Designing for Perceptual Crossing: *Applying and Evaluating Design Notions*

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In this paper we describe our research on how to design for perceptual crossing between person and artefact. We present the design-research process, the design and evaluation of the designed artefact *PeP+*, short for perception pillar plus, and the generated design relevant knowledge. In our previous research we formulated a number of design notions, namely *Focus the Senses, Active Behaviour Object, Subtleness, Reaction to External Event, Detecting Active Behaviour Subject, Reflecting Contextual Noise* and *Course of Perception in Time*. These notions are relevant for designing perceptive activity in an artefact to allow for perceptual crossing between a person and this artefact. The person is able to get the feeling of sharing a common space with the artefact: to feel involved. To further investigate these design notions we reconsidered and implemented them in the design of *PeP+*. We discuss how the different design notions are applied in the artefact and show their relevance in an experiment. In this experiment we compare three behaviours, namely *random*, *following* and *active*, of *PeP+* that are the result of the development of the design notions. The experiment gave insights into the development of the design notions and the experience of the person. This research uses phenomenology as a theoretical framework. Theory is used as inspiration and is the basis for synthesis.

Keywords **–** Designing Behaviour, Design Notions, Perceptive Qualities, Perceptual Crossing, Research through Design.

Relevance to Design Practice **–** This paper shows how to design for perceptive behaviour, and is relevant for enhancing the quality of interaction in the design of intelligent artefacts.

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Introduction

The research focuses on designing for perceptive qualities in artefacts and is inspired by and grounded in the phenomenology of perception (Merleau-Ponty, 1958) and ecological psychology (Gibson, 1986). Both bring forward the 'active nature of perception'[1] and argue that 'the body is the centre point of perception'[2]. This body that enables us to sense the world is here considered an active and open form. Perception is not seen as an internal representation built upon the sensory input we gain: It is seen as the result of the dynamic coupling between a person's action in relation to her or his environment and the sensory input this environment provides (Lenay et al., 2007). Perception is here considered the result of the actions we undertake and the sensory feedback these actions result in and the other way around (Figure 1). We can access the expressive qualities and the meaning of the world by means of our body. For us this is fundamental to our design-research as we can design for actions in artefacts and invite people to participate in active engagement with these artefacts.

About this active relation between our body and the world, i.e. perception, Abram, following Merleau-Ponty, states: "Perception is inherently interactive and participatory: It is a reciprocal interplay between the perceiver and the perceived" (Abram, 1996, p. 89). Our direct sensorial experience, our direct perception, only exists because of its reciprocal nature. We are

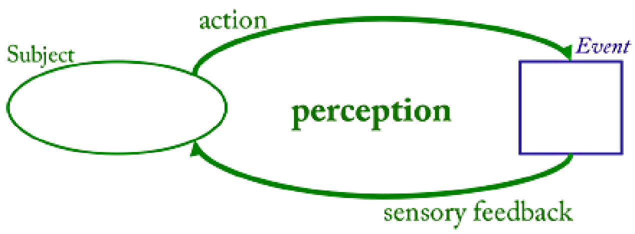

Figure 1. Theoretical descriptive model on the active nature of perception. Perception is the result of actions we undertake and the sensory feedback this results in and the other way around.

only able to touch because our body is a touchable thing; to touch is also to feel oneself being touched and to see is also to feel oneself seen. In the phenomenological description of the body of a person two aspects are described. (1) The 'lived-body' is the body as I experience it; it is my ability to perceive. (2) The 'body as an image' is, as it were, the object I am in space, my appearance to others (Lenay, 2010). It is in the reciprocal nature

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of perception that we recognize others as intentional subjects, that we distinguish their 'lived-body' from their 'body as an image' and that they recognize our presence as intentional subjects. This phenomenon is referred to as perceptual crossing and is the interplay of perceiving and being perceived. In more simple words: I can see you seeing me and you can see me seeing you.

Since 2010 **Eva Deckers** is working on her doctoral project, 'How to design for perceptive qualities in systems of interactive systems?', within the Designing Quality of Interaction Group at the Eindhoven University of Technology Department of Industrial Design. She also pursued her bachelor and master's degree education in this department and graduated cum laude in 2009. She will defend her doctoral work in May 2013. The work presented here is a direct result of her doctoral work. An important facet of her project is the fact that it has produced a number of iterations in the field of intelligent textiles, including her carpet design PeR, which has been exhibited on several occasions and which resulted in a number of different publications (dqi.id.tue.nl/per). Collaboration with an industrial partner on the development of the intelligent and interactive carpet shows the feasibility and market value of her work. She connects design-research to design-education as a lecturer and coach. She has been the chair of the alumni-association of IDEa since 2010.

Pierre Lévy is assistant professor in the Designing Quality in Interaction Group at the Eindhoven University of Technology Department of Industrial Design. He graduated from the Department of Mechanical Engineering (with a focus on Industrial Design) at the Compiègne University of Technology, France (2001), and gained a PhD with honours in Kansei Science at the University of Tsukuba, Japan (2006). After serving in a post-doctoral position at the Laboratory of Kansei Information Science at the Graduate School of Comprehensive Human Science at the University of Tsukuba, he became a researcher and lecturer at Chiba University as well as a lecturer at the University of Tsukuba. He has been an active member of the Japan Society of Kansei Engineering (JSKE), serving currently as an international counsellor of JSKE, a member of the Editorial Board of the Kansei Engineering International Journal, and as a co-organizer of the International Conference of Kansei Engineering and Emotion Research International 2010 in Paris, France. He explores opportunities for applying Kansei science and Kansei philosophy to product and interaction design.

Stephan Wensveen is Associate Professor of Interaction Design (since 2011) at the Mads Clausen Institute. He has an MSc (1995) and PhD (2005) in Industrial Design Engineering from TUDelft. In 2002 he became an assistant professor at TU/Eindhoven and joined the Designing Quality in Interaction group with Prof. Kees Overbeeke. His interest is in using the power of design to integrate research, education and innovation, which he demonstrated as project leader for the /d.search-labs and as initiator and research director of Wearable Senses and the nationally funded project on Smart Textile Services. Many of his papers are part of the standard curricula in interaction design schools and he is co-author of the book 'Design Research through Practice'. In 2011 he expanded his horizon on multi-disciplinary design and Participatory Innovation when he joined the SPIRE group of Prof. Jacob Buur at MCI.

René Ahn is an assistant professor in the Designed Intelligence Group at the Department of Industrial Design at the Eindhoven University of Technology. He has an MSc (1982, with honours) in theoretical physics. He has been employed at Philips Research Laboratories, and at Tilburg University, where he worked on subjects like automated deduction, computational semantics and the design of intelligent interfaces. In 1998 he joined the Institute of Perception Research (IPO) and in 2001 he gained a PhD from the institute of programming research and algorithmics at the Eindhoven University of Technology. His current interests are in adaptive algorithms, reinforcement learning, and embodied interaction and cooperation. He believes that the understanding and application of biological principles is essential to the further development of smart computation and interaction mechanisms.

Prof. Dr. **Kees Overbeeke** († 2011) was appointed full professor at Eindhoven University of Technology (TU/e) for Intelligent Products and System Design in the Department of Industrial Design in May, 2006. Kees Overbeeke studied psychology at the Katholieke Universititeit Leuven (1974). After working there he moved to the Faculty of Industrial Design Engineering at Delft University of Technology where he earned his PhD (1988) in spatial perception on flat screens. He headed the Form Theory Group as an Associate Professor until his move to the Department of Industrial Design of TU/e in 2002. During the academic year 2005-2006 he was invited as the Nierenberg Chair of Design at Carnegie Mellon's School of Design in Pittsburgh. At TU/e he headed the Designing Quality in Interaction group until September 2011. He sadly passed away on October 8th 2011.

Our perception of each other crosses, we attract and escape from each other's perception; we share a common space in which we can build a common history in our course of interaction (Lenay, 2010). It is in the other's perceptive activity that I recognize that I affect the sensitivity of the other person. And it is the other's perceptive activity that shows me that the environment affects that other person's sensitivity (referred to as primary and secondary inter-subjectivity, Gallagher & Zahavi, 2008, p. 197). It is because our perception of each other crosses that I understand my own intentionality; it shows me that I affect the sensitivity of the other; it shows me I'm *involved* in the situation.

Figure 2 shows a descriptive model of perceptual crossing between two persons. As explained before, perception is here considered active. Perceiving the perceptive activity of one another is the result of the actions they undertake towards each other and the sensory feedback they receive. Figure 2 presents this active coupling. Moreover the dotted lines show that the actions one undertakes to perceive the other are part of the perceptive activity the other perceives. For example, when a person turns her head to look at the other, the other perceives this action as part of the perceptive activity of the person. This also works the other way around. The perception of each other *crosses*.

The aim of our research is to design for perceptive activity in artefacts, which can engage in a reciprocal interplay with the person and the environment. By designing these perceptive qualities in an artefact the person and the artefact hypothetically are able to engage in perceptual crossing with each other and to share their perception of the environment. They come to understand each other's viewpoint and build a common history in their course of interaction, thereby positively influencing the person's feeling of involvement. Ultimately if the artefact is able to detect perceptive activity of the person and show meaningful perceptive activity in relation to this, both person and artefact perceive intentionality[3]. We investigate a new perspective on forming and framing the artefact's intelligence in a more action- and quality-centred way rather than a function-centred way.

We propose and evaluate a set of design notions to design perceptive qualities in artefacts that will make it possible for both person and artefact to show and understand their perceptive activity in the course of their interaction. We very deliberately add the last part of the statement: 'in the course of interaction', because if we like to design successful intelligent systems that are embedded in the background of our environment the question how to perceive and to act upon these systems is fundamental (Frens & Overbeeke, 2009).

Figure 3 shows the design relevant model on perceptual crossing between person and artefact with perceptive qualities. This artefact is able to perceive and show perceptive activity to and from the person allowing them to engage in a rich reciprocal interplay.

Besides affecting each other, both the artefact and the person also affect and are affected by the environment. In Figure 4 this common space is sketched by the addition of an external event. The perception of this event is the result of the actions they undertake towards the event and the sensory

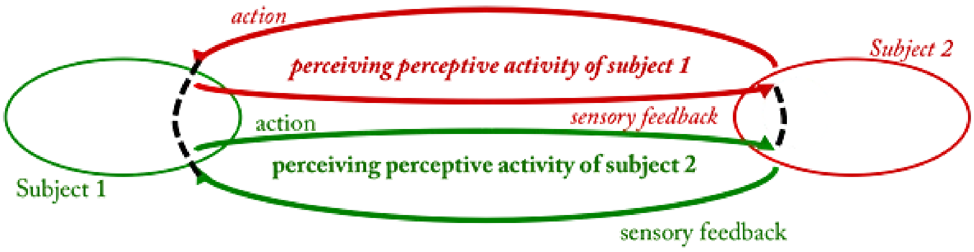

Figure 2. Design relevant theoretical model on perceptual crossing between two subjects (people)**.**

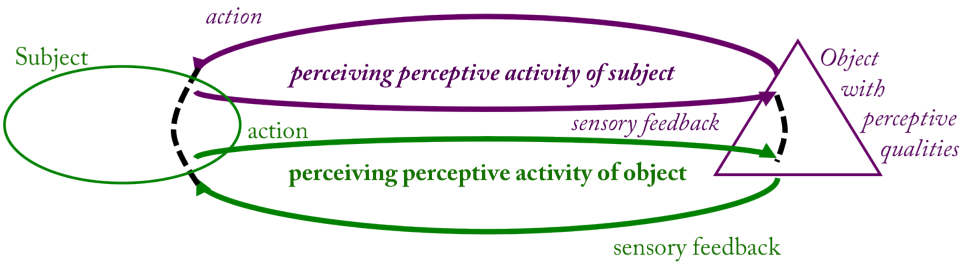

Figure 3. Design relevant model on perceptual crossing between subject (person) **and object** (artefact)**.**

feedback which this results in. This activity towards the event is also part of the perceptive activity that the other perceives (the dotted line in the model). When for example a person brings her nose close to a flower to smell it, the other perceives this activity towards the event. Please note that the lower part of the model in Figure 4 is a simplified representation of the model in Figure 3.

Related Work

In different related fields of design the relevance of phenomenology is introduced. In the HCI community several people based their approaches on phenomenological thinking (Fällman, 2003; Svanæs, 1999; Winograd & Flores, 1986). Dourish (2001) addressed phenomenology in his work on Embodied Interaction. Moreover in the fields of Movement and Interaction (Moen, 2005, Robertson, 2002, Schiphorst, 2009), Aesthetics and Interaction (Dalsgaard & Hansen, 2008, Hallnäs & Redström, 2002), Tangible Interaction (Hornecker & Buur, 2006) and Social Robotics (DiSalvo, Gemperle, Forlizzi, & Kiesler, 2002) phenomenology has shown its relevance. In the fields of Mediated Social Interaction (Deckers, Westerhoff, Pikaart, van Wanrooij, & Overbeeke, 2009; Lenay et al., 2007) and Social Robotics (Froese & Ezequiel, 2010; Marti, 2010) the phenomenon of perceptual crossing has been introduced.

Where in the referred work phenomenology is mostly used to provide knowledge about, and a better understanding of, the way people (users) are acting-in-the-world, our work takes a next step. We specifically aim at providing design relevant knowledge on how to design for new artefacts, that engage with people, in such a way that perceptual crossing, and therefore the feeling of sharing a common space, is possible. We move from using the theoretical background as method for analysis, to a means of inspiration and input for the synthesis of new designs in an action and quality centred way.

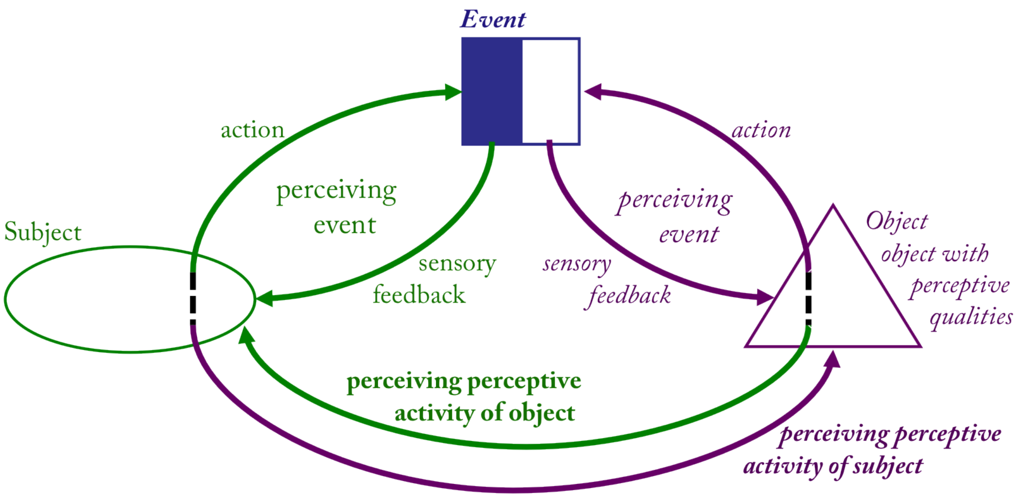

Figure 4. Design relevant model on designing for perceptual crossing between subject and artefact, including external event.

Approach

We propose notions (described further on) to design an object with perceptive qualities that is meaningful to multiple users and events. The research follows a Research through Design approach (Frayling, 1993). The process is iterative where we build and test several artefacts. To formalize the process, as suggested by Zimmerman, Stolterman, and Forlizzi (2010), we described the theoretical departure and the resulting design-relevant model (Figure 1, Figure 2, Figure 3, and Figure 4). In the process actual designing is highly valued: The artefact is built and experienced and is up to the standards to function as a physical hypothesis (Frens, 2006) in a controlled experiment, following the Lab approach (Koskinen, Zimmerman, Binder, Reström, & Wensveen, 2011). The artefact is deliberately minimalist in order to attribute the person's experience to the design variables. In the research, as a result of the process described in this paper, several design notions relevant for designing for perceptual crossing between person and artefact were discovered. We feel that such design notions should be used by design-researchers in order to strengthen the argument of their relevance (Forlizzi, Zimmerman, & Evenson, 2008) and to show how they are used as tools for inspiration and synthesis. In this way a step towards valorisation within design practice outside the academic environment can be made. To provide for extensibility (Forlizzi et al., 2008), we elaborately describe the design notions and evaluate them in an experiment.

Designed Artefact

In earlier research we set out perceptive activity in three components: (1) perceiving presence, (2) perceiving perceptive actions, and (3) perceiving expressivity (Deckers et al., 2009). This way the phenomenon of perceptual crossing becomes more tangible to start the design process. The *perception of presence* refers to perceiving the other's ability to perceive: the presence of the lived-body. The *perception of perceptive actions* is the perception of the exploratory actions the other undertakes to perceive. It is perceptive action, like looking at each other or moving the finger in exploratory fashion over the tabletop to discover the surface, that tell us what the other perceives. The *perception of expressivity* refers to the perception of the other's expressivity in relation to what she perceives. By perceiving the other's expressivity we come to appreciate how the other feels or thinks about what she perceives. If the other rubs a surface on the sensitive skin of the cheek this reveals to me that the surface feels soft or pleasant.

Based on these three components of perceptive activity and the design relevant model, several criteria apply for designing the artefact. The artefact should be able to perceive the presence, perceptive actions and expressivity of a person. And the artefact should be able to show perceptive activity to allow for reciprocity. In other words, based on the designed activity of the artefact, the person (1) should be able to perceive its presence, (2) perceive its perceptive actions, and (3) the person should be able to perceive its expressivity.

Background

The design of *PeP+,* short for perception pillar plus, is an iteration on the design of *PeP* (Deckers, Wensveen, Ahn, & Overbeeke, 2011). From designing and evaluating *PeP*, several design notions for designing perceptive activity in an artefact were formulated. Some of these notions were implemented in the design of *PeP.* Others were discovered after evaluating the design in an experiment (cf. Deckers et al., 2011 for a detailed description).

PeP is a purple square pillar, in the top surface of *PeP* a light body behaves (Figure 5). The perceptive activity is designed in this light body. The pillar functions as a housing for a static grid of 13 LEDs (Light Emitting Diodes), constituting the light body, and for the four sensors used to detect the person. The light body behaves according to the output of an algorithm that translates the input of the sensors. When no movement is detected the light body moves around in an explorative manner (*presence*). The light body focuses in the direction of a person and follows when the person walks around (*perceptive actions*). *PeP* was also enabled to perceive an event, namely music. The light body moves in the direction of the sound (*perceptive actions*) and can bounce to the beat of the music (*expressivity*).

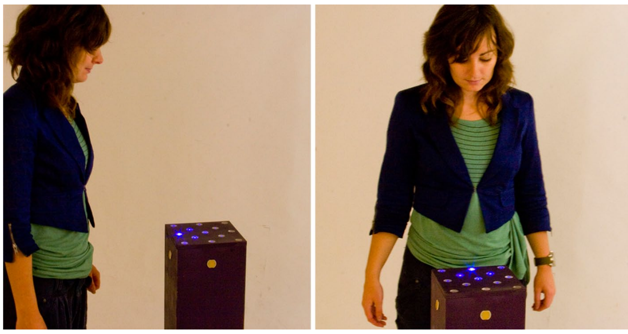

Figure 5. Impression of physical appearance and interaction with *PeP*.

In the experiment the possible perceptive connections between participant (subject), *PeP* (object) and music (event) were varied (Figure 4). The experiment showed that indeed the possibility of experiencing reciprocal perception and sharing perception of the common space positively influences the participants feeling of involvement (Deckers et al., 2011).

Although people experienced reciprocity of perception while interacting with *PeP*, the experiment brought forward strong clues about how to develop the design notions further. We will now discuss these clues and the development of our design notions through designing *PeP*+. To be able to really grasp the perceptive qualities that enable person and artefact to engage in perceptual crossing our sole focus while designing *PeP*+ was on the reciprocal interplay between person and artefact.

Physical Characteristics of *PeP+*

PeP+ is, in line with *PeP*, a square pillar. In the design of *PeP*+ eight sensors are used, instead of the four used in *PeP*. This is done to gain more detailed information on the position of a person. Moreover movements by the subject can be more closely followed. The algorithm links the sensor input to the output of 17 LEDs placed in a static matrix. Again the behaviour of a light body is constituted in this grid of LEDs. The light body becomes the focus of attention and the physical appearance of the pillar fades to the background. The light becomes the perceiving body. It is paramount that sensitivity and activity seem to be embodied in the light body. For this reason also the sensors are placed out of sight for the subject. The design of *PeP* did not provide a high resolution for the light body to behave, whereas the algorithm does provide for continuous movements. For this reason also four LEDs were added.

The top surface of *PeP*+ is made out of a combination of nylon threads and cast silicon. For this surface several material explorations were done. In *PeP*+ the aesthetics of the digital is more balanced and integrated with the aesthetics of the material and with the appearance of the light, compared to the design of *PeP*. The light should seem to move in the surface instead of being projected onto the surface. This gives the light more body.

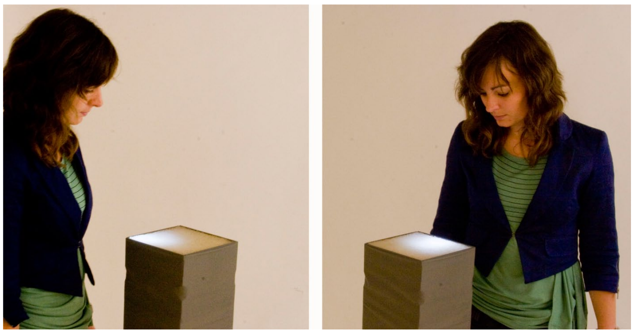

Figure 6. Impression of the physical appearance of and interaction with *PeP+*.

Design Notions

The following design notions were discovered in the process of designing and evaluating *PeP* and were reconsidered and implemented in *PeP*+. These design notions are meant as a tool for the synthesis for new designs and are the result of our process of investigating how phenomenological theory informs design.

The definition (in italics) and relevance of each design notion is discussed based on theory and examples. In addition their implementation in *PeP*+ is described. *PeP* is sometimes used as a reference to explain the development of the design notions in the design of *PeP*+. We think that design relevant insights are to be found both in the theory and in the practical implications.

Focus the Senses

Sensing and acting have to be embodied in order for the artefact to naturally focus its senses and to become more than just a following entity.

It seems natural for living organisms to concentrate their senses in the direction of stimuli, e.g., you close your eyes and turn your ear in the direction of the sound so as to better perceive the acoustic event**.** Sensing and acting are embodied. In other words, perception is active since it is a result of actions we undertake and of the sensory feedback this results in, and vice versa.

The use of a static matrix of sensors means that, without manipulation within the algorithm, the artefact is sensitive at all sides all the time. In *PeP*+ not all sensors are active all the time and there is a more direct relation between the sensor sensitivity and the action of the light body. The position of the light body not only depends on the sensor input, as was the case in *PeP*, but the sensor activity also depends on the position of the light body. At the moment that the light body comes within a certain range of a sensor that sensor becomes more sensitive than the others. Sensing and acting are much more integrated, in line with the theoretical idea of active perception.

Also stimuli that we have experienced before steer our focus. Time is considered a subjective experience (Merleau-Ponty, 1958, pp. 494-495). It is the experience of the continuous nature of our activity. Time is not perceived through concepts like minutes or hours, but as a sense of the length of duration of our activity. The implementation of a notion of time results in there being more than a simple, direct relationship between the person and the light body. Preceding activity or the lack of preceding activity steers the light body.

Although it seems natural to concentrate our senses in the direction of a stimulus this does not mean that we only perceive in the direction in which our senses are focused. What is behind us is not visually absent (Merleau-Ponty, 1958, p. 6). When something behind us is loud or moves quickly or suddenly we will react to this. In the case of the artefact, though only the sensor in range of the light body is active, big or sudden changes elsewhere will be detected. All sensors are also sensing the background and influence the behaviour of the light body when they detect a movement in the environment that exceeds a certain threshold.

All our sensors are moving sensors. We move our hand in exploratory fashion over a surface to perceive a surface and we turn our head in such a way that our eyes or ears are in the direction of an event. One could argue that the use of a moving sensor naturally embodies this focus of the senses, like the eyes in your head. The algorithm used in designing for perceptive behavior becomes very significant when using a static grid of sensors. Despite this need for a more complex algorithm the use of a matrix of static sensors is preferred as it covers a wider range of design applications, e.g., carpets (Deckers, Wensveen, & Overbeeke, 2010). Moreover by not using moving sensors but a static grid of sensors the shape of the artefact does not lead to anthropomorphic attributions. The emphasis is really on the artefact's dynamic properties, the behavior of the light design, rather than its appearance.

Active Behaviour Object

The artefact should be motivated to explore, this way it becomes possible for a person to perceive its presence and to engage in an active interplay of attraction and escape.

Perceptual crossing depends heavily on explorative movements like the ability to escape from, or to attract, each other's perception (Lenay, 2010). By the implementation of this design notion the artefact is capable of "perceptually motivated perceptive activity". If an artefact is just a following entity this might indicate that indeed the body is sensing and acting but it is questionable if such an artefact can be described as a perceiving body. We consider two kinds of active, explorative behaviour. (1) The light body should adopt an active and explorative behaviour to scan the environment. This is like living organisms that can scan the environment for events, e.g., you turn your body and head to look around the room to see whether someone is there. This is the kind of movement that makes an observer aware of the other's ability to perceive: The other's presence, as it were, even though no interaction has yet taken place between the observer and the entity under observation. (2) The artefact should also adopt this explorative behaviour when focusing on something. For example, to experience the surface of the tabletop one will not just touch it but also move one's fingers over it in an exploratory fashion. In a similar way our eyes are always in action to perceive. Perception is active (Gibson, 1986).

The light body is therefore not only attracted by the person's movement but also attracted by uncertainty (or curiosity) and expectation based on the past. Uncertainty and expectation are implemented in the algorithm based on principles known from Bayesian surprise theory (Itti & Baldi, 2009). The light body of *PeP*+ actively explores to locate the subject. This active behaviour strongly depends on implementations described in the forgoing notion 'Focus the Senses'. If all sensors are not active all the time the light body has to move in order to find out more about the person and the environment. The light body of *PeP* was merely a following entity. In *PeP*+ a notion of time is added. The time past since the last exploration, by the light body, of a specific side of the pillar influences the probability that the light body will explore this side of the pillar again. Also the activity detected in the previous exploration (expectation) of this specific side influences the probability of exploration on this side again. This makes time a subjective experience for *PeP*+; the more interesting the perception on a particular side was, the quicker the light body will get curious. Moreover the activity measured on one particular sensor also influences the appeal of neighbouring sensors, which stimulates the light body to actively explore the side where activity is detected. In other words time and previous input is used as a subjective motivation for *PeP*+ to explore different sides.

Subtleness

When designing for perceptive activity the subtleness of the physical appearance, the actual movements and their integration should be considered.

The actions we undertake to perceive are smooth: We turn our head in a continuous and sustained movement to look at what is behind us. The designer has to take into account the sustained and continuous nature of perceptive actions to create subtleness in both the physical appearance and the algorithm. In the algorithm the position of the light body adjusts gradually to capture this sustained and continuous movement. This way the light body appears to slide towards a new position instead of popping up there.

The physical characteristics of *PeP* did not allow for the subtleness that is reached within the algorithm. The resolution of the surface, in which the body of light acts, is increased in *PeP*+. The material of the top surface allows the light to spread better. The light seems to act within the surface instead of under it. The aesthetics of behaviour and physical appearance are better balanced in *PeP*+. The behavior we develop might ask for jumpiness in the movement of the light body. However this jumpiness should be deliberately designed in the algorithm and not be caused by a limitation in the physical aspects and electronic components.

Reaction to an External Event

The addition of an external event amends the reciprocal interplay, as it allows for sharing a common space.

The addition of an external event will enrich the common history a person can establish with the artefact in the course of their interaction. When we interact with someone events in the environment shape and influence the interplay, e.g., music, noise, light or objects can influence our interaction with someone. The artefact is able to perceive an event and show perceptive activity in relation to this. We found that the addition of an external event (Figure 4) amends the course of interaction between the artefact and the person sharing a common space (Deckers et al., 2011).

A person can perceive, as it were, 'through' the artefact (Deckers et al,. 2011). This is like when we see someone dancing to music that we don't hear ourselves: We perceive the music 'through' the dance, the activity of the person. If indeed someone can perceive 'through' the designed artefact that person is able to become aware of events that he or she cannot perceive directly.

In the experiment with *PeP* the perceptive connections between subject, object and external event varied and were explored by the participants (Figure 4). For now the external event is excluded in the design of *PeP*+ in order to closer investigate the phenomena of perceptual crossing between the person and *PeP*+, and the influence of the other proposed design notions. This notion of 'Reaction to an External Event' becomes especially meaningful when person and artefact are actually able to engage in a strong reciprocal interplay.

Detecting Active Behaviour Subject

The perceptive activity of the person should become meaningful to the artefact in the course of the interaction.

We are living organisms who use active and explorative movements in order to perceive. In the course of interaction the artefact should be enabled to detect this kind of perceptive activity. In the context of interactive interplay between an individual and an artefact, these actions become meaningful to the artefact. Therefore the light body is sensitive to changes in sensor input. Holding still for too long will result in no longer being detected as an intentional subject (perceiving the lived-body) but as an object in the environment (perceiving the body as an image). Perceptual crossing can no longer occur and the light body loses its focus.

When we engage in perceptual crossing, we attract and try to escape from each other's perception. The dynamics of disappearing, of being there and then not, creates a tension between us. So although, at a certain moment, you do not see me anymore there is still an active relation between us. Or when I sneak up on you, I already experience an active relation between you and me. As explained before, *PeP*+ is only active, in other words only has detailed perception, on the side the light body focuses on and is only sensitive to movement. This means that someone can sneak up to the design or try to escape from its perception.

Reflecting Contextual Noise

Contextual noise can be reflected in the perceptive activity of the artefact to create behaviour that is not anticipated but is a natural result of the context.

When we are in dialogue with someone else, our perception is focused on the other. However this does not mean that there is no contextual sensory input, nor does it mean that we don't undertake any action to get other sensory input. This is especially true when sensory input reaches a certain level, for example when something makes a lot of noise or a movement is sudden and quick. Unlike the events described in "Reaction to an External Event", the events that are regarded as contextual noise are not anticipated by the algorithm.

The light sensors integrated in *PeP* are influenced by environmental light conditions. The amount of environmental light is changed by the presence of a person as he or she causes a shadow to fall on the sensor. Not every side of the artefact might be equally exposed and so the effect the person causes might differ for different sensors. Moreover events other than the presence of a person might cause the environmental light conditions to change. For the design of *PeP*+ ultrasonic sensors are chosen that make the design, and especially the experiment, more controllable as these sensors are not that sensitive to contextual noise. Another advantage of choosing ultrasonic sensors is that it is very difficult to repeat input which is exactly the same. This increases the quality of the behavior, as *PeP*+'s behavior does not become too predictable.

The Course of Perceptions in Time

The artefact gets, as it were, an experience; it is aware of bygone perception and can anticipate future perception.

The notion of 'Course of Perceptions in Time' refers to experience. We like to stress again that time is here considered to be a subjective experience, a continuum of activity (cf. Focus the Senses). In line with this, experience is here considered a continuum of perceptions and thus includes an awareness of bygone perception and the anticipation of future perception (Schutz, 1967). It is in this design notion that the artefact, as it were, constructs an 'experience' based upon other design notions.

PeP had no awareness of its own perception. In other words it did not rely on history or anticipate what could happen next. In relation to the notions 'Focus the Senses' and 'Active Behaviour Object' we already considered and introduced a notion of memory into the design of *PeP*+. Bygone activity or the lack thereof motivates the light body to move. We have also seen that the detection of perceptive activity becomes meaningful to the artefact in the course of interaction with a person (Detecting Active Behaviour Subject). The advanced level of integration which this design notion entails leaves room for development but adds complexity. Before making this step it is useful to evaluate the development of the design notions at this stage.

Three Behaviours

In our process of designing for perceptual crossing we go through several iterative design cycles. We are building towards designing an artefact that truly engages in perceptual crossing and we develop the design notions throughout this process. By evaluating the development so far we gain insights on how this

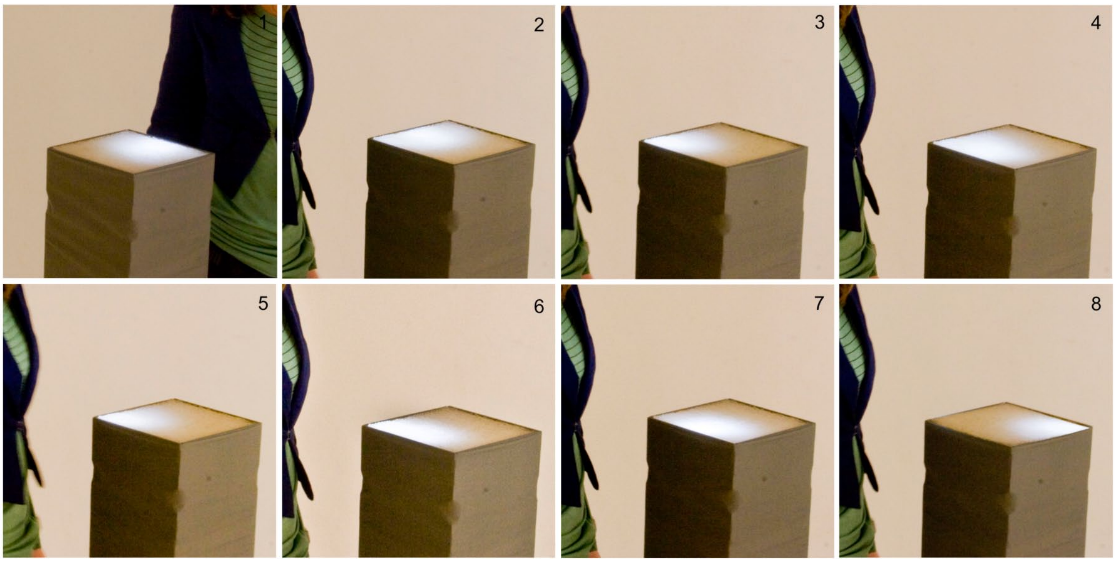

Figure 7. Impression interaction. The light body follows the person in a continuous sustained way when the person walks around the artefact (1-2), and focuses in the direction of the person (3). When the light body focuses the behaviour is active: the light body moves within the vicinity of the person (4-5). As time passes or as the subject is not active, the light body starts to explore other sides (6-7-8).

implementation affects a person's experience and how to develop the design notions further. This is in line with the Research through Design approach in which the designed artefact and the evaluation of the designed artefact are used as input for the next iterative cycle. On the *PeP*+ website (dqi.id.tue.nl/PeP), the reader can find a movie that presents these three behaviours, ***active***, ***following***, and ***random*** which are discussed next.

The ***active*** condition is the behaviour of *PeP*+ as discussed in the design notions. In the *active* condition the direct coupling between sensing and acting is applied. The light body is motivated to explore the person and the environment based on curiosity and expectation: It is more active than the *following* condition. The strongest connection between behavior and theory occurs in the *active* condition.

The behaviour that we designed in *PeP* is referred to as the ***following*** condition: The design notions are not as strongly connected to the theory and examples as in the *active* condition. In the *following* condition the behaviour of the light body is completely determined by the sensor input at that moment: the light body just follows. What may look like exploratory movements are merely an impression and do not actually involve active exploration.

A ***random*** condition is added as a control condition. In the *random* condition the activity of the light body is random. In this condition the light body cannot sense the presence of a person.

Experiment

As the design notions implemented in the *active* condition are closer to the theory, the assumption is that the experience of reciprocal perceptive interplay between person and *PeP*+ is stronger in the *active* condition than in the *following* condition. For the same reason the hypothesis is that in both the *active* and *following* condition the experience of reciprocal perceptive interplay is stronger than in the random condition. The experiment follows a 'Lab' approach (Koskinen et al., 2011) in which the behaviours are evaluated in a conditioned setting. This conditioned setting is made as minimalist as possible so that it is possible to attribute changes in a person's activity and experience to variables in the design of *PeP*+, and not to the setting itself.

Set Up

Participants

The 25 participants are architecture students. These students are trained in giving design critiques but are not aware of the ongoing research project and are unlikely to know about the theory underlying the project.

Comparisons

We were particularly interested in comparing the *following* and *active* condition and divided the participants over the different comparisons accordingly. This means there were more participants who compared the *active* to the *following* condition than participants who compared the *random* to the *active* or *following* condition. In Table 1 an overview of the comparisons is given.

Table 1. Overview of comparisons.

	Active	Following	Random
Active	-	6 participants	3 participants
Following	7 participants	-	3 participants
Random	3 participants	3 participants	-

Procedure

Before entering the lab the participants were given a short introduction to the experiment. In this introduction it was explained to the participants that they would encounter *PeP*+ when entering the lab. The door to the lab was shortly opened to give the participants an impression of *PeP*+. From this distance the participants just got an impression of *PeP*+'s physicality, they were not able to interact with *PeP*+. They were told that *PeP*+ has two different behaviours and that they were asked to compare the two behaviours. It was emphasized that they could freely explore while in the room with *PeP*+.

After the introduction a participant entered the lab alone and started a free exploration of *PeP*+. When the participant felt that he had completed his exploration he left the room. On average the participants (n = 25) spent approximately 2'30" exploring the first condition. The experimenter told the participant to wait a few moments and prepared the next condition. The participant entered the lab again to freely explore the second behaviour. Also this time the participant left the lab whenever he or she felt ready. On average the participants (n = 25) spent approximately 2'00" exploring the second condition. All the participants were filmed during the experiment.

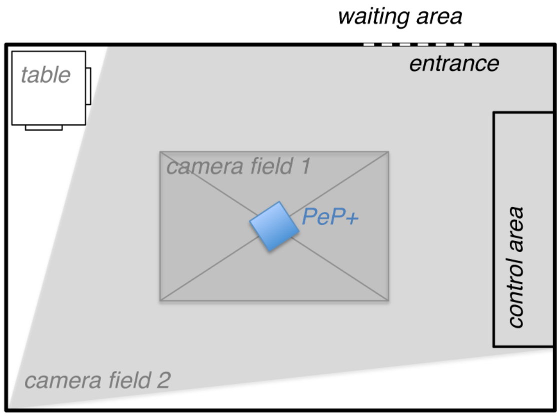

Figure 8. Overview of the Lab setting.

The experiment ended with an interview about the two behaviours which the participants had experienced. The interview took place in the lab to give the participants the opportunity to refer to *PeP*+ directly. The interview was also filmed.

Measurements

Participants were first asked to describe both situations, to compare them and to elaborate on the following aspects of the experience of the behaviour: clarity, preference, pleasantness, and involvement. Participants were asked to elaborate on which of the two behaviours they experienced was clearest to them, which of the two they preferred, found most pleasant, and in which condition they felt most involved. To get a deeper understanding of the participants' experience we based our questioning on the laddering technique (Rugg & McGeorge, 1995). A list of open, guiding questions was used to make sure that all relevant topics were discussed and to provide a focus for the participants' descriptions. We were very much interested in the qualitative descriptions and movements of the participants. We found it important to compare the transcribed descriptions of the participants to the intended design variables in order to be able to to frame our findings. If participants, for example, did not describe the intended differences between the conditions, our view of the qualitative data changed.

In line with this we first wanted to see if the descriptions of the behaviours corresponded with the intended design variables. In addition we were interested in seeing how clear the participants felt the behaviour of *PeP+* was. The stronger the perceptual relation, the clearer the behaviour will be. The feeling of being perceived and the degree of clarity of that perception hypothetically contributes to the preference for, pleasantness of and involvement in a condition. The guiding questions address different topics. Below per topic an example of the participants' descriptions is given. The behaviours which the participants refer to are included by the authors in italic type between brackets for ease of reading.

- ***Global description of the experience***
  e.g., "The first one (*following*) was a bit calmer and more smooth and the second (*active*) was a bit faster and reacted faster. It looks for you, it is quite funny that it reacts to where you are in the room. .." (participant 19, *following-active*)
- ***The feeling of being perceived***
  e.g., "The first time (*following*) I felt strongly that he saw me and wanted to guide me somewhere, wanted to move me. And second time (*random*) it seemed the light was busy with other things." (participant 2, *following-random*)
- ***Preference for one of the two conditions***
  e.g., "On one side the first one (*random*) is nice as you don't know what it is but the second one (*active*) is more interesting, I have a feeling of interaction." (participant 3, *random-active*)
- ***The clarity of the behaviour***
  e.g., "The first one (*random*) is not clear, the second (*following*) is. In the first one I wondered if it mattered I was there, if it would react to anything. In the second this was clear." (participant 13, *random-following*)
- ***The experienced pleasantness***
  e.g., "The second one (*following*) is more pleasant as it is more calm, but maybe also because it was a bit more familiar the second time. He was more continuous the second time but could not perceive better." (participant 11, *active-following*)
- ***The experienced feeling of involvement***
  e.g., "The first (*active*) seems to move because of you. I had more a feeling of ignorance that the second (*random*) acted so different. (participant 4, *active-random*)
- ***The participants' strategy***
  e.g., "I wanted to see what it is and try to find logic, and try to mislead." (participant 16 *active-random*).

We also analyzed the participants' movements while interacting with *PeP+*. We followed a method used for investigating 3-D form perception (Locher, Vos, Stappers, & Overbeeke, 2000). Several markers were used to indicate the different types of movement. This analysis allows for an immediate overview of the exploration of the participants. It becomes possible to see strategies and parameters of exploration (Figure 9). The mappings were used in an expert discussion. In this discussion the focus was on seeing if there were shifts and correlations in the participants' movements between the different conditions.

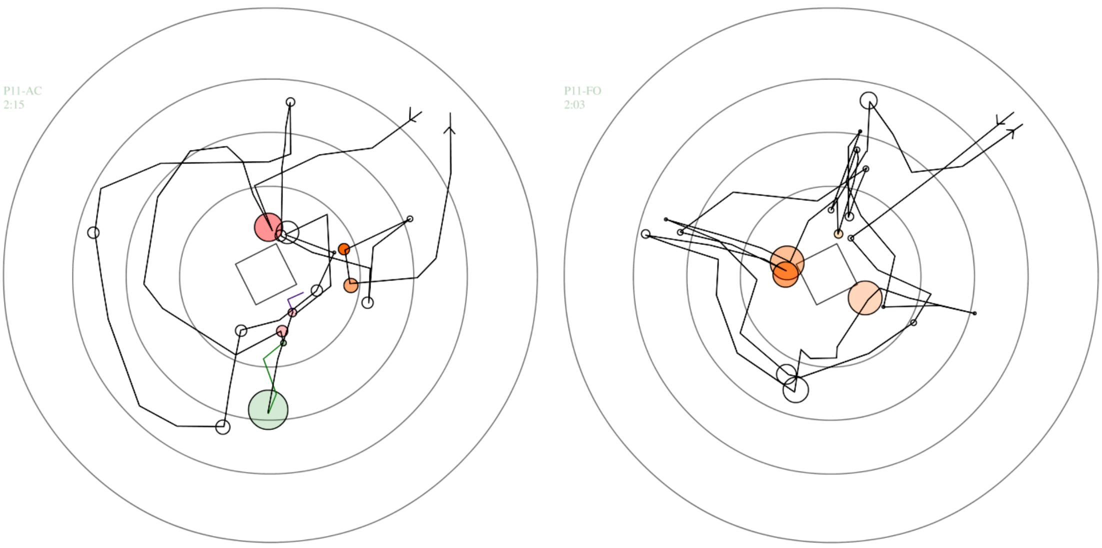

Figure 9. Movement mapping of participant 11. Left: active condition, right: following condition.
Interpretation of colours: black lines for walking and focusing – uncoloured circle for standing still observing – red circle for touching – orange circle for movement arms – green circle for shifting focus – green line for making a feint.

In these mappings, for example, walking around is drawn as a black line. Variations like running, arm movements while walking and making a feint are presented by colouring the line. When the participant stands at one spot for a second or longer a circle is drawn. The diameter of this circle corresponds with the seconds the participant was standing at that spot. When the participant is standing still, observing *PeP*+, only a black outline is drawn. Different fill in colours are used to indicate actions that the participants undertake while standing at one spot, e.g., arm-movements, touching or making sound. The lightness or darkness of a spot is used to indicate the intensity of an action on that spot (Figure 9). More activity in relation to the time is presented by a darker spot, e.g., moving the arms twice when standing at that spot is indicated with a lighter colour than moving the arms continuously. In addition, we measured the time the participants spent per condition.

From the interviews qualitative descriptors were abstracted that the participants used in their discussion of the two conditions they encountered using the affinity diagramming method. The first author derived nine main categories, namely explorative behaviour, character, contact, movement qualities, asking/steering, testing, relation, value judgment, and understanding.

Hypotheses

We test the following sets of hypotheses.

1. The participants are able to describe the intended difference between the conditions correctly.
2. The clarity in the active and following condition is higher than the clarity in the random condition. The clarity in the active condition is higher than in the following condition.
3. The active and following condition are preferred over the random condition. The active and following condition are more pleasant than the random condition. And in the active and following condition the involvement is higher than in the random condition. Furthermore the active condition is preferred over the following condition. The participants feel more pleasant in the active condition than in the following condition. The participants feel more involved in the active condition than in the following condition.

Results

The gathered data on correct description, clarity, preference, pleasantness and involvement is derived from three main components.

- Scores, generated from the answers given and comments made in the interview.
- Movement mappings, drawn from the video material.
- Descriptors, gathered from the interviews.

Correct description conditions

The first comparison made is to see whether a significant number of people describe the different conditions correctly. The results were analyzed using the chi square test for nonparametric statistics between two successive situations to see whether the observed sample differed significantly from the expected values (Siegel, 1956). It shows that for both the *active condition* and the *following condition* a random distribution can be rejected (with a level of significance of $p < 0.05$). The *random* condition is described incorrectly more often than the other two conditions. For the random condition the random distribution can't be rejected ($p < 0.1$). It seems that the participants see meaningful behaviour in this *random* condition. This phenomenon has been referred to as Apophenia (Conrad, 1958, as cited in Brugger, 2001).

Table 2. Overview of data on correct description: observed values *(expected values based on random distribution)* **e.g., 14** *(9.5).*

	Random	Following	Active	Total
Correct	**9** *(6)*	**14** *(9.5)*	**14** *(9.5)*	**37** *(25)*
Incorrect	**3** *(6)*	**5** *(9.5)*	**5** *(9.5)*	**13** *(25)*

Clarity

Table 3 gives per comparison an overview of the data gathered around the topic of clarity. Each participant experiences and compares two of the three conditions. The numbers indicate how many of the participants found a condition clearest of both; how many participants found no difference in clarity between the two conditions they experienced; and how many participants experienced a condition as unclearest of the two conditions they experienced. The numbers suggest that the *active* condition is clearer than the *random* and *following* condition. The clarity of the second condition the participant experiences might be influenced by the first condition. This can influence the results and therefore it is interesting to consider only the first of the two conditions the participants went through. Also, when comparing the first experienced conditions the numbers suggest that the *active* condition is clearer than both the *following* and *random* conditions.

Table 3. Overview on data of comparing all conditions on clarity comparing *following* and *random* (a), *active* and *random* (b) and *active* and *following* (c). The overview considers the order in which the participants experience the conditions. In section (d) and (e) a summary of the data is given, section (d) considering all conditions, section (e) only considering the conditions that were first experienced by the participant.

Table 3(a). Overview data on clarity, comparing *following* and *random* condition, considering order.

	Following 1	Random 2	Random 1	Following 2
Clearest	0	0	0	2
No distinction with 2nd	3	3	1	1
Unclearest	0	0	2	0

Table 3(b). Overview data on clarity, comparing *active* and *random* condition, considering order.

	Active 1	Random 2	Random 1	Active 2
Clearest	2	0	0	1
No distinction with 2nd	1	1	2	2
Unclearest	0	2	1	0

Table 3(c). Overview data on clarity, comparing active and following condition, considering order.

	Active 1	Following 2	Following 1	Active 2
Clearest	1	3	0	4
No distinction with 2nd	2	2	3	3
Unclearest	3	1	4	0

Table 3(d). Overview on clarity per condition.

	Random	Following	Active
Clearest	0	5	8
No distinction	7	9	8
Unclearest	5	5	3

Table 3(e). Overview on clarity per condition experienced first in the comparison.

	Random 1	Following 1	Active 1
Clearest	0	0	3
No distinction	1	6	3
Unclearest	5	4	3

This data corresponds with the mappings of the participants' movements and their descriptions of the three conditions. Participants figured out the *active* condition faster and easier; the time spent and the activity of the participants in the *active* condition (ū = 1'36", n = 9) are less than in both the *following* (ū = 2'48", n = 10) and *random* (ū = 3'12", n = 6) condition (Figure 10). Although the time spent and the total activity is less in the active condition than in the other two conditions, the movement qualities of the exploration are described by the participants as rich. This can be clearly seen when plotting all the mappings of the first *active* and first *following* conditions respectively together. Also positive descriptors relating to clarity are used more in the *active* condition.

Preference, pleasantness, and feeling of involvement

As the results on preference, pleasantness and feeling of involvement are similar we discuss them together. Table 5 shows that participants prefer, find more pleasant and feel slightly more involved in the *active* and *following* conditions compared to the *random* condition. But, as Table 4 shows, there is no clear difference in preference between the *following* and *active* condition. This goes also for pleasantness and feeling of involvement. The preference for a condition corresponds with the feeling of being perceived or not. The interview shows that when participants feel that they are not perceived by *PeP+*, this condition is not preferred. Note that here we show all the gathered data on these three topics. When only considering the participants that do feel that they have been perceived in the *following* and *active* conditions but do not feel perceived in the *random* condition, the effect increases.

Analyzing the data further shows that the order in which the *active* and *following* conditions are experienced has an influence. Participants especially prefer and find more pleasant the second experience when comparing the *active* and *following* conditions, regardless of which of the two conditions comes first (Table 4). There seems to be an order effect. A reason for this can be that participants are more familiar with the artefact in their second experience.. For example, participant 12 noted: "Situation 2 (*following*) is more pleasant, maybe a little because of habituation but also because he did not react too fast."

In line with the hypotheses, descriptors referring to explorative behaviour are used more to describe the *active* and *following* condition than are used to describe the random condition. This also goes for the descriptors referring to contact (feeling in contact with) and relationship (feeling there is a relationship). No difference was detected between the *following* and the *active* conditions in descriptors referring to explorative behavior. The movement qualities in the *active* condition are

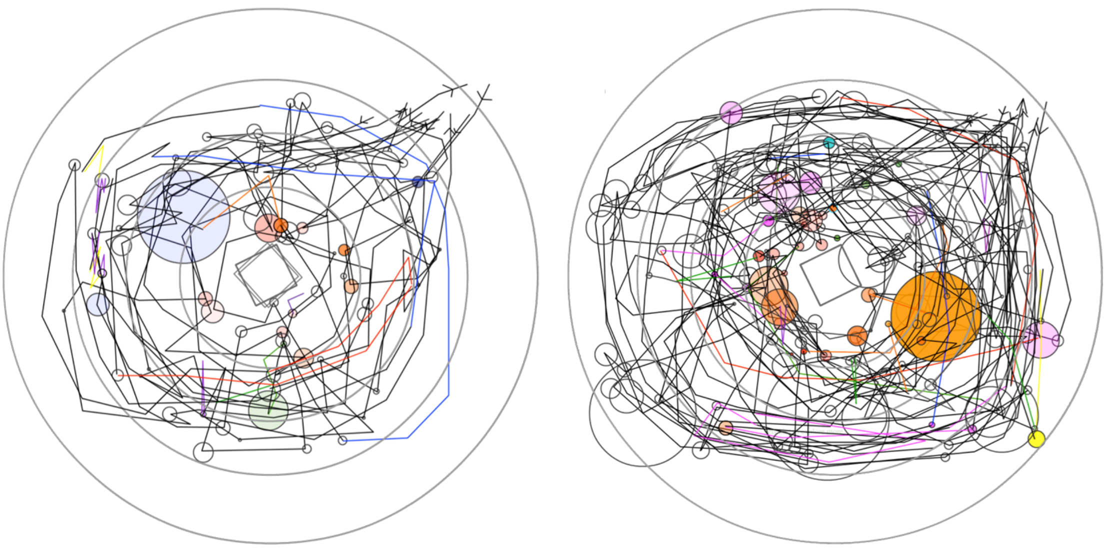

Figure 10. All mappings for first experiences plotted in one overview, n = 6 in both plots. Left the *active* condition experienced first (n = 6). Right the *following* condition experienced first (n = 6). Only participants that described the condition correctly are considered.

described as more quick, dynamic, active and agile. Descriptors (bold) in the category asking/steering are used more to describe the *active* condition, for example:

"Situation 2 (*active*) is a lot more interactive. In situation 1 (*following*) you can stand somewhere and nothing happens. In the second *PeP+* **undertakes own action that triggers you to do something.** … The second is **impatient**, like a puppy." (participant 25, *following-active*)

"I had the idea that the first one (*following*) followed me more and in the second (*active*) I was more **asked to go in a certain direction**. He did follow in the second but **tried to get me in a direction** and I was so stupid to do it." (participant 22, *following-active*)

Conclusions

The numeration of the conclusions corresponds with the description of the hypotheses (cf. Experiment, Hypotheses).

1. The experiment shows that the intended difference between the conditions is recognized and described accordingly. Participants attribute movement qualities such as active, agile and dynamic to the active condition. Moreover provocations are attributed to the active behaviour like 'trying to get me in a direction' and 'activates me'.
2. The clarity of the active condition is shown to be higher than the clarity of both the following and random conditions.
3. The following and active conditions indeed are preferred over the random condition. They are also experienced as more pleasant and the feeling of involvement is higher. Between the following and active condition no differences in preference, pleasantness or feeling of involvement is measured. In the comparison between the active and following condition it is remarkable that the second experienced condition is significantly preferred, is more pleasant and the feeling of involvement is higher.

Discussion

Where initially we considered the *active* condition as better fitting to the theory than the *following* condition we came to realise that this is a different behaviour, which people might prefer. In other words some people find the *active* behaviour unpleasant as they do not know what it exactly wants and other people like the initiative and even follow it to see what happens. Nonetheless from a technical point of view the *active* behaviour is stronger as it is possible to create a following behaviour by adjusting the variables that determine *PeP+*'s motivations to explore. The major finding is that participants in the *active* condition feel that they are significantly influenced by the behaviour of the light body. The perceptions that 'it wants something' and 'I'm trying to trick it' are very valuable and can be considered a strong argument for developing these design notions further.

Based on the design relevant theoretical model and on the three components of perceptive activity (cf. section Designed Artefact) we stated criteria for the designed artefact. The artefact should be able to perceive the perceptive activity of the person and be able to show perceptive activity to allow for reciprocity. Going through this iterative cycle we came to understand that indeed (1) the person can perceive the artefact, (2) the artefact can perceive the person, (3) the person can perceive the artefact perceiving her, but (4) the artefact *cannot* perceive that the person perceives it. The initiative *PeP+* shows, to which people attribute the meaning that 'it wants something', actually is not an initiative

Table 4. Overview of data on preference (a), pleasantness (b) and involvement (c) comparing the active condition to the following condition. The overview shows the order in which the conditions were experienced.

Table 4(a). Overview of data on preference.

	Active 1	Following 2	Following 1	Active 2
Preferred	1	5	1	6
No preference	0	0	0	0
Not preffered	5	1	6	1

Table 4(b). Overview of data on pleasantness.

	Active 1	Following 2	Following 1	Active 2
Most pleasant	0	3	0	5
No distinction	3	3	2	2
Least pleasant	3	0	5	0

able 4(c). Overview of data on involvement.

	Active 1	Following 2	Following 1	Active 2
Most involved	2	4	3	3
No difference	0	0	1	1
Least involved	4	2	3	3

Table 5. Overview of the data comparing the active and random condition (left) and the following and random (right) condition on preference (a), pleasantness (b) and involvement (c).

Table 5(a). Overview of data comparing preference in the active versus the random condition and in the following versus the random condition.

	Active	Random	Following	Random
Preferred	4	2	3	0
No preference	0	0	3	3
Not preffered	2	4	0	3

Table 5(b). Overview of data comparing pleasantness in the active versus the random condition and in the following versus the random condition.

	Active	Random	Following	Random
Most pleasant	2	1	3	0
No distinction	2	2	1	1
Least pleasant	1	2	0	3

Table 5(c). Overview of data comparing feeling of involvement in the active versus the random condition and in the following versus the random condition.

	Active	Random	Following	Random
Most involved	2	2	3	1
No difference	1	1	1	1
Least involved	2	2	1	3

that directly relates to *PeP+*'s perception of the person. It is an intrinsic motivation to explore the (common) space, which is subject to the activity of the person. This is different from recognizing the presence of the person and exploring the person rather than the common space. *PeP+* does not appreciate yet that it is being perceived and logically does not act upon this. The perception of the person and the perception of *PeP+* cannot cross as proposed in the theoretical design relevant model (Figure 3 & Figure 4). Nonetheless the descriptions of participants that relate to 'it wants something' or 'trying to get me in a direction' show that people already feel engaged in a rich reciprocal interplay.

In relation to this, the movement mappings provide us with strong insights into a person's strategies. The movement mappings show strong parameters of exploration in the interaction with *PeP+*, like alternating between moving and standing still and observing a person varying their position around, and distance from, the pillar. We saw that when the person explores very little, or does not behave actively, the behaviour of *PeP+* is unclear to the person. In other words the person has to be active if they are to engage in the reciprocal interplay. This supports our theoretical stance on active perception. Participants even indicate this in their descriptions, e.g., "The second (*active*) is more clear. At the beginning it was not as I stood still to see what happened. When I moved it was a lot clearer." (participant 6, *following-active*).

Figure 11 gives an impression of the movement plotting of (1) someone who was not explorative and described the *active* behaviour as random. And (2) a participant who was explorative and felt the light body in the *active* behaviour was trying to lead them in a particular direction. In our next interative cycle we will develop the behaviour further, such that *PeP+* comes to appreciate that a person is exploring it and also try to make it possible for *PeP+* to explore the person more elaborately.

To achieve this, the particular design notions of 'Detecting Active Behaviour Subject' and 'Course of Perception in Time' should be enriched to gain the perceptive qualities and intelligence we are aiming for. Although it was clear before conducting the experiment that some design notions were more strongly developed than others, it is because of the experiment and our observations that we came to understand not only which but especially how to develop these design notions further. In a next iteration we would like to focus on how the force of attraction and escape can happen between a person and the designed artefact.

In this paper our main contribution is that we are able to bring forward design notions for synthesis that are directly based in theory. The theoretical outline of phenomenology of perception is used to generate design relevant knowledge and is at the same time the subject of design relevant knowledge. The design relevant model and the design notions have been used as input for related design projects (Deckers & Levy, 2012) and by describing them elaborately we invite others to build upon our approach and to contribute to the development of the design notions. It might seem that our design notions are bound to the design of *PeP+*. We very deliberately take on a minimalist approach so our findings can be transferred to different artefacts in different contexts (Deckers et al., 2010).

Acknowledgments

We thank the editor and the reviewers for their valuable input. Your attention and comments helped us to improve the paper significantly.

Endnotes

1. My perception of the world is predominantly depending on the body I have. The affordances, the acts or behaviours permitted by objects, places and events of the world are actually what we perceive (Michaels & Carello, 1981). In first instance we do not perceive a chair as the concept of a chair as we have been told. In a first preconception we perceive the 'sitability' of the chair. We perceive the place to sit, and whether you perceive something as 'sitable' depends on your body.
2. It was Edmund Husserl who introduced the term and discipline of phenomenology. The basis of all his ideas was that he believed that phenomenology would bring forward the

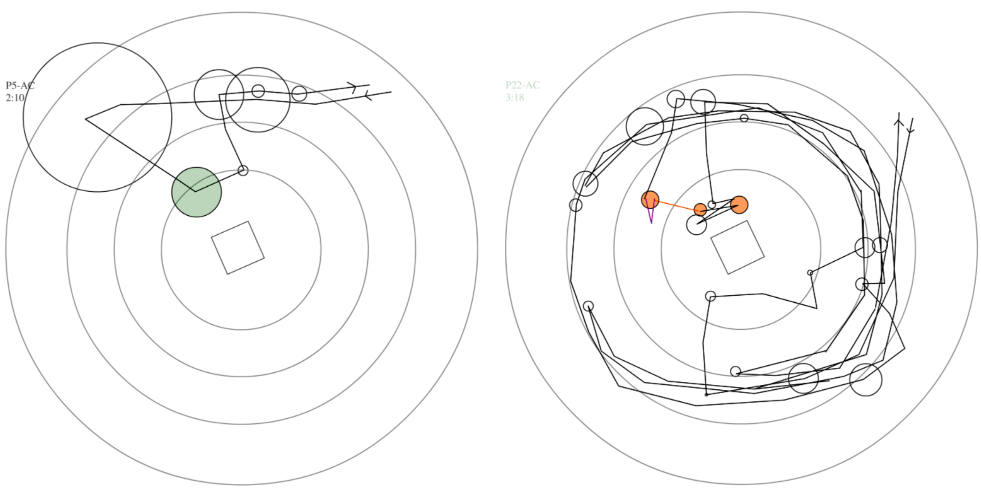

Figure 11. Impression of movement plottings on the relation between explorative behaviour of the participants and their experience. Left rather observing participant describing the *active* behaviour as random. Right explorative participant that felt that they were being pulled in a direction by the *active* behaviour.

'things themselves'. The emphasis is on how things appear to us in our direct, sensorial experience (Abram, 1996; Dourish, 2001). Husserl at that point, building on the Cartesian heritage, considered the body and mind as two separate qualities and described his notion of phenomenology as a pure mental, non-material dimension (Dourish, 2001). It was Maurice Merleau-Ponty who, in line with Husserl's work, took a more radical position. Merleau-Ponty rejects the assumption of a division of mind and body; that a human would be in essence self-subsistent, disembodied and transcendental. He argues that if we had no body there is no possibility of experiencing the world. The body is the true subject of experience (Abram, 1996; Merleau-Ponty, 1945)

3. The meaning of 'intention' is here also considered in an active and bodily sense. Intentionality is a profound concept in phenomenology conceived as the directedness of meaning (Dourish, 2001, Keller, 2001). Meaning is in this sense, as is perception, a relationship between perceiver and the perceived. It is not to be mistaken for the term we use to refer to as 'having a purpose in mind' or the 'purpose of actions'. Our interpretation of intentions in the thought of this research is as follows. When we can feel involved in a situation the activity of the other becomes meaningful for us. When we build a common history in the course of our interaction, we can build towards understanding what things meanto the other, what it means to the other that she is affected by me and the environment we are in. It is in the others activity, her expressivity, that I can appreciate her viewpoint, her intentions towards me and the environment. In time, in the course of the interaction I become able to anticipate the others perceptive activity.

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