

Affective affordances: Improving interface character engagement through interaction

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Abstract

The nature of humans interacting with interface characters (e.g. embodied agents) is not well understood. The I-PEFiC model provides an integrative perspective on human–character interaction, assuming that the processes of engagement and user interaction exchange information in explaining user responses with interface characters. An experiment using the Sims2 game was conducted to test the effects of aesthetics (beautiful versus ugly, as engagement factor) and affordances (help versus obstacle, as interaction factor) of interface characters on use intentions, user engagement, and user satisfaction. Results of the experiment showed that (1) people tended to use helpful characters more than obstructing characters, (2) user engagement was enhanced by beauty and perceived affordance of the character whereas (3) intentions to use the character were not affected by good looks, and (4) the most satisfied users were those that were engaged with the character as well as willing to use it. This stresses the importance of enhancing affordances so to increase user engagement with interface characters. The I-PEFiC model provided a valuable framework to study the (interdependent) effects of relevant factors in human–character interaction.

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Keywords: Human–computer interaction; Media entertainment; Interface characters; I-PEFiC model; Empirical study; Engagement; Use intentions

1. Introduction

‘For so long, the computer gaming industry was concerned with making their products look and sound better—and for good reason. There have been many instructional books and articles that have paced the advances in graphics and sound technology’ (Mark, 2003).¹ Yet, Mark also signals the need in the game development community to add ‘true interactive gameplay into their products’ (Mark, 2003). Whereas the focus used to be on graphic design, game AI ‘has only recently come into the primary focus as the next frontier of game advancement’ (Mark, 2003).

That the industry is switching from graphic to AI design may be for good reason as well, as suggested by the results of our experiment with the Sims2 game. If the gameplay was improved, not only the user’s willingness to interact with the game character increased but also the user’s engagement with the character. By contrast, just improving the appearance of the character had no effect on the willingness to interact with it. In the latest generations of computer games, hence, game AI seems to get more emphasis than graphic design when it comes to enhancing the overall user experience. The present study aims to investigate how graphic design in coalition with gameplay (i.e. time efficiency) of game characters affect use intentions and engagement.

In recent years, computer programs are increasingly anthropomorphized, that is, mimicking humans in appearance, behavior, emotion (e.g. Picard and Klein, 2002; Brave et al., 2005; Gratch and Marsella, 2005) and/or emulating human communication skills. Such anthropomorphized communication partners, or *interface characters*, feature in,

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¹Dave Mark is the president and lead designer of Intrinsic Algorithm, a computer game development company in Omaha, NE. The quote was drawn from his review of the book *AI Game Development* (Champan-dard, 2003).

for example, educational software, the Internet, games, and standard desktop applications. Although interface characters are increasingly prevalent, it remains unclear how users decide whether or not to interact with them.

Understandably, many studies have investigated the effects of interface characters on the user (for overviews see Dehn and Van Mulken, 2000; Ruttkay and Pelachaud, 2004). Many studies focused on realism effects by comparing realistic and unrealistic outer appearances of interface characters. From a designer's point of view, character interfaces differ from traditional interfaces because they have human- or animal-likeness. Obviously, the degree to which the character resembles a real person or living creature is likely to influence the user's experience and behavior in human–character communication (e.g. Berry et al., 2005). Next to realism, other factors are also likely to influence human–character interaction, as overviews of relevant factors show (e.g. Catrambone et al., 2004; Ruttkay et al., 2004). Despite such important insights, there is a need for an *integrative model* that takes into account the (interdependent) effects of a variety of factors that may explain human–character interaction. Therefore, in the present study we present a model as a conceptual framework to explain user engagement with and intentions to use interface characters. Then, we test hypotheses derived from the model. We believe such a model will be useful for the interface character community, as it allows for (1) a systematic empirical investigation of relevant factors, (2) investigations into the relative importance of factors, (3) an integration of past research results, (4) a deeper understanding of the psychological processes underlying human–character interaction, and (5) informing the design of interface characters.

2. Conceptual framework: I-PEFiC

Literature speaks of the possibilities and advantages of applying social science theories to study human–computer interactions (HCIs), because they resemble human–human interactions (cf. *the media equation*, Nass et al., 1994, 1995, 1996; Reeves and Nass, 1996). In line with these ideas, we take a new scientific perspective on studying humans communicating with interface characters. We apply a specific theory, based on interpersonal communication theory, which explains user perceptions of film and television characters. This model integrates different factors that contribute to affective bonding between humans and mediated characters. Unlike with film and television characters, however, people can actively interact with interface characters, thereby influencing the experience. Therefore, we adjusted the model and developed the Interactive PEFiC (I-PEFiC) model that aims to explain both affective bonding with and use of interface characters (Van Vugt et al., 2004). This model (see Fig. 1) integrates two main processes that are evoked during an encounter with an interface character: the engagement process (dashed) and the interaction process (drawn arrows).

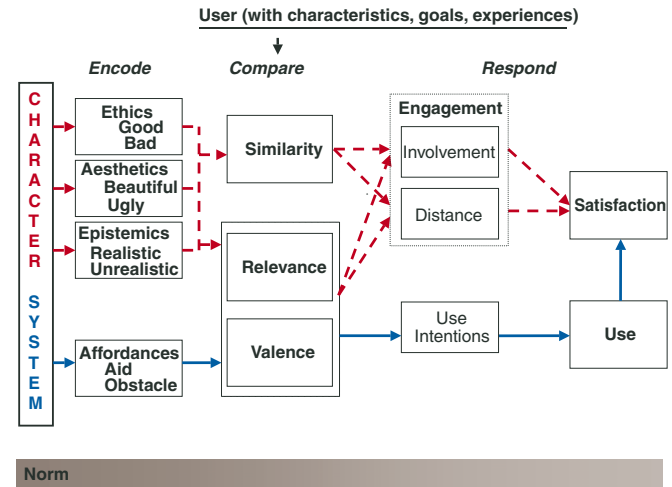


Fig. 1. Graphical representation of the I-PEFiC model.

In the following sections, we explain both the engagement and the interaction process in more detail. The present study focuses on the interdependencies between the two processes, which have been studied in different scientific areas.

2.1. The engagement process

The engagement part of the model is based on the model of Perceiving and Experiencing Fictional Characters (PEFiC) (Hoorn and Konijn, 2003; Konijn and Hoorn, 2005). The PEFiC model is based on psychological theories of emotion and interpersonal attraction. It explains user engagement (i.e. involvement and distances, Konijn and Hoorn, 2005) towards fictional characters, such as those from film and television.

In analyzing users' experiences towards fictional characters, PEFiC distinguishes between three phases, *encoding*, *comparison* and *response* (see Fig. 1). Typical factors in the encode phase of character engagement, each modeled with a positive and negative dimension, are ethics (good versus bad), aesthetics (beautiful versus ugly), and epistemics (realistic versus unrealistic). Comparison entails establishing personal relevance and valence towards the character. Also, similarity between the fictitious character and the self influences user response. Finally, the response phase concerns engagement with a character, which consists of parallel tendencies to approach and avoid the character, the backbone of the processes of involvement and distance. Konijn and Hoorn (2005) and Konijn and Bushman (in press) provide evidence that the (dis)liking of a mediated person is best explained by *both* involvement *and* distance experiences. Thus, involvement and distance are distinct experiences that do not comprise two ends of a single dimension; both can be experienced at the same time. PEFiC states that the trade-off between involvement and distance better explains (dis)liking a character than either involvement or distance alone.

The engagement process is likely to work similarly for interaction with interface characters. Because interface characters are a special type of fictional character, we believe that epistemics, ethics, and aesthetics also influence interactions between humans and interface characters. *Epistemics* then relates to the realistic and unrealistic outer appearances of interface characters. Does the interface character resemble a living creature, whether human- or animal-like, or is it a strange, fantasy creature? Many cues might attribute to the perception of realism, for example, the character's facial expressions, body and head movements, gestures, eye contact and gaze (e.g. Cassell et al., 1994; Cassell and Thórisson, 1999; Bailenson et al., 2001; De Rosis et al., 2003), as well as the character's abilities, intelligence, and conversational and social behavior (Dehn and Van Mulken, 2000; Hayes-Roth, 2003). *Ethics* relates to how nice or mean the interface character is. For example, does the interface character have mean intentions when communicating (e.g. spam)? Does the interface character make unfriendly or even sarcastic comments on the user's activities (cf. AGNETA and FRIDA, see Persson, 1999)? Or, does the character provide kind, helpful instructions (e.g. Clippit)? *Aesthetics* concerns the appearance of the interface character (is she beautiful or ugly?). Universal standards of beauty (e.g. average face shape and symmetry, see, among others, Johnston and Oliver-Rodriguez, 1997) exist, which apply to fantasy characters as well as to real people. Deviations from the beauty standards induce ugliness when, for instance, interface characters have misshapen skulls or show signs of 'physical' decay. Similarity, relevance, and valence judgments are based on these three 'encode' factors and impinge upon user engagement (involvement and distance towards the interface character). These three factors refer to user characteristics and goals. For example, is the character similar to the user in some way (e.g. both are female), does the character seem important (relevant) to the user's goals (e.g. efficient task completion, entertainment, or learning), and does the character seem to harm or sustain those goals (valence) (c.f. Frijda, 1988)?

Thus, the process of establishing affective bonds between humans and interface characters bears resemblance to how media users respond to film characters. Therefore, we began our investigation of human–interface character interaction with the PEFiC model, and modified it to incorporate its interactive nature.

2.2. The interaction process

The interaction part of the model was based on affordance theory (among others Gibson, 1979; Gaver, 1991; McGrenere and Ho, 2000) and technology acceptance theories (e.g. Davis, 1989; Venkatesh et al., 2003). The interactive side (i.e. affordances or action possibilities), yields intentions to use a system or not, which appeared strong predictors of actual use (Davis, 1989; Venkatesh et al., 2003). Thus, the interaction process focuses on the

user's decision of whether or not to interact with an interface character. The perception of affordances is typical for the interaction process.

2.2.1. Affordance theory

The ecological psychologist Gibson was the first to frame affordances as unified relations between the environment and an actor. 'The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill' (Gibson, 1979, p. 127). Affordances can be explained as action possibilities that actors have in the environment. That is, an affordance exists relative to (1) properties of the environment and (2) the action capabilities of an actor (McGrenere and Ho, 2000). For example, a chair has the affordance of 'sitting', because of its shape, height and carrying capacity. Humans' ability to sit, the length of their legs, and their weight, enables them to sit on the chair. The concept of affordances is of particular interest in the field of HCI, which is primarily concerned with studying how properties of computers (the environment) and humans (actors) influence their interaction with each other.

Goals are central in affordance evaluations. It is important to understand that an affordance does *not change* as the needs and goals of the person change (McGrenere and Ho, 2000 interpreting Gibson, 1979). A chair affords sitting, independent of whether a person wants to sit or not. However, people's actions *do* depend on the goal context. People typically act within the environment (they use an affordance) because of a goal they want to achieve (for example, performing a task or having fun). When humans interact with computer systems (such as interface characters), they perceive or 'encode' them *in terms of* action possibilities for goal achievement.

2.2.2. Affordances in I-PEFiC

Affordance theory often differentiates between affordances that are perceptible and affordances that are not perceptible, or hidden (Gaver, 1991). If a person notices that she/he can act in the environment in a certain way, this is called a perceptible affordance. A hidden affordance refers to an action possibility that a person fails to notice or does not understand (for example, because of poor design). Our model focuses on *user perceptions*, in which, obviously, perceptible affordances play a role. Hidden affordances, therefore, fall outside the scope of our model.

Like the other encode factors in the I-PEFiC model, affordances have a positive and negative dimension (aid versus obstacle, see Fig. 1). Affordances perceived as offering help (hence, aids) can be used to increase the likelihood that a desired goal can be reached. They indicate that progress is occurring (Peterson, *in press* and evoke intentions to use (cf. technology acceptance theory, Venkatesh et al., 2003). This process is further supported by positive outcome expectancies (i.e. positive valence—goals are supported). The side-effect of this process can be the excitement of positive emotions, such

as pleasure and pride (cf. Hoorn and Konijn, 2003). However, affordances can also obstruct goal achievement (hence, obstacles), for example, when the user is in a hurry to finish a document and Clippit pops up with an unhelpful suggestion. Thus, obstacles have the reverse nature of aids. They indicate that the current path of actions chosen may not lead to goal fulfillment (decreased effectiveness) (Peterson, in press), may prolong goal achievement (decreased efficiency) and/or increase the mental or physical effort required to accomplish a goal. As the technology acceptance theory (Davis, 1989; Venkatesh et al., 2003) argues, use intentions are likely to be influenced by efficiency and effectiveness considerations. Hence, obstacles normally invoke negative valence and result in intentions not to use. This process is accompanied by negative emotions (such as anger and disappointment) as a byproduct (cf. Hoorn and Konijn, 2003).

Most often, positive dimensions (e.g. beauty, aids) will result in positive effects (involvement, intentions to use, satisfaction), and negative dimensions (e.g. ugliness, obstacles) in negative effects (distance, intentions not to use, dissatisfaction). Further, the model allows for *positive effects of negative dimensions* as well as *negative effects of positive dimensions*. Thus, the model also explains why interface characters that are ugly (negative dimension) can still be involving (positive effect). Or why, in game contexts for example, obstacles might be needed for a positive experience such as challenge, and evoke intentions to use the character.

2.3. Dependencies between the engagement and interaction process

Typically, the appearance aspect of the interface character system evokes engagement (involvement and/or distance tendencies), whereas the interactive component (i.e. affordances) yields intentions to use or not. Studies on engagement processes and interaction processes typically have different roots (i.e. communication versus computer sciences, respectively). Because both can occur at the same time and in parallel, the question arises whether these are separate processes or whether interdependencies, such as those modeled in I-PEFiC, feature in human–character interaction.

First, affordances may influence the engagement process. When an interface character is ugly but helpful for task completion (e.g. is efficient), users can still feel involved. I-PEFiC explains this as follows: An affordance in an interface character system may increase intentions to use. However, because valence is central to both processes (see Fig. 1) and mediates this inclination, part of the influence of affordance may be redirected to involvement towards the interface character. Consequently, affordances of the interface character system not only affects use intentions but also engagement with the interface character. In this case, we speak of ‘affective affordances’. Second, appearance aspects, such as aesthetics, may influence the interaction process. When an interface character obstructs task completion yet is

nicely designed, individuals may still want to use it. In terms of I-PEFiC, aesthetics in an interface character may increase involvement, but because this inclination is mediated through valence, part of aesthetics’ influence may be redirected towards intentions to use the character. In other words, an aesthetically beautiful interface character may increase not only involvement with the interface character but intentions to use as well (cf. ‘What is beautiful is usable’, Tractinsky et al., 2000). By studying the interdependencies between the processes we may find answers to the following questions: What happens when a user is confronted with an efficient but ugly interface character, or, what happens when a user is confronted with a beautiful interface character that slows work progress?

If the interaction and engagement processes are unrelated, designers do not have to worry about ‘dressing up a system nicely’ to motivate individuals to use it. If the system works well, appearance aspects would not affect intentions to use. On the other hand, if the interaction and engagement processes depend on one another, appearance aspects would affect use intentions and vice versa. Designers could camouflage a deficient character system by making it look attractive. Conversely, a functional character system that appears ugly may be misjudged as unusable, which would evoke intentions not to use it. Similarly, a character system that is not usable might lead to felt distance to the character (cf. Microsoft’s Clippit), and a usable character system may increase involvement despite the character’s outer appearance.

Thus, the challenge is whether we should consider the interactive aspects of bonding with interface characters as a separate process that is independent of appearance aspects of the character, or whether it is integral to the interface character system experience. We focused on affordances as generators of the interaction process, and on aesthetics as producers of the engagement process. Earlier findings (Van Vugt et al., 2005) have shown that (perceived) aesthetics was a stronger predictor of user engagement in human–character interaction than (perceived) epistemics (realism) of the character. Remarkably, interface character research belittled the importance of aesthetics. Further, other HCI literature indicates that aesthetics has major influence on experiences when users interact with computerized products in general (e.g. Tractinsky, 1997). A confrontation with a (new) system is often a visual one, and during system interaction, visual information constantly is present and immediately evokes aesthetic judgments.

A simple graphical representation of the study can be seen in Fig. 2.

2.4. Hypotheses

Hypotheses derived from the above theorizing were as follows:

H1. If an engagement process is triggered, there is a significant main effect of aesthetics on engagement. If an interaction process is triggered, there is a significant main

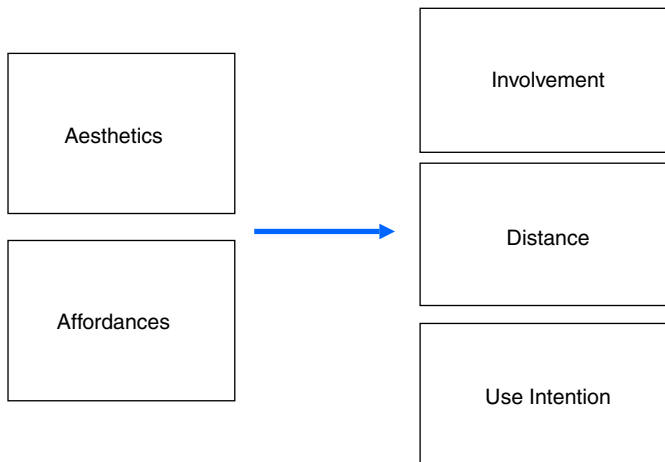


Fig. 2. Interdependencies between the engagement and interaction processes. Affordances may influence involvement and distance, and aesthetics may influence use intentions (see text).

effect of affordances on use intentions. In both cases, both relevance and valence may serve as a mediator between encode and response factors.

H2. If the engagement process is *independent* of the interaction process then there are no cross-over effects between the two processes. More specifically, there is no main effect of affordances on engagement, no main effect of aesthetics on use intentions, and no interaction effect of affordances and aesthetics on engagement and/or use intentions.

H3. If the engagement process and the interaction process are relatively *dependent* on one another, then, apart from the main effects of H1, cross-over effect(s) will be found. Thus, a main effect of affordances on engagement, a main effect of aesthetics on use intentions and/or a significant statistical interaction between aesthetics and affordances on engagement and/or use intentions should take place. Herein, relevance and valence may serve as a mediator between encode and response factors.

H4. If the engagement and interaction processes work together, this is reflected in end-user satisfaction. Satisfaction, then, depends on both engagement as well as use intentions.

3. Method

To verify whether engagement and interaction processes affect each other, we conducted an experiment with the Sims2 game environment. Sims2 offers possibilities to manipulate the interaction through affordances that help achieve a user goal or affordances that hinder achieving that goal. Moreover, Sims2 offers possibilities to adapt the outer appearance of the game characters.

3.1. Design

Participants ($N = 120$) were randomly assigned to one of the experimental conditions of a 2(designed aesthetics:

Table 1

Total task-completion times over the five experimental tasks ($N = 80$), in the two affordance conditions

	M (s)	SD (s)	N
Aid	302	52	40
Obstacle	675	15	40

beautiful character versus ugly character) \times 2(designed affordances: aid versus obstacle) between subjects design.²

We implemented the affordance conditions in terms of time efficiency. That is, in the ‘aid’ condition, subjects could quickly complete the tasks using the interface character. In the ‘obstacle’ condition, the tasks took at least twice as long. The tasks were designed such that task-completion time was highly dependent on use of the particular interface character. For the means and standard deviations of manipulated total task-completion time, see Table 1.

We systematically combined beautiful and ugly characters (factor designed aesthetics) with designed affordances that aided achieving a goal (accomplish a task efficiently) versus designed affordances that kept the user from doing so. Four main types of characters were designed: (1) beautiful characters that accomplished tasks efficiently, (2) beautiful characters that accomplished tasks inefficiently, (3) ugly characters that accomplished tasks efficiently, and (4) ugly characters that accomplished tasks inefficiently. For dependent variables, we measured involvement with and distance towards the character (engagement), as well as the intentions (not) to use the character in a subsequent task.

3.2. Participants and procedure

A sample of 120 university students (69 male, 51 female, mean age 23.97, $SD = 4.75$) participated as volunteers in the study. They were approached on an individual basis and randomly assigned to the experimental conditions. All were experienced computer users, and most of them (86%) had no prior Sims experience.

In a silent room where only one participant and one experimenter were present, the experimenter wrote down personal information, and introduced the Sims game. Then, the participants were informed about the nature of the tasks and were told to perform the tasks as fast as possible to increase the relevance of the task. To keep the participants motivated, the three fastest participants would be awarded with a vacation check worth 100 euros, the Sims2 game worth about 40 euros, and a book check worth 25 euros. They were told to press the stop button of a clock

²Initially, the design included a half aid–half obstacle condition to study boundary effects. However, the results regarding this condition obscured rather than clarified results. Therefore, we left them out of the present paper.

as fast as possible after each task. Then, they were shown a scheme on a second computer and were told that this scheme indicated the average time the tasks were performed by other participants. We made the experimental trials such, that in the aid condition, participants would perform faster than average, and in the obstacle conditions, participants would perform slower than average. Then, the participants were given a practice task to get familiar with the Sims interface and with the clock. If participants had no further questions, the five experimental tasks started. For each task, (1) the experimenter gave a short, written, task instruction to the participant, (2) the experimenter started the clock, (3) the participant performed the task and stopped the clock when the task was finished, and (4) the participant wrote down the time in the scheme on the second computer.

After five tasks, the participants completed the user-perception questionnaire. In the questionnaire, a final task with the Sims was introduced and they were informed that prices could still be won. Then, the user-perception questionnaire asked about the participants' preference to use the same Sim again or another Sim (use intentions). Then, one final (dummy) task was performed and the participants were thanked for participating in the experiment. The prizes were given to three students by raffle.

3.3. Materials

The Sims2 game, developed by Maxis,³ is one of the best-selling games in computer history. It is a dynamic three-dimensional interactive environment in which human-like characters (the 'Sims') live in a neighborhood, have houses, go to work, sleep, have families and friends, etc. The game options were saved so that all participants started in the same environment. An advantage of the game was that people could easily operate it, with some initial instructions and explanation.

When Sims' 'free will' is turned off, they cannot act on their own. Users could interact with Sims to let them perform certain actions. For example, a Sim could be ordered to read a book or take a shower. The upper left picture in Fig. 3 shows how users interacted with the character (let a Sim perform an action) by choosing between menu options (the affordances).

We implemented five experimental tasks in which the participants had to let a Sim (1) play the piano (see upper left picture in Fig. 3), (2) clean up the kitchen sink (see upper right picture in Fig. 3), (3) learn from a book, (4) repair the washbasin, (5) paint on an easel. The order of the tasks was randomized for each participant. Paper instructions explained the tasks one by one, and explained the stop-condition. An example of such an instruction is: 'Bella is standing in front of the kitchen sink. Clean up the kitchen sink. The task is finished when Bella stops cleaning up and stands still in front of the kitchen sink.'

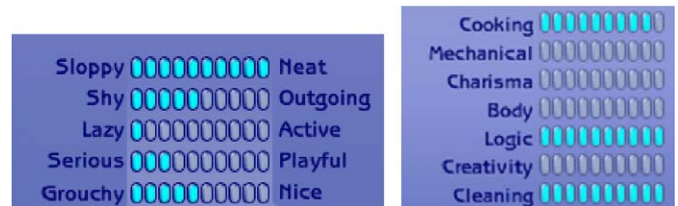


Fig. 3. Up, left: affordances are depicted in the form of menu options next to a Sim. Up, right: Bella is performing the task 'clean up the kitchen sink'. Below: Sims' personality and skills manipulated to create affordances as aids or obstacles for task completion.

In Sims2, characteristics such as personality traits and skills (see pictures at the bottom in Fig. 3) influence how a Sim wants to behave. We implemented aids and obstacles by adjusting these characteristics, which in turn affected task-completion time. For example, a sloppy personality and a low cleaning skill may double the time it takes to complete a cleaning task, compared to a neat personality and a high cleaning skill. Similarly, a Sim unskilled in mechanics takes much longer to repair a washbasin than a skilled Sim.

The aesthetics of the Sim was manipulated by applying standards of beauty universal in people (Johnston and Oliver-Rodriguez, 1997) to characters, as far as the Sims2 environment allowed. For example, the 'beautiful' character had a waist-to-hip ratio in the ideal range, an average face shape and symmetry, whereas the 'ugly' character deviated from these standards. Note that a character that is visually beautiful differs from a beautiful *design*. An ugly character can still be designed very well. Therefore, we conducted a pilot study to test whether several female Sims were perceived as beautiful or ugly. The girls presented in Fig. 4 were the most beautiful (left) and ugly (right) of the set and differed significantly in perceived aesthetics ($t(22) = 4.02, p < .001, N = 24$).

3.4. Measurements

All measurements were taken by means of a paper-and-pencil questionnaire containing Likert-type scales. Each item was followed by a six point rating scale, ranging from 1 (do not agree at all), 2 (do not agree), 3 (barely agree), 4 (agree a little), 5 (agree), to 6 (fully agree). Items were presented in mixed order.

³<http://www.maxis.com>



Fig. 4. Bella (left) and Berta (right) were perceived as beautiful and ugly characters.

Existing scales were used when possible in the construction of the structured user-perception questionnaire. When necessary, items were translated, adjusted to the purpose of the investigation and the specific material and the language use of the target group of participants (university students). The questionnaire consisted of 48 items.

Reliability analyses ($N = 120$) were performed on each set of items concerning separate scales. Selection criteria were (1) an optimal contribution to Cronbach's alpha by showing little or no increase in the alpha level when the item was deleted, (2) a minimal inter-item correlation of .30, (3) an inter-item total correlation within a scale is bigger than the correlation of each item with another scale (discriminant validity), and (4) a minimum of two items per scale. Items that failed on one or more of these criteria were not included in the measurement scales used in subsequent analyses.

We checked for the aesthetics manipulations (designed aesthetics) by means of a *perceived aesthetics* scale. This scale was measured by means of four items, based on scales used by Konijn and Hoorn (2005). In order to avoid directing the participant in an affirmative direction (see Dillman, 2000), two items were indicative (e.g. 'Bella looks nice') and two items were contra-indicative (e.g. 'Bella has an ugly appearance'). The scale was reliable according to a Cronbach's alpha of .89.

Further, we checked for the affordance manipulations (designed affordances) by means of a *perceived affordance* scale. Because it was the first time we measured perceived affordance as aids versus obstacles, we used eight items.

Compared to the original scale, one item had to be discarded because of the discriminant validity criterion. The remaining scale consisted of four indicative items (e.g. 'Bella is competent') and three contra-indicative items (e.g. 'Bella is clumsy') and was reliable (Cronbach's alpha = .88).

The measurement of *engagement* was based on scales used by Konijn and Hoorn (2005), distinguishing between *involvement* and *distance*. One item originally designed for the scale did not fit well based on psychometric analyses and was discarded. The remaining involvement scale consisted of three items (e.g. 'Bella appeals to me') and was reliable according to a Cronbach's alpha of .81. The distance scale was measured using four items (e.g. 'Bella leaves me with cold feelings') and was weakly reliable according to a Cronbach's alpha of .59.

The *use intention* measuring scale was based on behavioral intention scales used in technology acceptance literature (e.g. Davis, 1989; Venkatesh et al., 2003). Factor analyses showed that use intention was a bipolar scale, and did not consist of two unipolar scales as most other I-PEFiC factors. Because of the discriminant validity criterion, one item had to be discarded. The remaining scale existed of four indicative items (e.g. 'I want to use Bella again in a similar task') and three contra-indicative items (e.g. 'For this task, I would have preferred to use another Sim') and was reliable (Cronbach's alpha = .97).

The measuring scale *satisfaction* was based on the scale 'appreciation' used by Konijn and Hoorn (2005), and the ISO 9241-11 standard of satisfaction.⁴ Factor analyses showed that satisfaction consisted of two unipolar scales, a positive satisfaction scale and a dissatisfaction scale (just like engagement consists of the scale involvement and distance which are not the ends of one continuum, in Konijn and Hoorn, 2005). Compared to the original positive satisfaction scale, one item had to be discarded because of the discriminant validity criterion. The remaining scale existed of four items (e.g. 'Bella is ok') and was reliable (Cronbach's alpha = .81). Compared to the original dissatisfaction scale, three items had to be discarded because of the discriminant validity criterion. The remaining dissatisfaction scale existed of two items ('I am dissatisfied with Bella' and 'Bella makes me sad') and was reliable (Cronbach's alpha = .68).

As in Van Vugt et al. (2005), we measured several additional I-PEFiC variables for their potential influence⁵: *perceived epistemics* (five items, Cronbach's alpha = .74, after deletion of one item based on psychometric analyses), *perceived ethics* (three items, Cronbach's alpha = .70, after deletion of one item based on psychometric analyses), *perceived relevance* (four items, Cronbach's alpha = .79), *perceived valence* (four items, Cronbach's alpha = .76), and

⁴E.g. <http://www.idemployee.id.tue.nl/g.w.m.rauterberg/lecturenotes/ISO9241part11.pdf>.

⁵Measures irrelevant for the present study are not mentioned here.

perceived similarity (four items, Cronbach's alpha = .71). The appendix shows the items of the user-perception questionnaire and the reliabilities of each scale.

Finally, additional questions asked for some personal information about the participants such as gender, age, computer experience, game experience and previous Sims experience.

4. Results

4.1. Manipulation check

We assessed the effectiveness of the aesthetics manipulations (designed aesthetics, beautiful versus ugly character) and the affordance manipulations (designed affordances, aid versus obstacle), by performing a MANOVA with perceived aesthetics and perceived affordances as dependents. The tests of between-subject effects revealed that Bella ($M = 4.74$, $SD = .70$) was perceived as more beautiful than Berta ($M = 2.98$, $SD = .90$; $F(1, 116) = 149.83$, $p < .001$, partial $\eta^2 = .56$). Second, there was a significant difference in perceived affordances between the aid ($M = 4.15$, $SD = .77$) and the obstacle ($M = 3.42$, $SD = .80$) condition in the right direction ($F(2, 116) = 9.83$, $p < .001$, partial $\eta^2 = .15$). These main effects thus support our manipulation aims.

4.2. Preliminary analyses

Participants in various conditions had similar scores on the I-PEFiC factors perceived ethics and perceived similarity. Most participants (83%) scored 4.5 or higher on the ethics scale, thus they regarded all four character types as ethically 'good'. Most participants (84%) scored 3 or lower on the similarity scale, indicating that they perceived themselves as dissimilar to the Sims characters. Perceived ethics and perceived similarity can therefore be regarded constant variables that cannot explain differences between conditions. Therefore, they will not be used in subsequent analyses. The dissatisfaction scale was both severely skewed and peaked, and was therefore left out of further analyses. The other I-PEFiC variables satisfied the norms of normal distributions.

Age and previous experience with the Sims game co-varied with the designed affordances (age: $\chi^2 = 12.17$, $p < .007$; Sims experience: $\chi^2 = 29.78$, $p < .019$). None of the other personal characteristics had a significant effect on involvement, distance, or use intentions (according to MANOVA). Therefore, age and Sims experience were included as covariates in hypotheses testing. However, they turned out to not significantly affect the dependent variables ($p > .05$).

4.3. Hypotheses testing

To test H1 on the main effects of designed affordances on use intentions and of designed aesthetics on engagement

(i.e. involvement and distance), a MANOVA was conducted with designed affordances (aids versus obstacles) and designed aesthetics (beautiful versus ugly) as the between-subject factors. The dependent variables were use intentions, involvement, and distance.

The multivariate test showed significant main effects of both designed affordances and designed aesthetics (designed affordances: Wilks' lambda = .90, $F(3, 74) = 2.71$, $p < .05$, partial $\eta^2 = .10$; designed aesthetics: Wilks' lambda = .79, $F(3, 74) = 6.43$, $p < .001$, partial $\eta^2 = .21$). Furthermore, the interaction was significant (Wilks' lambda = .87, $F(3, 74) = 3.81$, $p < .013$, partial $\eta^2 = .13$).

Univariate F -tests confirmed the obtained multivariate results. More specifically, we found a main effect of designed affordances on use intentions ($F(1, 76) = 7.70$, $p < .007$, partial $\eta^2 = .09$), as hypothesized in H1. Thus, an interaction process was triggered. Participants were more keen to use helpful characters, which aid task completion ($M = 4.1$, $SD = 1.1$) than obstructing characters, which are obstacles for task completion ($M = 3.4$, $SD = 1.1$). Further, designed aesthetics affected user involvement with the character ($F(1, 76) = 17.89$, $p < .001$, partial $\eta^2 = .19$). Thus, an engagement process was also triggered. Participants felt more involved with the beautiful character ($M = 3.4$, $SD = .85$) than with the ugly character ($M = 2.6$, $SD = .82$). However, people felt as distant to the beautiful character ($M = 3.1$, $SD = .70$) as to the ugly character ($M = 3.3$, $SD = .74$) ($p = .36$).

These results confirmed our expectations regarding the simultaneous existence of an engagement process and an interaction process. However, in this study, our main goal was to test whether the engagement process was either independent (H2) or dependent (H3) of the interaction process. Therefore, we looked into cross-over effects between the two processes. The same MANOVA could be used for this purpose. First, we investigated whether aesthetics affected the interaction process, by investigating effects of designed aesthetics (beautiful versus ugly) on *use intentions*. We found no main effect of designed aesthetics on use intentions ($p = .55$). This suggests that participants were not keen to use a beautiful character more than an ugly character, or vice versa. Also, we did not find a significant interaction effect of designed aesthetics and designed affordances on use intentions ($p = .15$). However, the means indicate an interesting trend as shown in Fig. 5. When a character is obstructing, aesthetics does not matter, as participants are not willing to use the character anyway. However, when a character is helpful, aesthetics does seem to matter. Then, it seems that participants are more willing to use a beautiful than an ugly character. This means that a helpful *and* beautiful character is most ideal for individuals to use.

Second, we investigated whether affordances affected the engagement process by analyzing effects of designed affordances on user involvement and distance. We found no main effect of designed affordances on involvement

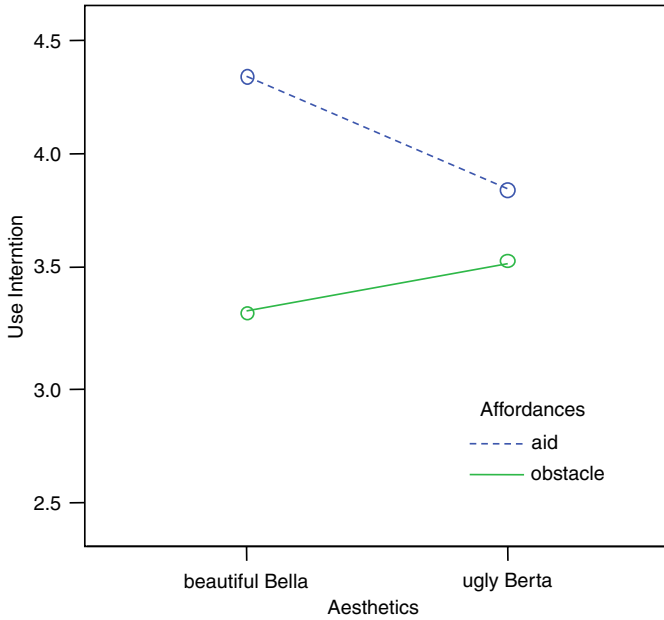


Fig. 5. The effect of designed aesthetics and designed affordances on use intentions.

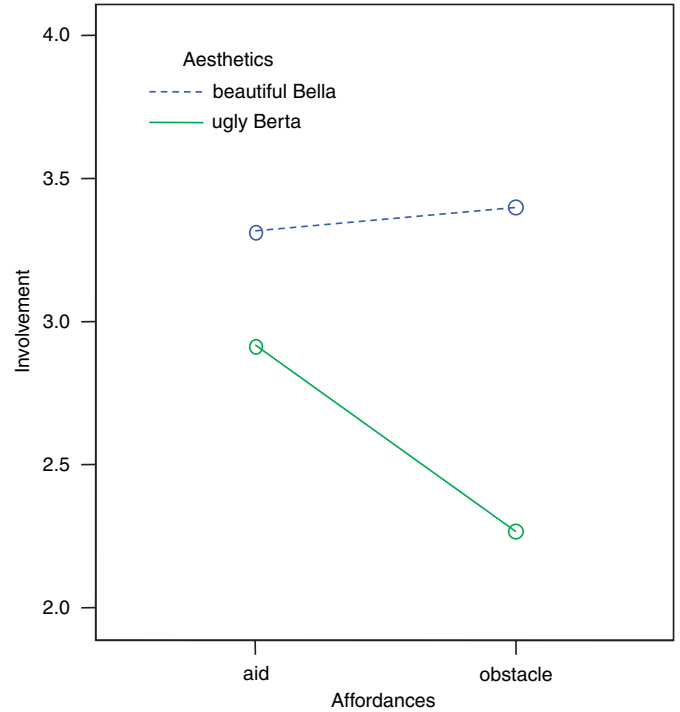


Fig. 6. The effect of designed aesthetics and designed affordances on involvement.

Table 2
Means and standard deviations of involvement (I), distance (D) and use intentions (U) in the conditions

	Beautiful	Ugly	Total
<i>Aid</i>			
I	3.3 (.10)	2.9 (.88)	3.1 (.95)
D	3.2 (.77)	3.0 (.68)	3.1 (.73)
U	4.3 (.89)	3.8 (1.17)	4.1 (1.1)
<i>Obstacle</i>			
I	3.4 (.68)	2.3 (.62)	2.9 (.86)
D	3.0 (.62)	3.5 (.74)	3.3 (.72)
U	3.3 (1.1)	3.5 (1.1)	3.4 (1.1)
<i>Total</i>			
I	3.4 (.85)	2.6 (.82)	3.0 (.92)
D	3.1 (.70)	3.3 (.74)	3.2 (.72)
U	3.8 (1.1)	3.7 (1.1)	3.8 (1.1)

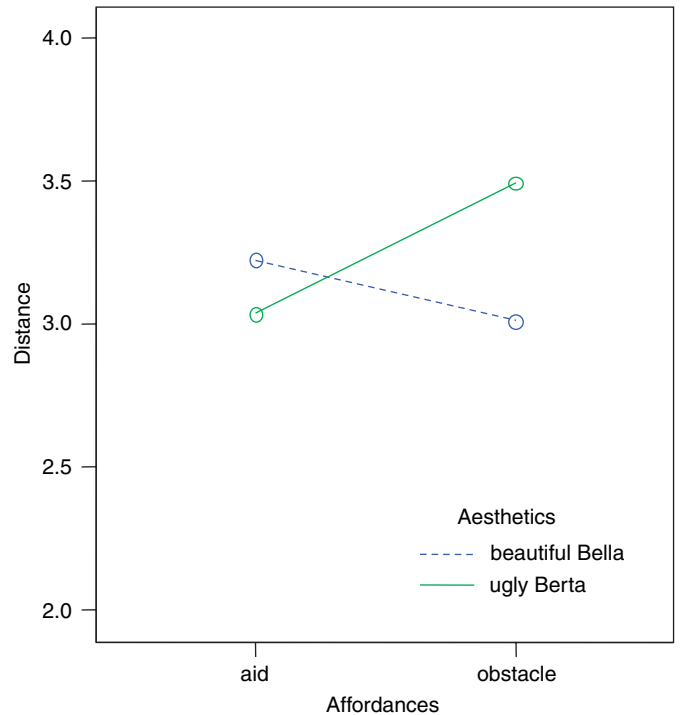


Fig. 7. The effect of designed aesthetics and designed affordances on distance.

($p = .13$), nor a main effect of designed affordances on distance ($p = .44$). However, significant interactions were found on both user involvement ($F(1, 76) = 4.09, p < .05, \text{partial } \eta^2 = .051$) and user distance ($F(1, 76) = 4.47, p < .04, \text{partial } \eta^2 = .056$). Participants were least involved with ($M = 2.3, SD = .62$) and most distant to ($M = 3.5, SD = .74$) the ugly character that obstructed task completion (see Table 2 and Figs. 6 and 7). Thus, when a character is beautiful, it does not matter whether the character helps or obstructs task completion; users are equally engaged with the character. However, when a character is ugly, it is important that the character aids task completion which increases engagement with the character, despite its ugliness.

To test H4, we used a regression analysis (multiple, method Enter) to predict users' satisfaction with the character from the continuous variables use intention, involvement, and distance ($R^2 = .34$). The standardized regression coefficients revealed that all three predictors had

comparable and significant contributions to satisfaction (use intention: *standardized beta* = .22, $t = 2.70$, $p < .008$, partial $r = .24$, semi-partial $r = .21$; involvement: *standardized beta* = .26, $t = 2.84$, $p < .005$, partial $r = .26$, semi-partial $r = .22$; distance: *standardized beta* = $-.29$, $t = -3.05$, $p < .003$, partial $r = -.27$, semi-partial $r = -.23$) These results indicate that end-user satisfaction is a complex construct that depends on both the engagement and the interaction processes.

In sum, the cross-over effects indicate that the two processes are dependent on each other in predicting the character's effect on its users. Thus, H2, predicting independent processes, was rejected and H3, predicting dependency between engagement and interaction processes, was supported. Likewise, H4 was supported, stating that satisfaction depends on both processes.

4.4. Additional analyses

The eye of the beholder. Because the I-PEFiC model predicts that a number of user *perceptions* in the encoding stage are central to user engagement and use intentions, we tested specific user perceptions in predicting user engagement and use intentions. Specifically, we tested whether perceived affordance, perceived aesthetics, and perceived epistemics provided better explanations than designed aesthetics and designed affordances did in the previous analyses.⁶ A MANOVA with designed aesthetics and designed affordances as independents, perceived aesthetics, perceived affordance, and perceived epistemics as covariates, and user involvement, user distance and use intentions as dependents, showed significant main effects of the factor designed aesthetics (Wilks' lambda = .87, $F(3, 70) = 11.30$, $p < .018$, partial $\eta^2 = .13$) and all covariates: perceived affordance (Wilks' lambda = .89, $F(3, 70) = 2.98$, $p < .037$, partial $\eta^2 = .11$), perceived aesthetics (Wilks' lambda = .67, $F(3, 70) = 11.30$, $p < .001$, partial $\eta^2 = .33$), and perceived epistemics (Wilks' lambda = .86, $F(3, 70) = 3.72$, $p < .015$, partial $\eta^2 = .14$). Thus, as expected, a variety of user perceptions were important for explaining user engagement and use intentions. Designed affordances and interactions between the factors did not significantly affect the dependents (p 's $> .20$). Thus, when users' perceptions of the Sims characters were taken into account, the effect of designed affordances initially found seemed to be overruled. Note, however, that the effects of perceived affordances became significant.

Univariate F -tests confirmed the multivariate results obtained, and indicated the effects of user perceptions specified for the various dependents. Consistent with the multivariate result, the effects of perceived affordance were significant on use intentions ($F(1, 72) = 4.99$, $p < .03$, partial $\eta^2 = .07$), involvement ($F(1, 72) = 3.67$, $p < .06$, partial $\eta^2 = .05$), and distance ($F(1, 72) = 4.05$,

$p < .05$, partial $\eta^2 = .05$). The more participants perceived that the character aided task completion, the more involved and the less distant they felt to the interface character. This further supported our hypothesis (H3) that the interaction and engagement processes are dependent on each other.

In addition, we found that perceived aesthetics significantly affected involvement ($F(1, 72) = 18.27$, $p < .001$, partial $\eta^2 = .20$) as well as distance ($F(1, 72) = 24.07$, $p < .001$, partial $\eta^2 = .25$), but not use intentions ($p = .67$). Similarly, perceived epistemics affected involvement ($F(1, 72) = 3.50$, $p < .07$, partial $\eta^2 = .05$) and distance ($F(1, 72) = 10.20$, $p < .002$, partial $\eta^2 = .12$), but not use intentions ($p = .41$). The more beautiful and realistic the participants perceived the character to be, the more involved and the less distant they felt towards the character. Thus, perceived aesthetics and perceived epistemics did also play a role in establishing user engagement towards interface characters, but they did not significantly contribute to use intentions, that is, the interaction process.

In sum, the results of this additional analysis showed that several user perceptions are important in explaining user engagement, namely perceived affordance, perceived aesthetics, and perceived epistemics. We performed a regression analysis to investigate the relative importance of each of these factors. The standardized regression coefficients revealed that perceived aesthetics was the best predictor of user involvement (*standardized beta* = .59), followed by perceived epistemics (*standardized beta* = .30), and perceived affordances (*standardized beta* = .13). Designed aesthetics and designed affordances did not contribute significantly to user involvement. Further, perceived aesthetics was also the best predictor of user distance (*standardized beta* = $-.77$), followed by designed aesthetics (*standardized beta* = $-.43$), perceived epistemics (*standardized beta* = .30), and perceived affordances (*standardized beta* = .20). Designed affordances did not contribute significantly to user distance. According to these analyses, a beautiful character appearance seems crucial to establishing user engagement with a character. In conclusion, perceptions of the character's beauty and realistic appearance increase engagement with the character, but are not that important for use intentions. The character's perceived affordances also contribute to engagement with the character and are decisive for use intentions. In assessing end-user satisfaction, however, both the engagement process and interaction process contribute.

Then, from the I-PEFiC model, *indirect* effects of perceived aesthetics and perceived affordances on use intentions and engagement may also be expected. Therefore, we tested the mediating roles of both perceived relevance and perceived valence. We found no effect of perceived aesthetics on use intentions, but we assume this effect is mediated by perceived relevance and perceived valence. To test mediation, the Sobel method is reliable (see Preacher and Hayes, 2004). Contrary to our expectations, tests suggested no mediation effect of perceived relevance

⁶The I-PEFiC variable perceived ethics was discarded from analyses because participants rated all characters as equally good.

results show that it is important to enhance both engagement and use intentions.

That the engagement process did not influence use intentions has as a consequence that whatever users think emotionally about office applications such as Microsoft's Clippit, their will to use the animated paperclip or not depends solely on the designed and perceived affordances. Making the darn thing look better may do something for the experience, and hence, for user satisfaction, but not for intentions to use it. In other words, covering up a badly designed software product by making it look good may lure a product designer or marketer into thinking that they did a job well done. After all, user satisfaction increased by improving the aesthetic user experience. But what a disappointment if users still leave the application untouched. After all, intentions to use are not fed by more beauty and thus, obstruction of task execution decreases the intention to use the system in spite of its good looks.

That perceived affordances influenced engagement has another consequence. Whatever users think about the usefulness of a gaming package does affect how they feel about the characters that the game features. Actually, our reasoning should stop here. Statistical rigor should prevent us to go into details about exactly how affordances and aesthetics cooperate in affecting user experience and use intentions. The statistically significant effect we found is that users were most willing to use a character for task execution when it was helpful and that if it was ugly, it should be helpful to be appreciated at all. However, this is not too exciting common-sense design information. Therefore, we did some eyeball inspection of the means in the Figs. 5–7 and came up with an interpretation that could guide our future research.

5.1. Out of the box and into the bin. When pretty interface characters become helpful or not

Although the following effects are not significant, the means in Fig. 5 show a trend that intentions to use seemed dependent on efficiency considerations as well as the character's visual appearance (i.e. designed aesthetics). The speculations offered next may serve as an interpretation of our findings as well as an impetus to explore possible research lines in the future.

Intentions to use the character for task execution were strongest when the character was both helpful *and* beautiful. But beauty may be precious; it is also capricious. Users were *least* intending to use a character when it was unhelpful (understandably) and beautiful (surprisingly)! Yet, this did not harm the user's engagement with the clumsy beauty. Quite the opposite, blundering Bella evoked the highest levels of involvement (Fig. 6) and the least distance (Fig. 7). Silly beauties are the nicest but alas, good for nothing.

Silly uglies can count on no mercy. They were deemed least involving and most distancing, yet, seen as somewhat *more* useful for the task than silly beauties. Thus, beauty is

a dangerous treasure to cherish. It is a catalyst of extreme judgements. When you are beautiful, you are expected to perform better than others do. If not, you are really a lousy worker but still very nice. Uglies better offer some help to be appreciated. A helpful Berta exerted moderate intentions to use, moderate involvement, and moderate distance. This seems like default attitude that is directed at the most common type of person we encounter; not too beautiful, usually helpful, evoking in us mild feelings of sympathy and reservation.

This becomes all the clearer, considering that the helpful Bella not only raised the strongest intentions to use and the strongest involvement, she also raised the same level of or even more *distance* than her ugly but helpful competitor. A top-performing beauty is suspicious, someone to keep an eye on, because she may be a joy but a strong rival as well (cf. Bridget Gregory in Konijn and Hoorn, 2005). Ugliness is more normal, less attractive but also less threatening.

When offered by an interface character, then, affordances can become affect-laden (hence, 'affective affordances') and may provoke user reactions other than intended by the sender/designer. If you want to cover up a bad (here slow) system with a beautiful design, you are in deep trouble. Users will like the design a lot but will deem it even worse usable than when you had an ugly (or normal) design. People do not expect too much if it does not look like much (cf. Kurosu and Kashimura, 1995; Tractinsky et al., 2000). The safest route seems to have a plainly looking design with many aiding affordances, so that people are willing to use it and feel mildly involved. If you really want to capitalize on user experience, beware of overdoing it on the side of aesthetics. It may increase the eagerness to use, it may boost involvement, but when it is really helpful to users, they become intimidated and if it does not help them or perhaps is even frustrating to them, your beautiful rubbish system is dragged into the bin.

5.2. Methodological considerations for future research

Finding software that allowed researchers to manipulate characters for suit experimental purposes did not appear to be an easy task. Such an endeavor is confined by constraints such as comparability of characters on all features except the manipulated ones, flexibility of character's features so the experimenter can mold them according to the studies' purposes, and operating in a task-environment where parameters can be set in multiple ways. We found the Sims2 game environment to be very useful for the purposes of the present study. The Sims2 game allowed for manipulations of the task-environment, the tasks to be accomplished, and manipulating the affordances as well as aesthetics factors, whereas the basic characteristics of each version that we created were similar. The Sims2 game suited our experimental purposes surprisingly well. Of course, we also experienced certain limitations of the game's possibilities, such as the limited

Table 3

The questionnaire items (translated from Dutch) of the user-perception questionnaire. The items printed in italics were removed from their scales after scale analysis. Also, the reliabilities of the scales are shown

Scale	Reliability (Cronbach's alpha)	Items
Aesthetics	.888	Bella looks nice Bella is pretty Bella is an ugly appearance Bella is nasty to see
Affordance	.882	Bella is competent Bella is knowledgeable Bella is skillful Bella is clever Bella is clumsy <i>Bella comes short</i> Bella is a bungler Bella messes about with things
Epistemics (realism)	.736	Bella has a natural look Bella resembles a real life person Bella is just like a real person <i>Bella is made with fantasy</i> Bella looks fake Bella differs from a real life person
Ethics	.651	Bella is good-natured Bella is reliable Bella is malicious Bella is a mean character
Valence	.757	With Bella I make a chance to win a prize Bella will allow me to perform the next task quickly With Bella it will take long to perform the next task With Bella I will fail
Relevance	.788	Bella is useful in carrying out the tasks Bella is worthwhile in carrying out the tasks Bella is worthless in carrying out the tasks Bella is useless in carrying out the tasks
Similarity	.709	Bella and I resemble each other internally Bella and I have characteristics in common Bella is different than I am Bella differs from who I am
Involvement	.808	Bella appeals to me Bella gives me a good feeling Bella attracts me <i>I am well-disposed towards Bella</i>
Distance	.594	Bella leaves me with cold feelings I feel negatively towards Bella I feel distance between Bella and me I dislike Bella
Use intentions	.965	I want to use Bella in the following task I want to continue with Bella in the following task I want to perform the following task with the help of Bella I want to work with Bella in the following task I'd rather use another Sim to perform the following task I want to ignore Bella in the following task I want to get rid of Bella in the following task <i>It seems like a bad plan to perform the following task with Bella</i>
Satisfaction	.810	<i>I am happy with Bella</i> It is nice to get on with Bella Bella is fine Bella is ok I am satisfied with Bella

Table 3 (continued)

Scale	Reliability (Cronbach's alpha)	Items
Dissatisfaction	.681	<i>Bella is a failure</i> Bella makes me sad <i>I think Bella is ridiculous</i> <i>I think Bella is a weak Sim</i> I am dissatisfied with Bella

tasks, the limited relevance of tasks, the limited comparability with tasks and embodied agents as they exist in regular computerized tasks (e.g. a word processor), and the impossibility of performing tasks *without* a character. Other games' suitability for experimental research on human–character interactions should be explored. In addition, future research should ascertain whether trends found in the present study are significant in other task-contexts (e.g. entertainment or learning).

Most participants in our experiment had no prior experience with the Sims game and can thus be regarded novices. Experienced Sims users might have perceived the characters and affordances differently than the novices. For example, they might have learned what affordances belong to particular characters shaping their perceptions accordingly (e.g. the valence they attribute to the character). Long-term investigations might tell us how user perceptions develop over time, and whether interdependencies between the engagement and interaction processes increase or decrease over time. For example, do experienced users only care for task efficiency, or are they still influenced by beautifully designed characters?

Finally, it would be interesting to measure not only use intentions but actual use as well. To study actual use, we would ideally create an environment in which users have the possibility to turn the interface character on and off. Future research might focus on a variety of task contexts and applications, such as standard desktop applications and the Internet, to further study the relations between the engagement and interaction processes.

In sum, to fully understand user reactions to interface characters, we recommend a fine-grained perspective, as several factors with roots in different scientific areas contribute. The I-PEFiC model allowed us to understand relations between user engagement and use intentions, factors that are often studied in isolation. Integrating approaches from communication science (i.e. media entertainment theory) with HCI was beneficial, and the study presented in this paper provides us with a more comprehensive understanding of human–character interactions.

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Appendix

The user-perception questionnaire is shown in Table 3.

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