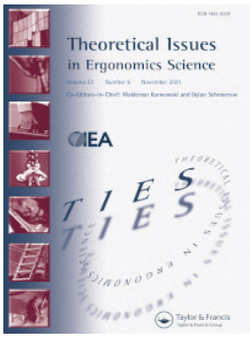

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Towards the design of a quick and universal questionnaire to assess the intuitiveness of products

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ABSTRACT

The goal of this research is to design a tool to assess intuitiveness of products. Existing scales such as INTUI (Diefenbach and Ullrich 2015) show some limitations when used by children and/or for evaluating non-digital products. We aim to obtain a more universal questionnaire tool. INTUI questionnaire measures the components of an intuitive interaction (Effortlessness, Gut feeling, Magical experience, Verbalizability and Intuitiveness) through 17 items. After removing or rephrasing several items, we tested a revised version (8 items) with 68 participants (children and adults) who performed a task (a drawing for children and subtractions for adults) with a digital device (tactile tablet for children and smartphone for adults) and a non-digital device (paper and pencil). The results led us to remove the "Verbalizability" and "Gut feeling" dimensions which were difficult to understand and inconsistent with the conceptual model. The final version of the questionnaire (5 items) including three dimensions (Effortlessness, Magical Experience and Intuitiveness) was tested with 69 adults to evaluate a Coffee Dispenser Machine. Both "Effortlessness" and "Magical experience" dimensions seem to reliably predict intuitiveness.

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KEYWORDS
Intuitive interaction; intuitiveness; questionnaire; design of products; user centered design

Relevance to human factors / ergonomics theory

Nowadays, users and industry want to have intuitive products (Fischer et al. 2009; Grandhi et al. 2011; Lagerstam et al. 2012; Naumann et al. 2008). Intuitivity is a prerequisite for users and a sales pitch for companies. Intuitiveness is not only a key dimension of usability (ISO 9241-210) but also of universal design (Story et al. 1998; third principle), that generalizes usability to all groups of users. Different methods allow to evaluate the intuitiveness of a product. In our work, we used the INTUI questionnaire, however, we found that it was not understood by all categories of users, especially children, and that it did not allow us to evaluate any type of product, especially those that are not digital. Our goal is to offer a simplified version usable with the largest number of users and products.

To our knowledge, the group named "Intuitive Interaction Research" is the main research team that has studied this concept. Blackler, Popovic, and Desai (2018) reviewed the research method toolkit to measure intuitive interaction. Data collection methods include observation, verbal protocol, interview, diary, application of schemas and questionnaires. Among these tools, the INTUI questionnaire (Diefenbach and Ullrich, 2015) aims to understand

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and study intuitive interaction with user interfaces and products. We used this tool with children to evaluate the intuitiveness of a universal orientation map – originally designed for visually impaired people. We did not succeed, as INTUI was too complex for children and it was not relevant to a non-digital product. In this respect, we decided to create a new version of INTUI that would be usable by any kind of people and measure the intuitiveness of any kind of product. The purpose of this paper is to present the design process of our revised version of INTUI.

Literature review

Users spontaneously associate "intuitiveness" with "intuition", which reveals that they expect to use a product easily with no prior learning required and that using the product will be a source of pleasure. However, "intuition" and "intuitive interaction" are opposing notions. For Blackler et al. (Blackler 2006; Blackler, Popovic, and Mahar 2002; Blackler, Popovic, and Mahar 2003a, 2003b, 2004a, 2004b, 2005) "intuitive use of products involves utilizing knowledge gained through other experience(s). Therefore, products that people use intuitively are those with features they have encountered before. Intuitive interaction is fast and generally non-conscious, so people may be unable to explain how they made decisions during intuitive interaction". Conversely, in the common sense, intuition is a process that usually does not require any prior experience and that is unconscious (e.g. Agor 1986; Bastick 2003; Fischbein 1987; Hammond 1993). For Tonetto and Tamminen (2015) intuition is "a way of processing information based on automatic, affective and personal standards, but it is not the opposite of rationality". According to these definitions, intuition would be grounded on nature whereas intuitive interaction would be grounded on nurture.

Interestingly, we observe some parallels between the comparison of intuition vs. intuitive interaction and affordance in Gibson's sense vs. in Norman's sense. The origin of the concept of affordance may be attributed to Gibson (1977, 1979) and his research on ecologic psychology of perception. Norman (1988) popularized it in the field of design. According to Gibson, affordance is "an action possibility available in the environment to an individual, independent of the individual's ability to perceive the possibility" (McGrenere and Ho 2000). For Norman "the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used". The main difference between these two approaches is that for Gibson, affordance is the possible action itself whereas for Norman it is the possible action and the way it is made visible to the actor (McGrenere and Ho 2000). Therefore, intuition would correspond to Gibson's affordance whereas intuitive interaction to Norman's. Indeed, to Gibson an affordance exists or not whereas to Norman, an affordance depends on the properties of an object that are perceived by users following their prior experience.

Users want to experience intuitiveness when they use a product; they don't read manuals to learn how to use a product (Blackler et al. 2016) and like fluent interaction with consistent system feedback to their actions, without learning and without errors (usability). They are not aware of the mobilization of prior knowledge. To meet this need, companies rely on prior knowledge and experience to design new products and build on specific methodological approaches such as user experience, captology (Fogg 2003) or emotional design (Norman 2004; Walter 2011) aiming to provide pleasure, emotions, and even symbiotic relations with products. Intuitiveness is part of their design brief, although the concept is hardly formalized.

Intuitive interaction

Blackler, Popovic, and Mahar (2010) define five properties of an intuitive interaction:

Prior experience

Prior experience is the most important factor of intuitive interaction (Blackler, Popovic, and Mahar 2010; Hurtienne and Blessing 2007; Hurtienne and Israel 2007; Mohs et al. 2006; O'Brien, Togers, and Fisk 2008). Prior experience is "the collection of experiences that individuals have had in the past" (Lawry et al. 2019). They underline the difference with "prior knowledge" which is defined "as knowledge that has been acquired as a result of prior experience – knowledge that can then be applied in the future" (Lawry et al. 2019). The more prior experience users have, the more intuitive the interaction will be. Prior experience is close to the concept of familiarity, as for Raskin (1994) intuitive means familiar.

Non-conscious processing

During non-conscious process, users are not able to explain the sub-steps of their task because they do not think on how to interact with the product. For Bowers (1984), information could be perceived by users without being consciously noticed and may be processed without being encoded in long-term memory. Several authors consistently model skill acquisition process through three stages: 1) error-prone, 2) slow to fast interaction, and 3) non-conscious interaction (Anderson 1995; Ericsson and Towne 2010) – an intuitive interaction belonging to the third stage.

Speed

Intuitive interaction results in quicker task processing because it does not involve any reasoning or analytical process that would slow interaction down (Bastick 2003 cited by Blackler, Popovic, and Mahar 2010; Salk 1983 cited by Blackler, Popovic, and Mahar 2010).

Individual differences

While there is no difference in intuition between genders (Woolhouse and Bayne 2000), Lawry and colleagues (2019), have shown that youngsters (20 – 30 years) are more familiar with contemporary interfaces and use products intuitively more quickly than older users (Blackler, Popovic, and Mahar 2010; O'Brien 2010). This result is consistent with previous studies, which showed that age (reaction time, cognitive processes in decline) affects task duration and error rate (Langdon, Lewis, and Clarkson 2007; Lewis, Langdon, and Clarkson 2008 cited by Blackler, Popovic, and Mahar 2010). Moreover, age affects the capacity to retain information learned during prior experiences (Baracat and Marquie 1994, cited by Blackler, Popovic, and Mahar 2010; Howard and Howard 1997, cited by Blackler, Popovic, and Mahar 2010; Kok et al. 1994) because decision making, working memory and attention play an essential role in the acquisition and transfer of information.

Correctness of intuitive interaction

By definition, because intuitive interaction is expected to grow across experience, it should be correct and act as a guide. Nevertheless, Klein (1993) and Eysenck (1995) (cited by Blackler, Popovic, and Mahar 2010) indicate that it could be wrong if prior experience is

wrong itself. A user can perform a task on the basis of his/her experience without being aware that his/her experience is wrong or unoptimized.

Intuitiveness model

INTUI Model explores the dimensions of intuitive interaction in a user experience perspective. To build this model, Diefenbach and Ullrich (2010, 2015) draw on literature about usability, user experience, emotional features of product and holistic experience (Hassenzahl and Tractinsky 2006).The four components of their model of intuitive interaction are:

- ***Effortlessness***: intuitive interaction is fast and performed without cognitive effort.
- ***Gut feeling***: intuitive interaction is guided by gut feelings.
- ***Magical experience***: people get the feeling of living a magical experience and they refer to their interaction with expressions such as "incredible" or "extraordinary".
- ***Verbalizability***: people are unable to verbalize the sub-steps conducted to achieve the goal of their task; they even forget to verbalize (Diefenbach and Ullrich 2015).

In this model, two levels of factors influence intuitive interaction (Figure 1).

The ***First-level factors*** include the product, user characteristics and the context of use (Diefenbach and Ullrich 2015). The ***Second-level factors*** include use mode**,** domain transfer distance (relation between current application domain and prior knowledge) and the judgement about the product and its intuitiveness, which is built during interaction. These second-level factors interact with first-level factors (Tretter, Diefenbach, and Ullrich 2018).

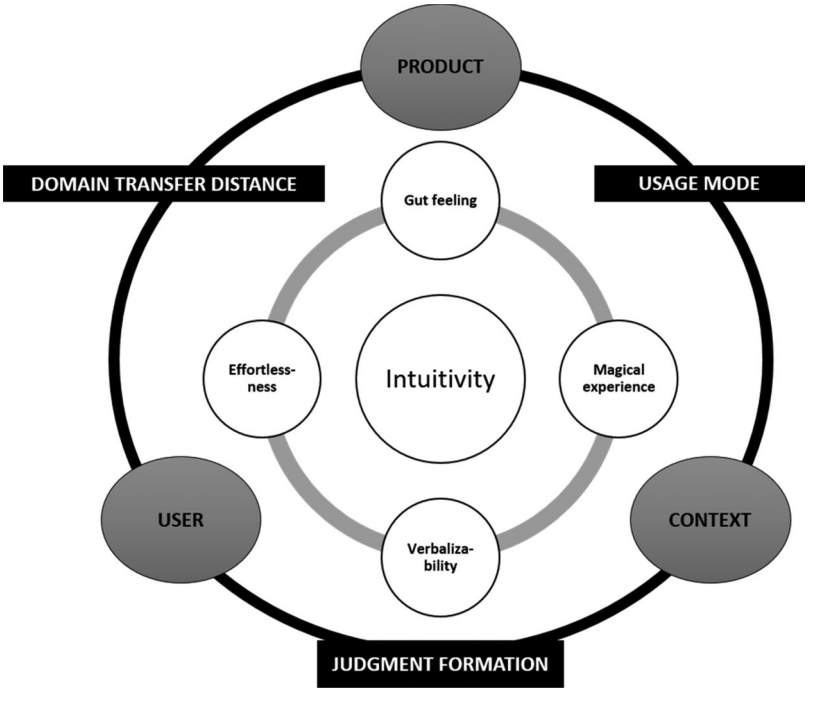

Figure 1. Intuitive interaction model.

INTUI questionnaire

The initial INTUI questionnaire measures the four components of intuitive interaction model: Effortlessness, Verbalizability, Gut feeling, and Magical experience. The 17 items are presented with 7-point semantic differential Osgood-type scales (Table 1).

Three empirical studies validated the reliability and validity of this questionnaire, as the authors wanted to offer an easily applicable tool to practitioners and researchers (Ullrich and Diefenbach 2010). These studies involved 334 participants (mean age = 28.7; 262 women and 72 men) and used MP3 devices (study 1), photo editing software and hotel booking websites (study 2). For each product, participants had to go through a number of predefined tasks (for example, changing the volume on the MP3 player) and assess the intuitiveness of interaction with INTUI questionnaire. In study 3, each participant had to describe a situation where s/he used a technical product for the first time without referring to user manual, and then completed the INTUI questionnaire.

Limitations of INTUI

In a previous study, we chose to use INTUI questionnaire with children (6 – 11 years old) to measure the intuitiveness of several orientation maps. We compared three different products: a 2 D static orientation map, a 3 D static orientation map and a multimodal dynamic orientation map. We identified four limitations of the INTUI tool:

1. INTUI (composed of 17 items) is too long for children;
2. The vocabulary is too complex to understand, we had to find synonyms or explain the meaning of words and sentences (e.g., “I acted deliberately” or “I performed unconsciously”);

Table 1. Items of INTUI.

Items
Effortlessness
[While using the product] it took me a lot effort to reach my goal / I reached my goal effortlessly
[While using the product] I felt lost / I easily knew what to do
[Using the product] required my close attention/ ran smoothly
[Using the product] was easy / was difficult
[Using the product] came naturally / was hard
Gut feeling
[While using the product] I acted deliberately / I acted on impulse
[While using the product] I performed unconsciously, without reflecting on the individual steps / I consciously performed one step after another
[While using the product] I was guided by reason / I was guided by feelings
[While using the product] I acted without thinking / I was able to explain each individual step
Magical experience
[Using the product] was nothing special / was a magical experience
[Using the product] was trivial / carried me away
[Using the product] was fascinating / was dull
Verbalizability
[In retrospect] it is hard for me to describe the individual operating steps/ I have no problem describing the individual operating steps
[In retrospect] I can easily recall the operating steps / It is difficult for me to remember how the product is operated
[In retrospect] I’m not able to express in which way I used the product / I can say exactly in which way I used the product
Intuitiveness
[Using the product] was very intuitive / wasn’t intuitive at all

3. Children identified redundancies between items and refused to answer, claiming for example "you have already asked";
4. Finally, some questions were not adapted to a non-digital product, in particular items related to the "Verbalizability" dimension, which refer to the product's internal process (e.g., the item "it is hard for me to describe the individual operating steps/I have no problem describing the individual operating steps").

Given these limitations, our research goal was to design and validate a new version of INTUI questionnaire, which would firstly be understandable by children and adults, and secondly be usable to evaluate the intuitiveness of non-digital products.

Questionnaire revision

To create a questionnaire understandable by children, we redesigned items and scales of the initial INTUI questionnaire (Table 2).

Items

To reduce both the duration of evaluation and redundancy between items, we selected one or two items for each dimension of the model. Then, we worked with an expert (primary school teacher) to rephrase and adapt items for them to be understandable by 6-year-old children.

The "intuitiveness" dimension being key for INTUI, we decided to keep the item even if it was complex to understand by children and planned to explain to children that "intuitive" means "natural".

Scales

Seven-point Osgood-type scales are not appropriate for 6-year-old children because their use require a fine capacity of judgement. van Laerhoven, van der Zaag-Loonen, and Derkx (2004) showed that 5-point scale are usable with children provided that each degree of the scale is labeled.

Table 2 highlights the differences between the initial INTUI and the revised INTUI tool.

Method

Participants

Sixty-eight French volunteers participated, including 40 children (mean age = 7.5; SD = 1.43, 30 girls and 10 boys) and 28 adults (mean age = 24, SD = 2.09; all men). Children were recruited in a holiday center and adults were recruited in a graduate school of engineering.

Material

In our previous study, we observed that INTUI did not allow us to measure the intuitiveness of a non-digital product, hence in this study, each participant had two tasks to perform

Table 2. Difference between the items of Initial INTUI (left-hand column) and Items of Revised Intui (right-hand column).

Dimensions	Items of Initial INTUI	Items of INTUI revised
Effortlessness	[While using the product] it took me a lot effort to reach my goal / I reached my goal effortlessly	[Q1] To […]*: You did not know what to do at all You did not know what to do Between both You knew what to do You knew perfectly what to do
	[While using the product] I felt lost / I easily knew what to do	
	[Using the product] required my close attention / ran smoothly	[Q2] To do […] was: Not easy at all Not easy Between both Easy Very easy
	[Using the product] was easy / was difficult	
	[Using the product] came naturally / was hard	
Gut feeling	[While using the product] I acted deliberately / I acted on impulse	[Q3] To do […]: You did not think at all You did not think Between both You did think You thought a lot
	[While using the product] I performed unconsciously, without reflecting on the individual steps / I consciously performed one step after another	
	[While using the product] I was guided by reason / I was guided by feelings	
	[While using the product] I acted without thinking / I was able to explain each individual step	
Magical experience	[Using the product] was inspiring / was insignificant	[Q4] To do […] was: Very common Common Between both Good Magical
	[Using the product] was trivial / carried me away	[Q5] To do […] was: Very unfunny Unfunny Between both Funny Very funny
	[Using the product] was fascinating / was dull	
Verbalizability	[In retrospect] it is hard for me to describe the individual operating steps/ I have no problem describing the individual operating steps	[Q6] Can you explain what you did to do […]?
	[In retrospect] I can easily recall the operating steps / It is difficult for me to remember how the product is operated	[Q7] Imagine, if I ask you to explain to a friend how you made to […]? You would be? Not able at all Not able Between both Able Very able
	[In retrospect] I'm not able to express in which way I used the product / I can say exactly in which way I used the product	
Intuitiveness	[Using the product] was very intuitive / wasn't intuitive at all	[Q8] To do […] was: Not intuitive at all Not intuitive Between both Intuitive Very intuitive

*The space in square brackets is to be filled in with the task to be performed.

sequentially, one with a digital device (Smartphone or Tablet) and another one with a non-digital device (paper and pencil) (Figure 2).

Children were instructed to reproduce a geometrical drawing (Figure 3) on paper with felt pens (task 1) and on a digital tablet (task 2). For task 2, we used the application "draw-me" for its simplicity of use. We chose geometrical shapes with various colors and line thickness.

Adults were instructed to make two subtractions (3625 – 167; 286 – 197) by hand (task 2) and on their smartphone calculator (task 1).

Experimental design

This study includes two experimental conditions, and two populations (Table 3).

Participants performed the two tasks in a counterbalanced order.

Procedure

The procedure was identical for the two conditions and the two groups. Firstly, the experimenter explained the procedure. Then, participants individually performed the two tasks in a counterbalanced order. Afterwards, each participant completed twice the revised INTUI questionnaire, one for the first task and one for the second task. We chose to have the questionnaire filled in after the completion of both tasks in order to foster comparison between the two tasks and the two products. Children did not directly fill in paper forms; instead, the experimenter read the

Figure 2. Experimental conditions.

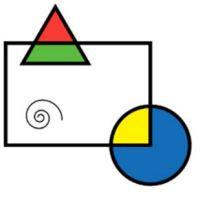

Figure 3. Drawing model.

Table 3. Experimental design.

	Children	Adults
Condition 1 : task 1 then task 2	N = 20	N = 15
Condition 2: task 2 then task 1	N = 20	N = 13

Table 4. Summary of items by dimension.

Dimensions	Items	Sense
Effortlessness	Q1 (Know what to do)	(reversed)
	Q2 (Easy)	
Gut feeling	Q3 (Without thinking)	
Magical experience	Q4 (Magical) Q5 (Funny)	
Verbalizability Intuitiveness	Q7 (Verbalizable) Q8 (Intuitive)	(reversed)

questions and wrote their answers. In contrast, adults self-reported their answers directly on the paper form. Finally, participants completed a sociodemographic questionnaire including age, gender, level of education, and potential disabilities (visual, auditory, motor, cognitive and "dys" impairments). The whole experiment including the two tasks lasted 10 minutes.

Results

Hypotheses

We first examined the reliability of each dimension (Effortlessness, Gut feeling, Magical experience and Verbalizability) along the following hypotheses:

- **Hypothesis H1**: Items "Know what to do" (Q1) and "Easy" (Q2) will be reliable because they belong to the same dimension "Effortlessness"

- **Hypothesis H2**: Items "Magical" (Q4) and "Funny" (Q5) will be reliable because they belong to the same dimension "Magical experience"

We also investigated the relations between the dimensions (Table 4):

- **Hypothesis H3**: Dimension "Intuitiveness" (Q8) can be predicted from the four dimensions (Effortlessness, Gut feeling, Magical experience and Verbalizability).

We also carried out two ANOVAs to determine whether the "product type" variable (digital vs. non-digital) as well as the control variable "presentation order" influence the intuitiveness score. These analyses were performed in an exploratory approach, as we had no hypothesis on the more or less intuitive nature of products and no hypothesis on any order effect.

Results for children

Our Hypotheses H1 (alpha = 0.434, r = 0.277, p = 0.013) and H2 (alpha = 0.492, r = 0.326, p = 0.003) are not supported. Therefore, the corresponding items were not aggregated and were analyzed separately. Hypothesis H3 was tested through a regression model with Intuitiveness (Q8) as dependent variable and including the other six items as predictors.

H3 proved to be partially verified, as only two items ("Know what to do" (Q1), $\beta = 0.25$, $t = 2.41$, $p = 0.018$; and "Verbalizable" (Q7) $\beta = -0.314$, $t = -2.998$, $p = 0.004$) appear as significant predictors of intuitiveness. To better inform these results, we computed the correlation matrix (Table 5).

The correlation matrix shows that the item "Know what to do" (Q1) is not correlated to any other item, which suggests that this question was not understood by children. Interestingly, the item Q7 "Verbalizable" appears to be negatively correlated to all other items, except for item "know what to do" (Q1).

Regarding product and order effects, we did not observe any significant effect of the "product" variable on the set of items, in particular for the "Intuitive" item ($F(1,76) = 0.013$, $p = 0.911$). Conversely, we observed a significant main effect of the variable "presentation order" on item Q5 "Funny" ($F(1, 76) = 4.371$, $p = 0.04$), which shows that the task was less funny the second time ($M = 4.15$, $SD = 0.86$) than the first time ($M = 4.5$, $SD = 0.60$, Figure 4).

Analysis of open-ended question "verbalizable"

In both conditions, children described sub-tasks without difficulty; answers were descriptive, they checked one by one each step explaining what form and color they used, for example: "I started with the big rectangle using the black felt pen".

Results for adults

Our hypotheses H1 (alpha = 0.773, r = 0.651, $p < 0.001$) and H2 ((alpha = 0.692, r = 0.532, $p < 0.001$) are confirmed. We subsequently aggregated items Q1 and Q2 into the "Effortlessness" dimension and Q4 and Q5 into the "Magical experience" dimension.

Table 5. Correlation matrix of children ("rev." means reversed).

	Q1rev. know what to do	Q2 easy	Q3 without thinking	Q4 magical	Q5 funny	Q7rev. verbalizable	Q8 intuitive
Q1rev. Pearson's Correl.	1	,091	,036	-,048	,017	,179	-,083
Sig.		,424	,752	,674	,884	,113	,466
N	80	80	80	80	80	80	80
Q2 Pearson's Correl.	-,091	1	,277*	,384**	,420**	-,317**	,398**
Sig.	,424		,013	,000	,000	,004	,000
N	80	80	80	80	80	80	80
Q3 Pearson's Correl.	,036	,277*	1	,275*	,286*	_,382**	,449**
Sig.	,752	,013		,014	,010	,00	,000
N	80	80	80	80	80	80	80
Q4 Pearson's Correl.	-,048	,384**	,275*	1	,326**	-,243*	,351**
Sig.	,674	,000	,014		,003	,030	,001
N	80	80	80	80	80	80	80
Q5 Pearson's Correl.	-,017	,420**	,286*	,326**	1	-,250*	,225*
Sig.	,884	,000	,010	,003		,025	,045
N	80	80	80	80	90	80	80
Q7rev. Pearson's Correl.	,179	-,317**	-,382**	-,243*	,250*	1	-,495*
Sig.	,113	,004	,000	,030	,025		,000
N	80	80	80	80	80	80	80
Q8 Pearson's Correl.	,083	,398**	,449**	,351**	,225*	-,495*	1
Sig.	,466	,000	,000	,001	,045	,000	
N	80	80	80	80	80	80	80

**The correlation is significant at level 0.01 (bilateral).
*The correlation is significant at level 0.05 (bilateral).

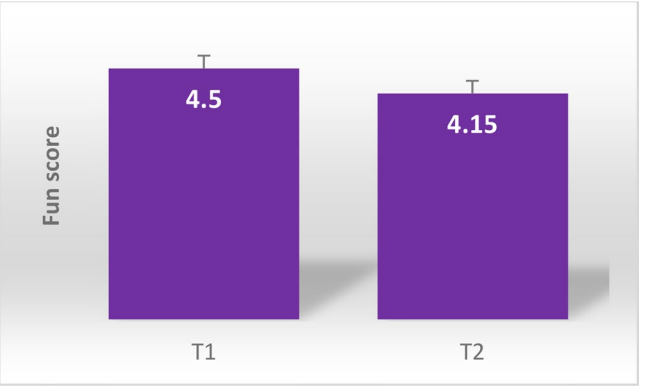

Figure 4. Mean fun score and standard error as the function of the task performed (first task T1, second task T2).

Hypothesis H3 was examined using a regression model with Q8 ("Intuitiveness" dimension) as dependent variable and the four other dimensions (Effortlessness, Gut feeling, Magical experience and Verbalizability) as predictors. H3 proved to be partially supported, as the "Magical experience" dimension ($\beta = 0.329$, $t = 2.555$, $p = 0.014$; $R^2 = 0.192$) appears as the only significant predictor of intuitiveness.

The correlation matrix notably shows that the "Verbalizability" dimension is negatively correlated to all others dimensions except for the "Magical experience" dimension (Table 6).

Regarding the product and order effects, we observed three significant main effects of the variable "product type". Firstly, on the "Gut feeling" dimension ($F(1, 52) = 48.18$, $p < 0.001$), showing that participants had more gut-feeling in the digital ($M = 1.29$, $SD = 0.71$) than in the non-digital condition ($M = 3.11$, $SD = 1.17$). Secondly, on the dimension "Effortlessness", showing that the digital condition ($M = 4.95$, $SD = 0.21$) required less effort than the non-digital condition ($M = 4.32$, $SD = 0.72$, $F(1, 52) = 19.42$, $p < 0.001$). And finally, on the "Verbalizability" dimension ($F(1, 52) = 11.63$, $p = 0.001$), showing that participants

Table 6. The correlation matrix of adults ("rev." means reversed).

	Q1rev. effortlessness	Q2-3 gut feeling	Q4-5 magical experience	Q7rev. verbalizability	Q8 intuitiveness
Q1rev. Pearson's Correl.	1	,713**	-,209	-,434**	,175
Sig.		,000	,123	,001	,196
N	56	56	56	56	56
Q2-3 Pearson's Correl.	,713**	1	-,165	-,487**	,237
Sig.	,000		,223	,000	,078
N	56	56	56	56	56
Q4-5 Pearson's Correl.	-,209	-,156	1	,140	,264*
Sig.	,123	,223		,304	,049
N	56	56	56	56	56
Q7rev. Pearson's Correl.	-,434**	-,487**	,140	1	-,273*
Sig.	,001	,000	,304		,042
N	56	56	56	56	56
Q8 Pearson's Correl.	,175	,237	,264*	-,273*	1
Sig.	,196	,078	,049	,042	
N	56	56	56	56	56

**The correlation is significant at level 0.01 (bilateral)
*The correlation is significant at level 0.05 (bilateral)

were more able to explain how they performed the task in the digital condition (M = 4.93, SD = 0.26) than in the non-digital condition (M = 4.39, SD = 0.79) (Figure 5).

The analysis of the open-ended question on "Verbalizability" shows that, similar to children, adults described sub-tasks without any difficulty in all conditions.

Discussion and final INTUI revised

Discussion

In this section, we discuss the results of the two groups. Our goal is to determine what items are relevant to the final version of the questionnaire.

Validity of our questionnaire

Results obtained with children suggest that "Effortlessness" and "Magical experience" dimensions are not reliable. However, they still appear as reliable with adults. Furthermore, both these dimensions seem highly relevant to assess intuitiveness of products, as one of the "Effortlessness" items (Q1 "Know what to do") predicts intuitiveness with children, and "Magical experience" dimension as a whole predicts intuitiveness with adults. Therefore,

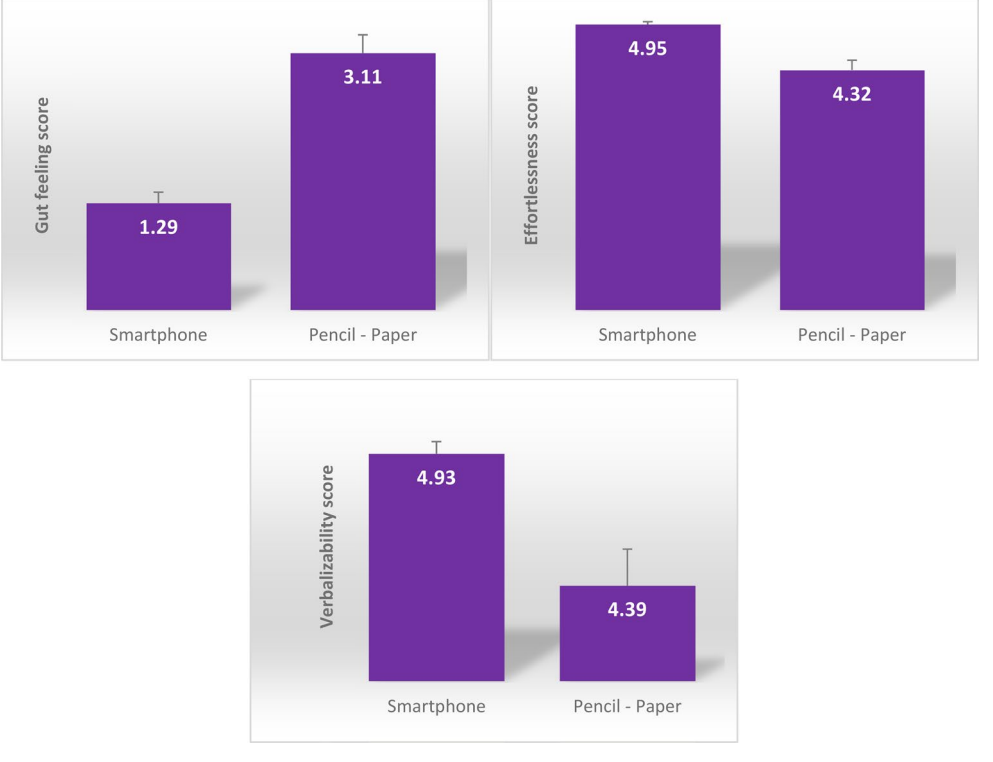

Figure 5. Mean and standard error of gut feeling, efforlessness and verbalizability as the function of the product used for the task (digital condition: smartphone, non-digital condition: pencil – paper).

we decided to keep the items of these dimensions in the final version of the questionnaire for further validation.

Regarding the "Verbalizability" dimension, we obtained a series of results suggesting that this dimension may not be relevant. Both adults and children data show that this dimension correlates negatively with the other dimensions of the INTUI model, in the sense that the more participants are able to verbalize their actions, the more intuitive the task. In contrast, the initial model as elaborated by Diefenbach and Ullrich (2015) posits that in intuitive interaction, people should not be able to verbalize their decisions and sub-steps to achieve the task. We have three potential explanations for this puzzling result. The first one concerns the phrasing of the item (e.g., "Imagine, if I ask you to explain to a friend how you made to […]? Would you be able?") that may induce a social desirability bias prompting participants to answer positively. We translated this questionnaire from an English version, which was itself translated from a German one, therefore the problem could also be a linguistic or even a cultural one related to the notion of "capacity to verbalize".

Our second explanation relates to the theory itself and the idea that an intuitive experience should not be verbalizable. To build their INTUI questionnaire, the authors used literature about intuition, although the definition of intuitive interaction is different from the definition of intuition, as previously mentioned.

Our last explanation concerns the influence of the tasks performed by participants. To test whether the experiment was influenced by the tasks, we could replicate it using the same stimuli as those used by the authors (Ullrich and Diefenbach 2010), i.e., MP3 devices.

Considering these issues with the "Verbalizability" dimension, we decided to remove this dimension from the final version of the questionnaire.

We also chose to remove the "Gut feeling" dimension, which children did not understand and which did not predict global intuitiveness in any of the regression models.

Product-type (digital vs. non-digital) effect

No effect of product-type appeared with children, but we observed significant effects of this variable on "Gut feeling", "Magical experience" and "Verbalizability" dimensions with adults. This result is not surprising, as performing a substraction by hand is more cognitively demanding than with a calculator. During this task, the experimenter collected verbatim such as "I forgot", "it is not easy". First, these results confirm that our questionnaire is usable with digital and non-digital products. In this respect, it provides a contribution to previous literature and previous tools available that had been designed mainly for digital products. Secondly, these results suggest that our questionnaire showed a good capacity to capture differences between products in a way that is consistent with actual experience of users.

Effect of task order

With children, we observed an effect of this variable on the item "Funny", showing that children found the task less funny the second time they performed it, whatever the device used. This result is logical, as for a child, to do the same task twice can be boring. This result shows the capacity of our questionnaire to capture children feelings with regard to a task and therefore supports the view that it is usable by children.

Final INTUI revised

Our final questionnaire therefore includes three dimensions (Effortlessness, Magical experience and Intuitiveness) and is composed of 5 items (Table 7). We designed a new test to validate this version, as elaborated in the following section.

Test of the final version

Method

Participants

Sixty-nine French volunteers participated (mean age = 22.01; SD = 8.86, 23 women and 46 men). They were recruited in a graduate school of engineering.

Material

In this study, participants had one task to perform with a Coffee Dispenser Machine (digital device; Figure 6). We chose a daily product used by our participants that seems easy to use.

Participants were instructed to order a Cappuccino with two measures of sugar, which included five steps:

Table 7. Final INTUI revised.

Effortlessness	[Q1] To […]*: You did not know what to do at all You did not know what to do Between both You knew what to do You knew perfectly what to do [Q2] To do […] was: Not easy at all Not easy Between both Easy Very easy
Magical experience	[Q3] To do […] was: Very common Common Between both Good Magical [Q4] To do […] was: Very unfunny Unfunny Between both Funny Very funny
Intuitiveness	[Q5] To do […] was: Not intuitive at all Not intuitive Between both Intuitive Very intuitive

*The space in square brackets is to be filled in with the task to be performed.

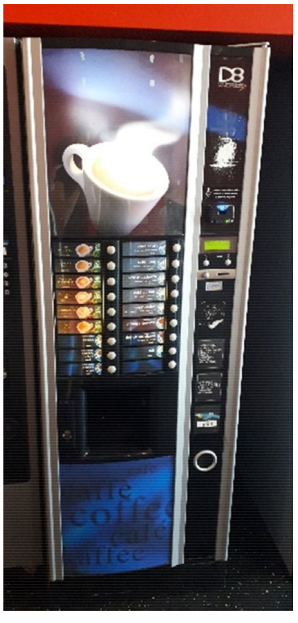

Figure 6. Coffee dispenser machine used for the experiment.

- Step 1: insert money into the Coffee Dispenser Machine
- Step 2: decrease the sugar doses
- Step 3: choose the drink (Cappuccino)
- Step 4: wait for the Coffee Dispenser Machine to proceed
- Step 5: take the Cappuccino.

Procedure

The procedure was identical for all participants. Firstly, the experimenter gave the general instruction "I will ask to you to make a fictive order on the Coffee Dispenser Machine. When the task will be finished, you will answer some questions". Then he gave the task instruction "You must order a Cappuccino with two measures of sugar; tell me when you have finished". Participants individually performed the task, and finally, they completed the final version of INTUI questionnaire and a sociodemographic questionnaire including age, gender and level of education. The whole test lasted 10 minutes.

Results

Hypotheses

Similarly to our previous study, we first examined the reliability of each dimension (Effortlessness and Magical Experience) along the following hypotheses:

- **Hypothesis H1**: Items "Know what to do" (Q1) and "Easy" (Q2) will be reliable because they belong to the same dimension "Effortlessness".

Table 8. Summary of items by dimension.

Dimensions	Items
Effortlessness	Q1 (Know what to do)
	Q2 (Easy)
Magical Experience	Q3 (Magical)
	Q4 (Funny)
Intuitiveness	Q5 (Intuitive)

- **Hypothesis H2**: Items "Magical" (Q3) and "Funny" (Q4) will be reliable because they belong to the same dimension "Magical experience".

We also investigated the relations between the dimensions (Table 8):

- **Hypothesis H3**: Dimension "Intuitiveness" (Q5) can be predicted from the two dimensions (Effortlessness and Magical Experience).

Results

Our Hypotheses H1 (alpha = 0.774, $r = 0.641$, $p < 0.001$) and H2 (alpha = 0.662, $r = 0.495$, $p < 0.001$) are confirmed. The corresponding items were then aggregated. Participants reported that they knew how to order a Cappuccino on the Coffee Dispenser Machine ($M = 4.28$, $SD = 1.03$) and that this order was easy ($M = 4.39$, $SD = 0.86$). However, the order was neither magical ($M = 2.23$, $SD = 1.10$) nor funny ($M = 2.32$; $SD = 1.08$). Finally, for participants, it was quite intuitive ($M = 3.77$, $SD = 1.15$) to order a Cappuccino.

The regression model shows that "Intuitiveness" (Q5) was predicted only by the "Effortlessness dimension" ($\beta = 0.343$, $t = 2.972$, $p = 0.004$). "Magical experience" was not a significant predictor ($\beta = -0.072$, $t = -0.626$, $p = 0.534$). Hence, Hypothesis H3 is partially verified.

Discussion

We obtained opposite results with adults with regard to those from Study 1. Indeed, the "Magical experience" dimension was a predictor of intuitiveness with adults whereas the "Effortlessness" dimension was not predictive. This discrepancy between the two tests might come from the impact of the product itself on the understanding and interpretation of what a "Magical experience" may be. This terminology may be less appropriate for evaluating an everyday product, with comparison to evaluating a new innovative product, such as e.g. a "Flyboard Air" (Figure 7). In the latter, their experience is much more likely to be perceived as magical, than when using a coffee machine. However, the "Magical experience" dimension remains interesting to investigate in any context of use and with any products; therefore we decided to keep it for further experiments.

Implication and limitations

To our knowledge, only one group of researchers took a strong interest in intuitive interaction, strived to define this concept more thoroughly and explain the processes involved. However, the INTUI questionnaire proved not usable with children and not appropriate to

Figure 7. « Flyboard air » by Franky Zapata.

evaluate non-digital products. From a methodological viewpoint, we contributed to the search for a tool that would enable a quick assessment of intuitiveness of digital and non-digital products, usable with participants of any age. Such a tool is expected to be usable in a user-centered design process (ISO 13407 1999) during the evaluation phase (Figure 8).

In this perspective, we conducted two studies to design an accessible version of this tool. At the end, we kept five items out of the seventeen initial ones. Both the "Effortlessness" and "Magical experience" dimensions seem to predict intuitiveness, depending on the product. If we consider the five properties of an intuitive interaction (Blackler, Popovic, and Mahar 2010), the importance of the "Effortlessness" dimension is not surprising. For a reminder, these properties are: 1) prior experience, 2) non-conscious processing, 3) speed, 4) individual differences and 5) correctness of intuition. We can observe that the underlying notion of the first three properties relates to effort, which means that the less a product requires effort, the more intuitive it may be.

However, to confirm this result, we must now conduct more studies to evaluate the reliability and sensibility of our questionnaire.

Firstly, we intend to test the latest version of INTUI with children, as our initial goal was to design a questionnaire usable by them. We also have to test our questionnaire with more diverse adult profiles. In the present study, it was tested only by students in engineering, who may have a specific way of thinking about products and may therefore not be representative of the general population. As both our studies emphasized an impact of the product on the dimensions measured, we also wish to investigate the extent to which the concept of intuitiveness applies to a variety of products, and in which respect. We intend to use it with digital and non-digital products but also with more or less new and innovative products.

Secondly, because of the above-mentioned discrepancies in our results, we feel urge to investigate in more depth the underlying theoretical model of intuitiveness. As previously stated, the design of intuitive products corresponds to the demand of both customers and manufacturing companies. It is therefore a timely and important issue, which should be studied with a new approach. Our literature review emphasizes that intuitiveness and intuitive interaction are complex matters and currently lack a clear theoretical framework. Our studies were based on Blackler and colleagues' (2010, 2015) work, which models intuitiveness as composed of four dimensions (magical experience, effortlessness, gut feeling and verbalizability) assessing the five properties of users' experience (Blackler, Popovic, and

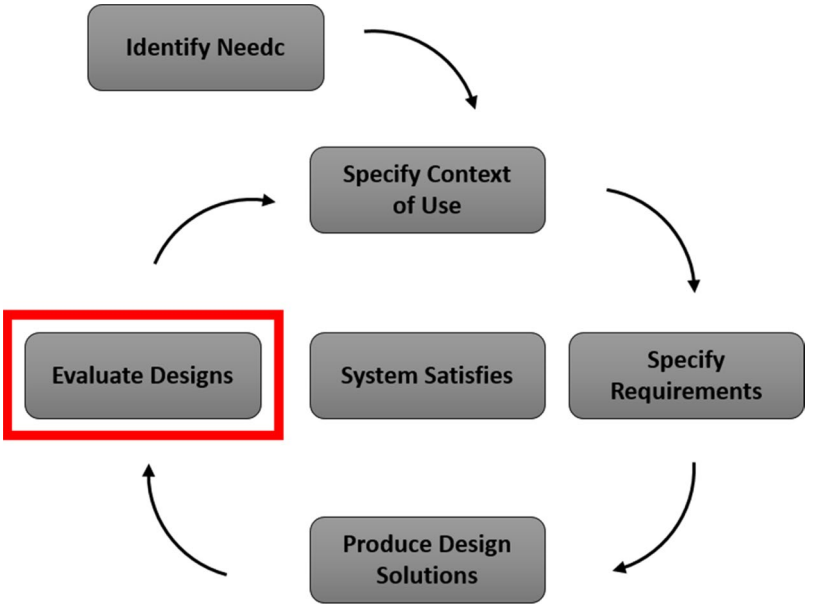

Figure 8. User centered design process (source: usability.gov).

Mahar 2010). However, our results regarding items understandability, theoretical consistency and impact of the nature of products lead us to question the very concept of intuitiveness and the means to measure it.

Krippendorff (2007) recommends considering users motivations to use products for user-centered design projects. His approach, based on theories of motivation and Flow (optimal experience; Csikszentmihalyi 1975), posits that designers' aim should be to create intrinsically motivating user interfaces. Motivation is a widely studied psychological process, for which the currently dominant conceptual framework relies on Self-determination theory (Deci and Ryan 1985). It models motivation as a continuum between amotivation and intrinsic motivation (when an activity is conducted for its own sake, for the pleasure and interest it generates, which are individual internal rewards). Several variations of extrinsic motivation (activities performed for external reasons, such as monetary rewards, constraints, or avoidance of detrimental consequences) lie in between the two ends of the continuum. In Self-determination theory, motivation is expected to result in the satisfaction of three fundamental psychological needs: need for autonomy, competence, and relatedness. Activities meeting one or several of these needs are likely to stimulate intrinsic motivation. Furthermore, someone engaged in an intrinsically motivating (or autotelic) activity is likely to experience the psychological state of Flow (Csikszentmihalyi 1975), characterized by attentional absorption, well-being and high levels of performance. Therefore, Flow could be viewed as a measurable psychological outcome demonstrating that a high level of intrinsic motivation has been achieved. In this respect, only intuitive products may enable intrinsic motivation process to be activated and generate the desirable state of Flow. Intuitiveness of products may appear as a prerequisite for intrinsic motivation and Flow: for a given activity, the more intuitive the product, the higher the subsequent levels of intrinsic motivation and Flow. Therefore, an alternative approach to existing scales

may be to assess user motivation and Flow during product use and infer product intuitiveness from the measure of these psychological phenomena.

All in all, further research remains necessary to investigate more deeply the concept of intuitiveness, its relations to well-documented cognitive processes, and provide improved measurement tools that any company could use to design intuitive products.

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