components section *Other*).

4.2.2. Role of transfer distance for overall impression of intuitiveness

To explore which of two contrasted scenarios (lower or higher transfer distance) participants perceived as a clearer case of intuitive interaction, we performed *t*-tests against the (theoretical) scale midpoint of 2.5. In accordance with H2, the overall mean rating on Intuitive Interaction ($M = 3.39$) significantly exceeded the scale midpoint between the two scenarios (see Table 3, line *Overall mean* for statistical data). This effect indicates that scenarios with higher transfer distance

Table 2. Agreement with suggested components of intuitive interaction/use.

	Agreement scores[a]						Ratios of agreement[b]			
Components	*M*	SD	*t*	df	*P*	*d*	% agree	χ^2	df	*P*
INTUI										
Gut Feeling	3.07	0.85	8.26	151	<0.001	0.67	78	46.42	1	<0.001
Verbalizability	3.05	0.89	7.50	149	<0.001	0.61	75	36.51	1	<0.001
Effortlessness	2.89	0.89	5.39	151	<0.001	0.44	69	22.13	1	<0.001
Magical Experience	2.98	0.88	6.68	150	<0.001	0.54	74	33.38	1	<0.001
Other[c]										
Effectiveness	2.74	0.91	3.20	151	<0.01	0.26	57	2.63	1	n.s.
Prior knowledge	2.72	0.90	3.05	148	<0.01	0.25	57	2.96	1	n.s.
Unconsciousness	2.83	0.92	4.43	149	<0.001	0.36	63	9.63	1	n.s.
Other context	2.78	0.89	3.92	151	<0.001	0.32	63	10.53	1	<0.001

Note: Bonferroni-adjusted significance level = 0.003.

[a] *t*-tests for significance of deviation from (theoretical) scale midpoint of 2.5.

[b] χ^2 tests for significance of deviation from disagreement.

[c] See Table 1 for origin of components in other researchers' definitions of intuitive interaction.

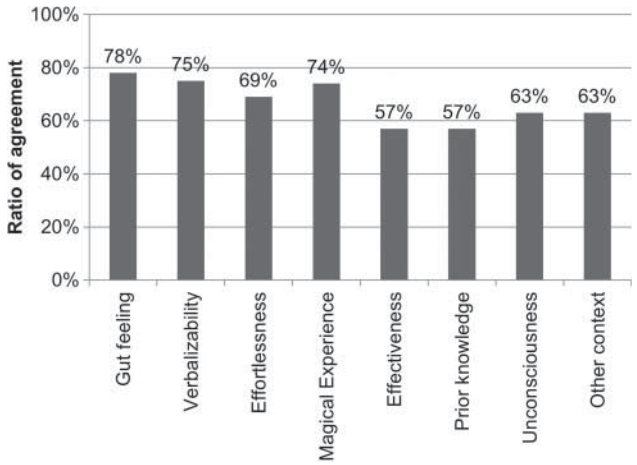

Figure 4. Ratio of agreement to statements on different components of intuitive interaction/intuitive use.

Table 3. Mean scenario ratings for intuitive interaction and *t*-tests for significance of deviation from (theoretical) scale midpoint of 2.5.

Measure/subgroup	*M*	SD	*t*	df	*P*	*d*
Overall mean	3.39[a]	0.65	16.85	151	<0.001	1.37
Application domain						
Mp3-player	3.35[a]	0.76	13.77	151	<0.001	1.12
Photo editing software	3.41[a]	0.76	14.44	145	<0.001	1.20
Bread machine	3.40[a]	0.73	15.03	148	<0.001	1.23
Level of contrast						
Extreme contrasts	3.59[a]	0.57	23.59	151	<0.001	1.91
Moderate contrasts	3.35[a]	0.65	16.09	151	<0.001	1.31

Note: Bonferroni-adjusted significance level = 0.008.

[a] Significantly above scale midpoint, i.e. tendency toward scenario with higher transfer distance.

were perceived as clearer cases of intuitive interaction than those with lower transfer distance. Separate analyses within the three studied application domains confirmed the generalizability of this effect (see Table 3, subsection *Application domain*). Separate analyses within extreme as well as moderate scenario contrasts confirmed the effect within both subgroups of scenario pairs (see Table 3, subsection *Level of contrast*). However, a paired *t*-test contrasting participants' ratings for extreme versus moderate scenarios also revealed a sensitivity for gradual differences in transfer distance. For extreme scenario contrasts, the mean rating for Intuitive Interaction ($M = 3.59$) was significantly higher than the mean rating for moderate scenario contrast ($M = 3.35$, $t(149) = 3.66$, $P < 0.001$, $d = 0.39$). The more obvious the difference in transfer distance between the two contrasted scenarios, the more definite was the tendency to rate the scenario with higher transfer distance as the clearer case of intuitive interaction. This gradual effect underlines the role of transfer distance as the underlying factor for perceptions of intuitive interaction, as assumed in the domain transfer model.

4.2.3. Role of transfer distance for INTUI-pattern

The analyses of scenario ratings for the four INTUI-components confirmed our hypotheses about the specific impact of domain transfer distance on different experiential facets of intuitive interaction. As assumed in H3, differences in transfer distance between the scenarios affected the specification of the INTUI-components in different directions. For Gut Feeling and Magical Experience (H3a, H3b), the mean ratings were significantly higher than the (theoretical) scale midpoint of 2.5 between

Table 4. Mean scenario ratings and *t*-tests for significance of deviation from (theoretical) scale midpoint of 2.5 for the four INTUI-components.

Measure/subgroup	*M*	SD	*t*	df	*P*	*d*
Overall means						
Gut Feeling	3.17[a]	0.59	14.03	151	<0.001	1.14
Verbalizability	1.94[b]	0.68	−10.23	151	<0.001	−0.83
Effortlessness	1.99[b]	0.71	−8.88	151	<0.001	−0.72
Magical Experience	3.50[a]	0.44	27.79	151	<0.001	2.25
Application domain						
Mp3-player						
Gut Feeling	3.09[a]	0.73	9.84	151	<0.001	0.80
Verbalizability	2.08[b]	0.83	−6.26	151	<0.001	−0.51
Effortlessness	2.06[b]	0.81	−6.73	150	<0.001	−0.55
Magical Experience	3.52[a]	0.57	21.99	151	<0.001	1.78
Photo editing software						
Gut Feeling	3.22[a]	0.71	12.40	148	<0.001	1.02
Verbalizability	1.75[b]	0.77	−11.87	148	<0.001	−0.97
Effortlessness	1.84[b]	0.81	−9.90	148	<0.001	−0.81
Magical Experience	3.50[a]	0.55	22.08	148	<0.001	1.81
Bread machine						
Gut Feeling	3.22[a]	0.68	13.18	151	<0.001	1.07
Verbalizability	1.98[b]	0.74	−8.60	151	<0.001	−0.70
Effortlessness	2.07[b]	0.81	−6.64	151	<0.001	−0.54
Magical Experience	3.48[a]	0.59	20.26	151	<0.001	1.64
Level of contrast						
Extreme contrasts						
Gut Feeling	3.27[a]	0.70	13.47	151	<0.001	1.09
Verbalizability	1.90[b]	0.79	−9.33	151	<0.001	−0.76
Effortlessness	1.98[b]	0.86	−7.48	151	<0.001	−0.61
Magical Experience	3.59[a]	0.57	23.59	151	<0.001	1.91
Moderate contrasts						
Gut Feeling	3.13[a]	0.60	12.81	151	<0.001	1.04
Verbalizability	1.96[b]	0.68	−9.93	151	<0.001	−0.81
Effortlessness	1.99[b]	0.68	−9.11	151	<0.001	−0.74
Magical Experience	3.46[a]	0.46	25.71	151	<0.001	2.09

Note: Bonferroni-adjusted significance level = 0.002.

[a]Significantly above scale midpoint, i.e. tendency toward scenario with higher transfer distance.

[b]Significantly below scale midpoint, i.e. tendency toward scenario with lower transfer distance.

the two scenarios, indicating a higher degree of Gut Feeling and Magical Experience for the scenarios with higher transfer distance (see Table 4, subsection *Overall means*). In contrast, for Verbalizability and Effortlessness (H3c, H3d), the mean ratings were significantly lower than the (theoretical) scale midpoint of 2.5 between the two scenarios, indicating a higher degree of Verbalizability and Effortlessness for the scenarios with lower transfer distance (see Table 4, section *Overall means*).

Moreover, we further explored the resulting INTUI-pattern by analyzing differences between the single components. An analysis of variance with *component* (Gut Feeling, Verbalizability, Effortlessness, Magical Experience) as a within-subjects factor and *scenario rating* as a dependent variable revealed significant differences between the components, $F(3, 453) = 262.49$, $P < 0.001$, $\eta^2 = 0.64$ (see also Table 5, section *overall means*). The pairwise comparison of mean differences (Bonferroni adjusted) revealed Gut Feeling along with Magical Experience both to be significantly higher than Verbalizability and Effortlessness. This was consistent with our basic assumptions in H3. Moreover, the mean rating for Magical Experience was still higher than that for Gut Feeling, indicating that Magical Experience especially is affected by the level of transfer distance underlying intuitive interaction. This is comprehensible, considering that high transfer distance affects the apparentness of the knowledge transfer source. Thus, the experience will appear as

Table 5. Analyses of variance within INTUI-pattern, testing the significance of differences between the four INTUI-components' specification.

Measure/subgroup	F	df	P	η^2
Overall means	262.49	3, 453	<0.001	0.64
Application domain				
Mp3-player	143.20	3, 450	<0.001	0.49
Photo editing software	249.34	3, 453	<0.001	0.63
Bread machine	188.70	3, 444	<0.001	0.56
Level of contrast				
Extreme contrasts	210.60	3, 453	<0.001	0.58
Moderate contrasts	246.56	3, 453	<0.001	0.62

Table 6. Intercorrelations between INTUI-components and overall rating on intuitive interaction.

Rating	Gut Feeling	Verbalizability	Effortlessness	Magical Experience
Intuitive interaction	0.52**	−0.15	0.02	0.54**
Gut Feeling		−0.31**	−0.03	0.52**
Verbalizability			0.39**	−0.28**
Effortlessness				−0.28**

** $P < 0.01$.

more or less magical, depending on whether one is aware of this source or not.

Separate analyses within the different application domains as well as within extreme scenario contrasts and moderate scenario contrasts confirmed the generalizability of the hitherto reported effects of transfer distance on the resulting INTUI-pattern (see Table 4, subsections *Application domain* and *Level of contrast*). Within all subgroups, a higher degree of Magical Experience and Gut Feeling was related to the scenario with higher transfer distance, whereas a higher degree of Effortlessness and Verbalizability was related to the scenario with lower transfer distance. Also, the pattern within the four components, revealed by analyses of variance, stayed the same for all subgroups of scenarios (see Table 5, subsections *Application domain* and *Level of contrast*). In all cases, significant differences between the components emerged. Pairwise comparison (Bonferroni corrected) showed Magical Experience as well as Gut Feeling to be higher than Effortlessness and Verbalizability, and also higher ratings for Magical Experience compared with Gut Feeling.

As already discussed for the rating on Intuitive Interaction, paired t-tests revealed also that participants' ratings for Gut Feeling and Magical Experience were affected by gradual differences in transfer distance. For Gut Feeling and Magical Experience, extreme scenario contrasts induced higher mean ratings (see Table 4, subsection *Extreme contrasts*) than moderate scenario contrast (see Table 4, subsection *Moderate contrasts*). The difference between extreme and moderate contrasts was significant for Gut Feeling ($M = 3.27$ vs. 3.13, $t(151) = 3.35$, $P < 0.001$, $d = 0.25$) as well as Magical Experience ($M = 3.59$ vs. 3.46, $t(151) = 3.52$, $P < 0.001$, $d = 0.21$). However, for Verbalizability and Effortlessness, the extremeness of scenario contrasts had no significant effect on the components' specification (Verbalizability: $M = 1.90$ vs. 1.96, $t(151) = -0.37$, *n.s.*; Effortlessness: $M = 1.98$ vs. 1.99, $t(151) = -1.44$, *n.s.*). This finding highlights the special relevance of transfer distance for the subjective experience of intuitive interaction. While the highly experience-oriented components of Gut Feeling and Magical Experience were sensitive to subtle differences in scenarios of intuitive interaction, the same differences were less relevant for the more task- and classical usability-oriented components of Verbalizability and Effortlessness.

This differential effect of extremeness of scenarios also explains that analyses of variance showed the same INTUI-pattern for extreme and less extreme scenarios. This was because Verbalizability and Effortlessness were not susceptible to gradual differences in transfer distance. Altogether, from an experience perspective the gradual differences in transfer distance are thus more relevant for the emotional aspects of intuitive interaction than for aspects that parallel classical usability aspects. It is important to note that the non-sensitivity of Effortlessness only refers to participants' subjective experience. Our study did not refer to objective performance-related parameters. Gradual differences in transfer distance could have an effect on how easy it is to transfer relevant knowledge and, in turn, task performance. This question, however, was not part of the present study and may be explored in future research.

4.2.4. *Correlational analysis of relations between INTUI-components and overall rating on Intuitive Interaction*

Finally, we analyzed the correlations between scenario ratings on the four INTUI-components as well as the overall rating on Intuitive Interaction (see Table 6). This was an explorative analysis to gain deeper insight into the relations between the components and their relevance for the overall rating on Intuitive Interaction. Gut Feeling ($r = 0.52$, $P < 0.001$) and Magical Experience ($r = 0.54$, $P < 0.001$) were both significantly correlated to participants' overall judgment on the scenario as representative of intuitive interaction. Also, Gut Feeling and Magical Experience were positively intercorrelated themselves ($r = 0.52$, $P < 0.001$). Still they both had a distinct share in the overall impression of intuitiveness: the partial correlation between Magical Experience and Intuitive Interaction (controlled for Gut Feeling) remained significant (partial $r = 0.37$, $P < 0.001$) as well as the partial correlation between Gut Feeling and Intuitive Interaction, controlled for Magical Experience (partial $r = 0.33$, $P < 0.001$).

Verbalizability and Effortlessness were inter-correlated ($r = 0.39$, $P < 0.001$) but not correlated to participants' overall judgment on the scenario as a representative of intuitive interaction. However, analyses of partial correlations revealed that the contribution of Effortlessness was suppressed by Magical Experience (partial r between Intuitive Interaction and Effortlessness, controlled for Magical Experience = 0.21, $P < 0.001$). Thus, Effortlessness may play a role for classifying an interaction as intuitive, but only as long as this did not come at the expense of Magical Experience. Again, this underlines the central role of Magical Experience for the phenomenon of intuitive interaction as a whole.

5. GENERAL DISCUSSION

5.1. Summary of key findings

The present study provides an empirical substantiation of the INTUI-model of intuitive interaction and the assumed effect of domain transfer distance. As shown by the majority agreement to statements related to all four INTUI-components, Gut Feeling, Verbalizability, Effortlessness and Magical Experience all form relevant constituents of intuitive interaction. The considerably high ratings for the INTUI-components (69–78% agreement) suggest that they represent particularly those facets of intuitive interaction, which are subjectively obvious for users (when compared with the more analytical facets, introduced by other researchers' definitions, with levels of agreement of 57–63%). Altogether, participants' ratings in the first part of our study confirm the INTUI-components to be a significant part of their personal picture of intuitive interaction.

The second part of our study demonstrates the components' specific role within different scenarios of intuitive interaction, with transfer distance as a central influencing factor. As hypothesized, participants judged scenarios with high transfer distance as more appropriate representations of intuitive interaction. In line with our domain transfer model, Gut Feeling and Magical Experience were characteristic of use cases with high transfer distance whereas Effortlessness and Verbalizability were more characteristic of use cases with low transfer distance.

5.2. Main research contributions

The main strength of the INTUI-model lies in unravelling the phenomenon of intuitive interaction and its manifold facets from an experiential perspective, which provides a valuable extension of the research landscape on intuitive interaction. The holistic perspective of the INTUI-model is not contradictory to existing approaches with a stronger focus on objective and clear-cut characteristics. It rather adds another level of description that puts emphasis on the users' subjective experience and contributes to a comprehensive understanding of intuitive interaction.

In this respect, the present study provides a number of new contributions to HCI research. First, we demonstrate the general applicability of a holistic, phenomenological-based model of intuitive interaction and the added value beyond previous conceptualizations. While other researchers' definitions each highlight single aspects of relevance, the INTUI model complements these with knowledge from intuitive decision-making and the study of subjective user statements. Our analysis yielded a unified model of four components, which participants confirmed as meaningful for their understanding of intuitive interaction. The high agreement especially for the INTUI-related statements indicated that Gut Feeling, Verbalizability, Effortlessness and Magical Experience are relevant aspects and provide an advanced understanding of the phenomenon of intuitive interaction.

Moreover, the present study provides an empirical test of theoretical model assumptions. It shows that the INTUI-model not only suggests possible constituents of intuitive interaction but also allows for prediction of the components' relative specification in light of certain factors. Previous studies already explored effects in relation to product, user, context, usage mode and judgment formation. The present study reveals further that the relation between the application domain and the origin of prior knowledge, the so-called domain transfer distance, shapes the particular experience of intuitive interaction.

The concept of domain transfer distance also provides a new perspective on prior conceptualizations of knowledge transfer in intuitive interaction such as the 'intuitive interaction continuum' (Blackler, 2006) or the 'continuum of knowledge in intuitive interaction' (Naumann *et al.*, 2007). While previous research primarily used these models for describing the basis for intuitive interaction, the combination with the INTUI-model and the concept of domain transfer distance also allows predictions about experiential consequences. For example, the present findings suggest that intuitive interaction based on knowledge transfer from the sensorimotor level (rather high transfer distance) should provide more Magical Experience than if based on knowledge transfer from the expertise level (rather low transfer distance).

Similarly, the INTUI-model and the concept of domain transfer distance may provide a framework for understanding the challenges of knowledge transfer in the context of tangible interfaces (Hornecker, 2012). Hornecker scrutinizes the seamless knowledge transfer between the real world and computer-augmented situations and points out that 'leveraging prior real-world knowledge may mislead users to believe that these systems are 'like reality' (when they are not)' (Hornecker, 2012, p. 175). In Horneckers's case study, children made misassumptions about the properties of digital objects, such as expecting 3D objects to react according to the laws of force and gravity. Even though the system did not respond to their actions, they still tried more of the same types of actions. Lacking an opportunity for reflection, they might get 'lost in a Magical Experience'. The problem is not the high transfer distance, but

the parallel activation of any knowledge about 3D objects in the real world (some of it useful and some of it distracting).

Understanding intuitive interaction as a combination of all four INTUI-components emphasizes that Magical Experience is one part, but the other components should not be left out of sight and must be triggered according to the product's complexity and actual possibilities. In sum, the INTUI-model and the suggested research framework support the systematic exploration of differentiated research questions about the experience phenomenon of intuitive interaction and allow a better understanding of when an interaction feels intuitive and when it does not.

5.3. Implications for design

Besides contributions to research, the present findings highlight possible starting points for design. First, designers can make use of the INTUI-framework as a repertoire to reflect on the desired experience and related design strategies: The four INTUI-components offer scope to specify the desired pattern of experience. The surrounding influencing factors provide different ways to shape the interaction towards the specified pattern. As the present study shows, one of these influencing factors that designers can make use of is the domain transfer distance.

Previous approaches typically promote single recommendations and resources for interface design, e.g. Image Schemas, metaphoric mappings, so-called natural input modalities like speech, gesture, gaze or touch, use of established symbols or interaction patterns (Antle *et al.*, 2009; Blackler *et al.*, 2010; Hurtienne and Israel, 2007; Hurtienne *et al.*, 2010; Knopfle and Voss, 2000; Macaranas, 2013; Macaranas *et al.*, 2012b). The INTUI-model displays the variety of possible starting points for intuitive interaction and potential contradictions between these. While Effortlessness builds on low transfer distance, picking up established concepts and making use of obvious metaphors, Magical Experience builds on higher transfer distance, bringing established knowledge in quite different and so far unrelated contexts. While Verbalizability aims at making steps of usage more cognizant and supports explicit memorization, Gut Feeling builds on implicit knowledge application and learning. Instead of giving explicit cues, Gut Feeling and Magical Experience exploit the human need for exploration, only guided through unconscious processing. These different experiential aspects emphasize the challenges within design and the need to be explicit about which kind of intuitiveness one wants to support. This decision surely depends on the product domain and usage scenarios to design for. For example, company online portfolios often aim at exploration of the company's recent projects/products/activities. This provides room for an emphasis on Magical Experience and Gut Feeling and navigation concepts that deviate from the status quo (high transfer distance). Consequently, SecondStory (secondstory.com) uses horizontal instead of vertical scrolling; SilkTricky (silktricky.com) presents its projects on a single-page website where the chosen article folds out and the other articles shift off (for more similar examples see Haack, 2013). In other scenarios, however, the support of conscious interaction and high Verbalizability (e.g. medical software) or Effortlessness (e.g. a ticket machine) might appear more relevant. In these cases, the designer may adopt interaction concepts built on low transfer distance. These examples show how the INTUI-components may serve as an inspiration and orientation for design, with a particular focus on design options through transfer distance.

Secondly, the concept of transfer distance can assist design for innovation. A possible starting point is reflection on the correct balance between cues to activate prior knowledge (supporting access to prior knowledge, a basic prerequisite for intuitive interaction) and the non-apparentness of those cues (supporting unconscious access to prior knowledge, essential for the Magical Experience component). If one only cares for the former, design will favor solutions of low transfer distance, providing quick access to prior knowledge and, in the short run, effortless interaction. However, this focus might prevent new, even better solutions with more experiential value, which, if once established, could be comparably effortless in the long run. For example, a smartphone with the same answer-a-call-interaction as most phones on the market (slide from left to right) will probably be denoted as intuitive, at least by users with prior experience in the domain of smartphones. When thinking about intuitive interaction only in the sense of familiarity and cognitive effortlessness, the slide gesture seems ideal and there is no reason for change. Taking a broader view, however, the familiar gesture seems rather questionable from a metaphorical and semantic perspective, and even from a usability perspective. There are actually a number of users searching for alternatives in newsgroups (see for example https://discussions.apple.com/thread/5732346, http://www.droidforums.net/threads/slide-to-answer-call.37309/, http://forums.whirlpool.net.au/archive/2196167, http://forums.imore.com/iphone-4/207680-answering-calls.html). After questioning the familiar, the INTUI-components can be a trigger for possible new directions. For example, in highlighting Magical Experience and Gut Feeling, the designer could pick up a metaphor from other domains, still supporting intuitive interaction but in a more magical way.

Another possible starting point for innovative, but still intuitive, interaction styles would be to integrate the concept of domain transfer distance in existing innovation design methods in HCI (e.g. Holmquist, 2012, 2013; Ljungblad and Holmquist, 2007; Shneiderman, 2007). For example, the transfer scenario method by Ljungblad and Homquist (2007) seeks to assist designers in developing inventive ideas without losing grounding in real human needs. The starting point is a marginal practice, i.e. a specific meaningful activity, shared by several individuals. This practice is then transferred to a different context, involving a particular technology. While the original method was tailored to the creation of innovation based

on technological prerequisites, the authors argue that it could be modified to include other types of preconditions, e.g. taking a certain location or activity as a starting point. A similar approach could work for design for intuitive interaction: Taking an abstract task as a starting point, identifying meaningful interaction styles in other domains and transferring those to the current application domain/technology. Striving for intuitive *and* innovative interaction styles does not exclude employing established design solutions.

We do not claim that all interfaces and usage scenarios will profit from interaction concepts based on high transfer distance. However, we think that use cases of high transfer distance actually provide the most interesting and relevant opportunities for research and design of intuitive interaction. If users already know how to operate an interface—because of previous use of the same system or very low transfer distance—the interaction concept does not need to be particularly intuitive. Somehow or other, users will know what to do. In contrast, intuitive interaction becomes relevant if users do not explicitly know how to interact (because of high transfer distance), but they could know if the right knowledge becomes activated. The challenge for design is to provide cues that quickly activate relevant prior knowledge and, through this, provide an experience of competence that motivates users to continue in system exploration. This is what we see as the actual realm of intuitive interaction design and the most promising field for new insights into the phenomenon.

Thirdly, on a more general level, the present study also reveals the importance of exploring the mechanisms underlying the experience of intuitive interaction (here: domain transfer distance as one relevant factor for the 'obviousness' of interaction concepts and the four INTUI-components). As a reviewer remarked, 'The interesting question then is what happens when users think they have an obvious reason for effortlessly using something, but something else and more implicitly is working 'behind the curtains' that is actually causing the effortlessness'. We agree that the exploration of knowledge transfer 'behind the curtains' is one of the most interesting issues in the field of intuitive interaction. In an unpublished study, we explored one-shot observational learning as one possible mechanism of knowledge transfer behind the curtains of Apple's Magic Mouse. Half of the participants were introduced to the interaction concept by means of a short video (opportunity for observational learning) before they used the Magic Mouse themselves. These participants rated the interaction concepts as 'obvious' and 'intuitive'. If provided without prior video, as for the other half of participants, the same interaction concept was hardly usable and rated as non-obvious/non-intuitive. Maybe, a similar effect happened at the introduction of the first iPhone. People thought it was intuitive to use (think of the zoom-gesture) because the gesture was 'obviously' the right one. In fact ('behind the curtains') it was an example of one-shot learning (easily imitable) introduced by excessive marketing campaigns. Understanding the underlying principles of intuitive interaction thus builds a great resource for designers, since it is all about providing the necessary cues to trigger relevant prior knowledge. The most magical experience probably results if the cues are effective (well-learnt prior knowledge) but the user is not aware that he or she was already taught that knowledge (e.g. through experiences in other product domains, observational learning, marketing campaigns).

6. LIMITATIONS AND FUTURE RESEARCH

The present study provides a first validation of the suggested INTUI-components and the idea of domain transfer distance as a relevant factor for users' understanding of intuitive interaction as well as its differential effect on Effortlessness and Verbalizability versus Gut Feeling and Magical Experience. However, our study also has some limitations and leaves open questions to be addressed by future research.

First, one must interpret the present findings in the context of the experimental study setting, tailored to testing our specific assumptions. We surveyed participants' agreement to a set of items, representing the components of intuitive interaction of the INTUI-model and further components we found in the literature. Here, one could argue that the items we used may not have been sufficient to convey the whole meaning of the different components or may not have been exact representatives of what other authors wanted to express in their definitions. To explore the idea of domain transfer distance, we created a particular situation where participants had to make a decision about which of two scenarios represented a clearer example of intuitive interaction. This forced-choice paradigm allowed us to gain insight into peoples' naive theories about intuitive interaction and its substantial ingredients from an experience perspective. However, the effect of transfer distance as well as the identified tendencies toward Gut Feeling and Magical Experience revealed by correlational analysis should not be generalized yet. Even though we studied different scenarios in different product domains, these still represent only a selective part of the whole range of possible experiences of intuitive interaction. Thus, future studies are needed before making general claims.

Secondly, the study was carried out via an online survey. The present findings rely on participants' imagination of what would feel intuitive and their memories of past usage situations but not what they actually felt when interacting with a product. Research in other disciplines generally showed that people have a good imagination of how they would react and feel in a given situation and indicate no major differences between hypothetical and real scenarios (e.g. Horowitz and McConnell, 2002). However, intuitive interaction is a special field and especially the relevance of unconscious knowledge access suggests it to be only partially accessible by introspection. While we actually performed a number of studies on the INTUI-model

based on peoples' first-hand experiences in a laboratory (e.g. Ullrich and Diefenbach, 2010a, 2010b, 2011), this was the first empirical study on the concept of domain transfer distance. Hence, future research is necessary to further explore the effect of domain transfer distance by practical use cases and design examples.

Thirdly, the present study must be seen as a first test where specific operationalizations (items, scenarios) served as representatives of a more general model and its assumptions. After having found support for the general usefulness of the model, each of the single INTUI-components as well as the concept of domain transfer distance should be explored and specified in further detail. For example, Magical Experience is still quite a broad concept, representing the experiential and emotional side of intuitive interaction, which deserves more attention in future studies.

Likewise, the concept of domain transfer distance still lacks clarity and poses open questions and theoretical challenges. Our current understanding of the concept is quite broad. We assume that intuitive interaction is based on prior knowledge which can be manifested on different levels (e.g. muscle memory on the motor level, metaphoric knowledge on a culture level). Consequently, there are several paths along which knowledge transfer can take place (also cf. Blackler and Hurtienne, 2007, p. 42 ff). The concept of domain transfer distance refers to the 'length' or 'difficulty' of these paths but is not restricted to a specific path. Factors affecting the transfer distance could be the familiarity of an interaction concept in a given technology (e.g. swipe gesture is well established in the context of touch displays) but also the familiarity of an icon for a given function. For example, the disk icon is still established for the save function—even though floppy disks have almost disappeared from the real world (see Hanselman, 2012 for more examples).

Moreover, as with any concept referring to innovation, transfer distance is of relative nature. Once an interaction style becomes transferred and established in the new domain, the transfer distance changes from high to low. An example is the concept of direct manipulation and the desktop metaphor that aimed at transferring interaction styles from the domain of 'real' working environments to the domain of computers. At the time of early desktop computers, this was quite innovative and seems to be a case of rather high transfer distance. As enthusiastic user reports suggest, this was a kind of magical experience for many (see for example, Shneiderman, 1993, pp. 18). Nowadays, the desktop metaphor has become an integral part of the domain of computers, and often not even considered as metaphor any longer.

Research must further explore strategies how to integrate the present insights on transfer distance in design solutions and further specify relevant parameters. This, for example, refers to critical borders of transfer distance as well as potential criteria and cues for successful knowledge transfer. Additionally, it should be explored in which way such cues can be provided to enable successful knowledge transfer without losing the magic of 'suddenly appearing' insights, thus providing an optimal experience of intuitive interaction.

7. CONCLUSION

Throughout our exploration of intuitive interaction as an experiential phenomenon, we encountered its fascinating possibilities, making it the 'holy grail' of HCI, but also the challenges and seeming contradictions in defining and assessing it. Though experiences of (non)-intuitive interaction are omnipresent in daily life, the phenomenon is hard to grasp and there is much more room for controversy about what characterizes intuitive interaction than, for example, what constitutes usability. Based on literature analysis and user surveys, intuitive interaction appears as a multifaceted phenomenon: A phenomenon in between thinking and feeling, which may consist of completely unconscious knowledge transfer but also memorable and verbalizable interaction steps and which may be hard to differentiate from applying learnt knowledge, especially when considering repeated usage over time. These difficulties to draw a clear line between what is intuitive and what is not, led us to a liberal, holistic model that acknowledges the many forms of intuitive interaction. While we identified Gut Feeling, Verbalizability, Effortlessness and Magical Experience as central components of intuitive interaction, their relative specification and the emerging pattern of components further depends on different factors related to product, person and context.

This complexity makes it a particularly interesting and challenging topic within HCI and the design of interactive systems, which we explored from an experiential, subjective perspective. However, our subjective and experience-oriented approach does not suggest that the phenomenon becomes inaccessible to empirical research or design. In fact, the INTUI-framework offers numerous starting points for experimental research and design. The present study highlighted the concept of domain transfer distance as one of such starting points. We hope that our research serves as an inspiration and fruitful trigger for an ongoing deeper and interdisciplinary exploration of the many facets of intuitive interaction. We are looking forward to the next steps of our exploration, uncovering some more of the mystery of magically intuitive interaction.

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APPENDIX: SURVEY AND SCENARIOS

Text in italics is for explanatory purpose only and was not part of the original survey.

You surely know the concept of 'intuitive interaction'. But what exactly do you mean if you say that a product is intuitive to use? We are interested in your opinion! Please rate your agreement to the following statements:

Items presented in random order

	Not at all agree			Completely agree
Intuitive interaction is guided by feelings rather than reason	☐	☐	☐	☐
Intuitive interaction means instantly being able to operate a product but you cannot tell why	☐	☐	☐	☐
Intuitive interaction means that users can accomplish their tasks effortlessly	☐	☐	☐	☐
Intuitive interaction means that operating a product is surprisingly simple, almost magical	☐	☐	☐	☐
Intuitive interaction means that users can accomplish their tasks effectively	☐	☐	☐	☐
Intuitive interaction relies on the application of already acquired knowledge	☐	☐	☐	☐
Intuitive interaction is performed unconsciously	☐	☐	☐	☐
Intuitive interaction relies on prior knowledge gained in other contexts	☐	☐	☐	☐

Please further describe your understanding of 'intuitive interaction' by rating the following examples:

Scenario 1
Lisa instantly knows how to operate her new mp3-player. She is somehow already familiar with the scroll wheel. This is because of her stereo system.Intuitively she knows which direction to scroll to pick the next song

Scenario 2
Marie instantly knows how to operate her new mp3-player. She is somehow already familiar with the scroll wheel. This is because she knows the preceding model.Intuitively she knows which direction to scroll to pick the next song

	Scenario 1		Scenario 2	
Which of the two scenarios represents the clearer case of intuitive interaction?	☐	☐	☐	☐
In which of the two scenarios will the interaction be experienced as more feeling-guided?	☐	☐	☐	☐
In which of the two scenarios will the interaction be experienced as more magical?	☐	☐	☐	☐
In which of the two scenarios will the interaction be easier to describe and verbalize?	☐	☐	☐	☐
In which of the two scenarios will the interaction be experienced as more effortless?	☐	☐	☐	☐

Full list of nine scenario pairs (presented in random order, same set of questions for all scenario pairs):

Pair #1	Scenario 1	Scenario 2	*Domain: mp3 player*	*Contrast: moderate*
	Lisa instantly knows how to operate her new mp3-player. She is somehow already familiar with the scroll wheel. This is because of her stereo system.Intuitively she knows which direction to scroll to pick the next song *Transfer distance: medium*	Marie instantly knows how to operate her new mp3-player. She is somehow already familiar with the scroll wheel. This is because she knows the preceding model.Intuitively she knows which direction to scroll to pick the next song *Transfer distance: low*		
Pair #2	Scenario 1	Scenario 2	*Domain: mp3 player*	*Contrast: moderate*
	Jana instantly knows how to operate her new mp3-player. Even though her previous player did not have a scroll wheel, she intuitively knows which direction to scroll to pick the next song. Maybe like a clock: right for forwards, left for backwards *Transfer distance: high*	Lisa instantly knows how to operate her new mp3-player. She is somehow already familiar with the scroll wheel. This is because of her stereo system.Intuitively she knows which direction to scroll to pick the next song *Transfer distance: medium*		
Pair #3	Scenario 1	Scenario 2	*Domain: mp3 player*	*Contrast: extreme*
	Marie instantly knows how to operate her new mp3-player. She is somehow already familiar with the scroll wheel. This is because she knows the preceding model.Intuitively she knows which direction to scroll to pick the next song *Transfer distance: low*	Jana instantly knows how to operate her new mp3-player.Even though her previous player did not have a scroll wheel, she intuitively knows which direction to scroll to pick the next song. Maybe like a clock: right for forwards, left for backwards. *Transfer distance: high*		
Pair #4	Scenario 1	Scenario 2	*Domain: bread machine*	*Contrast: moderate*
	Susanne instantly knows how to operate her new bread machine. She knows the icons on the keys from her friend's bread machine. Intuitively she knows which keys to press to adjust the weight and browning of the bread *Transfer distance: low*	Maja instantly knows how to operate her new bread machine. She knows the icons on the keys from other home appliances such as toaster or washing machine. Intuitively she knows which keys to press to adjust the weight and browning of the bread. *Transfer distance: medium*		
Pair #5	Scenario 1	Scenario 2	*Domain: bread machine*	*Contrast: extreme*
	Daniela instantly knows how to operate her new bread machine. Intuitively she knows which keys to press to adjust the weight and browning of the bread. She is not sure whether she has seen the icons on the keys before—maybe the weight icon looks similar to the weights in the gym *Transfer distance: high*	Susanne instantly knows how to operate her new bread machine. She knows the icons on the keys from her friend's bread machine. Intuitively she knows which keys to press to adjust the weight and browning of the bread *Transfer distance: low*		

Pair #6	Scenario 1	Scenario 2	*Domain: bread machine*	*Contrast: moderate*
	Daniela instantly knows how to operate her new bread machine. Intuitively she knows which keys to press to adjust the weight and browning of the bread. She is not sure whether she has seen the icons on the keys before—maybe the weight icon looks similar to the weights in the gym	Maja instantly knows how to operate her new bread machine. She knows the icons on the keys from other home appliances such as toaster or washing machine. Intuitively she knows which keys to press to adjust the weight and browning of the bread		
	Transfer distance: high	*Transfer distance: medium*		
Pair #7	Scenario 1	Scenario 2	*Domain: photo editing software*	*Contrast: moderate*
	Tom assists his buddy with photo editing. Though he has never worked with photo-editing software before, he intuitively knows where to look for the contrast option. As if by itself, the cursor moves to the menu items properties, brightness and contrast—maybe there are similar labels in the menu of his TV.	Max assists his buddy with photo editing. He uses different software on his computer but the menu structure is quite similar. Intuitively he knows where to look for the contrast option.		
	Transfer distance: high	*Transfer distance: medium*		
Pair #8	Scenario 1	Scenario 2	*Domain: photo editing software*	*Contrast: extreme*
	Bruno assists his buddy with photo editing. He uses the same software on his computer. Intuitively he knows where to look for the contrast option	Tom assists his buddy with photo editing. Though he has never worked with photo-editing software before, he intuitively knows where to look for the contrast option. As if by itself, the cursor moves to the menu items properties, brightness and contrast—maybe there are similar labels in the menu of his TV		
	Transfer distance: low	*Transfer distance: high*		
Pair #9	Scenario 1	Scenario 2	*Domain: photo editing software*	*Contrast: moderate*
	Max assists his buddy with photo editing. He uses different software on his computer but the menu structure is quite similar. Intuitively he knows where to look for the contrast option	Bruno assists his buddy with photo editing. He uses the same software on his computer. Intuitively he knows where to look for the contrast option		
	Transfer distance: medium	*Transfer distance: low*		