Proceedings of the ASME 2017 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference
IDETC2017
August 6-9, 2017, Cleveland, Ohio, USA

DETC2017-67207

EYE GAZE EXPERIMENT INTO THE RECOGNITION OF INTENDED AFFORDANCES

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ABSTRACT

An eye-tracking experiment aimed at testing the claim that individuals understand how to use artifacts through the visual perception of their intended affordances was conducted. Sixty-one participants were asked to state the manner in which they would interact with an artifact after looking at their screen-based images for ten seconds with their gaze captured. The participants' responses to perceived affordance were compared to their gaze data. Although individuals identified plausible affordances, a binary logistic regression analysis was inconclusive as to which eye-tracking variable is likely to entail a successful identification of the *intended* affordance. That said, there was a strong correlation between perception of the intended affordance and mention of either the artifact's function or semantic category. The results suggest that affordances may not have a significant impact in the usability of products and interfaces. Extrapolating from the findings, we postulate that analogical priming may be a better explanation for the way individuals understand what to do with the artifact.

INTRODUCTION

Since the introduction of the concept of affordance into design thanks to Donald A. Norman [1, 2] – especially in the areas of interaction design, industrial design, and educational design – the affordance theory developed by James J. Gibson [3, 4] became a widely-adopted set of design principles aimed at improving the usability of artifacts, such as end-consumer products and interfaces.

A key driver of the popularity of affordances as an essential design principle is the claim that if practitioners design with affordances in mind, then users will automatically understand how to use the artifact without any further direct instruction. This claim is true only if affordances exist in the object, including its environment, rather than in the mind of the perceiver. The problem is that whether the affordance is in the object or in the mind remains an outstanding debate. While Gibson argued that affordances arise from direct perception of physical constraints [3, 4], Norman postulated that (perceived) affordances originate from physical, logical, and cultural constraints [5] – in other words, affordances live both in the mind of the perceiver and in the characteristics of the object. Norman's claim is supported by the theory that the human mind generates a conceptual model, also known as mental model [6, 7], of the way objects work in order to help people predict the outcomes of their actions. In that sense, the more an individual develops a mental model of a particular object, the more they are going to perceive the object constrained by that model.

Although the veracity of those claims remain unproven, if Gibson is correct, then design practitioners should expect a correct use (i.e., use as *intended*) of whatever artifact they design as long as it is, to some extent, congruent with the user [8-10]. On the other hand, if Norman's claim is true, then congruence alone would not suffice to ensure a correct use of the artifact. In order to succeed, the design would need to have features that align with the user's knowledge and motivations [11], and provide cues that rely on the user's past experience. In practice, the artifact's affordances would need to match the user's mental model to be successfully perceived.

Interested in solving such a long-standing puzzle, we had previously made claims that generated controversy [12, 13], but there are a few reasons why we should question the validity of the assertion that affordances arise from the object. First, the majority of studies on visual perception of affordances involved either simplistic objects or simplistic representations of ordinary objects, that is, stimuli with low design content and low geometrical complexity, such as bottles, coffee cups, cutlery, and fruits [8, 10, 14-17]. From a design practice point of view, they are simple in appearance and have low novelty. Second, the artifacts conventionally investigated in perceptual psychology are ones to which people are likely to have been habituated. As such, it is not possible to distinguish between the perception of the affordance or possibly an analogical primed recognition [18-20]. Third, given that direct perception is a required element of this claim, then it would make sense to observe this phenomenon in studies involving affordance perception. However, from an analytical point of view, there is no clear divide between direct perception, which constitutes a bottom-up approach [21], and top-down processing [22] in perception. As a result, there is no agreement as to what metrics can be interpreted as direct perception, and we are left without any clarity around the nature of affordances.

Another point worth mentioning is that the concept of affordance is broad and not so useful when it comes to designing products and interfaces, and improving their usability. In this context, the affordances to focus on are the ones that design practitioners intend to be perceived, known as *intended affordances*, which refer to the intended manner by which the function of an artifact is enacted by a user in a given environment [23]. Therefore, we investigate the claim that affordances are perceived in such a way that users understand how to use artifacts through the visual perception of their *intended affordances*. Although this claim may apply to simple and well-known artifacts, this may not hold true when the artifacts are not that obvious.

In our previous experiment [23], we conjectured that users require prior exposure to intended affordances to perceive them. By taking this into account, it is reasonable to consider that affordances may involve more than just direct perception in order to be successfully identified.

Although, from a usability perspective, automatic processing [24] is the ideal scenario – which is what designers should be aiming for – there are circumstances where this is unlikely to occur due to a number of reasons. Depending on how complex the artifact is or how unexpected its appearances are, along with the user's knowledge and motivations, perceiving intended affordances may require significant cognitive effort that rather relies on top-down processing.

Based on the above, we conducted an eye-tracking experiment to observe how human gaze behaves when looking at novel or surprising artifacts [25]. We established areas of interest for each artifact that delineate where the first interaction with the user is supposed to occur, that is, the actual action an intended affordance entails upon perception. Then we sought potential correlations between the gaze data and whether the intended affordances were correctly identified.

If our proposition is proven to be true, this would mean that intended affordances have more chances of being perceived when users look at where they are supposed to interact with the artifact. As design advice, what is really important, though, is that it would suggest that intended affordances dwell in the realm of conception instead of perception. Thus, design practitioners should not expect that users will perceive how to use an artifact based upon its intended affordances alone but rather on how familiar they are with those intended affordances.

BACKGROUND

When Gibson [3, 4] coined the term *affordance* – which can be defined as "the actionable properties between the world and an actor (a person or animal)" [2] – he argued that affordances would require a bottom-up approach [21], also known as *direct perception* [26] , in order to be perceived. This notion was a fundamental part of Gibson's ecological psychology, and meant that information in our sensory receptors is enough to perceive anything, with no need of any higher-level cognitive processes to mediate between sensory experience and perception [27].

On the other hand, at that time psychologist Richard L. Gregory [22] argued that perception is a constructive process which relies on top-down processing. According to this approach, active processing of information – based on either past experiences or stored knowledge – is required to solve perceptual problems and make inferences about what is perceived.

Later on, when Norman [1, 2] introduced the concept of affordance to the design community, his view on how affordances are perceived was different from Gibson's. He claimed that (perceived) affordances rely on the user's past knowledge and experience, highlighting their mental models and perceptual capabilities over their action capabilities. This assertion goes hand in hand with the previously described top-down approach.

Although there is still no conclusive evidence of which perception process relates to affordances, it is possible that both bottom-up and top-down approaches are correct, each one being applicable depending on the circumstances or on the nature of the affordances.

While there is evidence that *instinctive affordances* [11] may exist, such as in the artifacts that afford nesting for mice [28], which are successfully perceived without any previous experience or knowledge, it is reasonable to consider that intended affordances require, to some degree, cognitive effort in order to be perceived. For instance, when a user faces an artifact they are not familiar with, it is likely that they will try to guess how to use it through analogical primed recognition, that is, by analogy to other artifacts that exist in their repertoire (i.e., memory) [18-20].

Therefore, an investigation is needed to understand how people perceive intended affordances of novel or surprising artifacts. This edge scenario could help design practitioners understand whether the affordance theory can be considered a set of design principles to hold on to when introducing novelty into products and interfaces.

EYE-TRACKING RESEARCH

With the aforementioned goal in mind, an implicit research method would be valuable in assessing a spontaneous or automatic response towards stimuli [29], as there is evidence that participants are less able to consciously control the outcome of implicit measures compared to self-report measures [30].

Depending on the technique applied, the collected data could be reliable enough to the point of suggesting a potential link between stimuli response and its underlying perception process. However, it is important to mention that this response would still need to be compared against explicit measures – captured by a questionnaire, for example – in order to identify when individuals successfully perceived the intended affordance.

Under this light, eye-tracking is a suitable implicit measurement technique for our study. In general, eye-tracking methods are based upon the eye-mind hypothesis, which states that that there is a strong correlation between where people are looking and what they are mentally processing [31]. Gaze data have become a well-known instrument for providing insights into human cognitive processes, as they facilitate the investigation of the origins of behaviors [32]. As a result, eye-tracking has been used in multiple fields of study [33], such as design [34, 35], human-computer interaction [36, 37], industrial engineering [38], and psychology [39].

The human eye possesses a repertoire of movements that allow us to point it at target locations of interest. Saccades are the type of eye movement used to move the fovea rapidly from one point of interest to another. Fixation is a period of time during which the eye is relatively stable, so as to bring an object of interest into visual focus allowing for the image details to be processed. Human perception is guided by alternating these sequences of fixations and saccades.

According to Raney *et al* [40], fixation duration and fixation count are often taken to index cognitive effort. Increased processing demands are associated with increased processing time or changes in the pattern of fixations. Thus, more effortful processing may be reflected by longer fixation duration or a larger number of fixations.

It is worth pointing out that, in our search for any previously related studies, we were unable to find research about affordance perception, in which an implicit method such as eye-tracking was applied.

HYPOTHESES

First, given that intended affordances entail an action from the user in order to fulfil the artifact's designed purpose, we hypothesize that people are more likely to look at where they are supposed to interact with the artifact in order to successfully perceive intended affordances (*H1*). Second, when people face novel or surprising artifacts, they are more likely to expend significant cognitive effort to correctly perceive intended affordances, which may indicate top-down processing. Thus, we hypothesize that people will spend a considerable amount of time looking at the artifact to successfully perceive intended affordances (*H2*).

If the first hypothesis (*H1*) is shown to be correct, this would mean that design practitioners should pay special attention to the areas of the artifact where users are expected to interact with (in order to fulfil its designed purpose), by making them visually more prominent and less ambiguous. As a result, this would make the artifact less prone to misuse. If the second hypothesis (*H2*) is true, this would suggest that either (a) intended affordances dwell in the realm of conception instead of perception, or that (b) perception of intended affordance goes from bottom-up to top-down processing, as novelty increases. Thus, design practitioners should not rely on the theory of affordances alone when aiming for the usability of artifacts. Instead, they should take into account that users will perceive intended affordances based on how familiar they are with those affordances.

EXPERIMENT

We designed our experiment with both implicit and explicit measures. Along with eye-tracking, an on-screen questionnaire containing multiple-choice and open-ended questions was applied. Gaze data provided quantitative information on the visual acquisition of information. The eye-tracking device and its corresponding software were used to collect, refine, and analyze gaze data. In parallel to this, questionnaire responses provided a mix of quantitative and qualitative information about the participants' interpretation of what they have seen. Those responses were analyzed and compared with the gaze data to uncover any significant correlations between them.

Participants

A sample of 61 participants – which was within the estimated sample range obtained by a statistical power analysis (α=5%, β=20%) – took part in the study. The requirements were a minimum age of 18 years and the ability to see large-size images on a computer screen without the aid of corrective eyeglasses (if applicable).

Participants were postgraduate students from either the University of Sydney or the University of New South Wales or Australian professionals from a variety of fields, such as design, project management, and information technology. Students were recruited with the aid of lecturers. Professions were recruited via social media (e.g., LinkedIn) and design-related discussion groups. The sample consisted of 38 males and 23 females, whose age ranged between 18 and 65 years old. Participation in this study was completely voluntary and no compensation was provided. All recruitment and experiment protocols were approved by the University of Sydney Ethics Committee.

Materials

A total of 12 artifacts of various types were considered in the experiment. They were divided into 2 sets, *set A* and *set B*, with 4 and 8 artifacts, respectively. *Set A* was used as a warm-up and contained only ordinary, low-novelty artifacts: a glass, a pair of scissors, a paper weight, and a shovel (Figure 1-Figure 4). For *set B*, artifacts provided were either likely to be unknown to participants or, to some extent, novel in affordance or appearance, based upon a quantitative analysis of novelty using the SAPPhIRE model [23, 41]. These were an ashtray, a

Figure 1: Glass (set *A*)

Figure 2: Paper weight (set *A*)

Figure 3: Pair of scissors (set *A*)

Figure 4: Shovel (set *A*)

Figure 5: Ashtray (set *B*)

Figure 6: Cake server (set *B*)

Figure 7: Caliper (set *B*)

Figure 8: Clip applier (set *B*)

Figure 9: Corkscrew (set *B*)

Figure 10: Ice hammer (set *B*)

Figure 11: Key ring (set *B*)

Figure 12: Knife sharpener (set *B*)

cake server, a caliper, a clip applier, a corkscrew, an ice hammer, a key ring, and a knife sharpener (Figure 5-Figure 12).

Given that our study relies on perception alone – which means that our focus is on the recognition of intended affordances prior to any action taken upon the artifact – we decided to limit the ability of the participants to physically manipulate the artifact to determine its intended affordance. In other words, the experiment was restricted to only one of the five traditionally recognized senses: sight. As a result, a total of 12 images were generated accordingly, which made up the stimulus set. These images were high-quality full-color PNG (*Portable Network Graphics*) files, which were manipulated and resized to fit a square of 1000×1000 pixels with a resolution of 72 dpi; they were placed over a white background, and any logos or labels were removed. A visual indication of the scale of the artifact (in relation to a human being) was generated as well.

Although one may argue that pictures of objects would not be able to elicit the intended affordances of their real-world counterparts, it is known that the former can merely be seen as a stimulus degradation of the latter [15]. Therefore, it was expected that this approach would not compromise the experiment results.

For each image from *set B*, an area of interest, also known as AOI – which can be defined as a boundary around an element or feature of the eye-tracking stimulus – was drawn and its coordinates (in pixels) were stored in a text file. Given that the stimulus set was made of images depicting artifacts, AOIs were established on the basis of representing the location where the first interaction between user and artifact is supposed to occur, that is, the actual action an intended affordance entails upon perception. For instance, the AOI of a pair of scissors would correspond to its bows.

Procedure

All stimuli were presented on a 23-inch monitor integrated with a TX300 eye-tracker from Tobii Technology (Stockholm, Sweden), at a sampling rate of 120Hz. Participants were seated at approximately 60cm viewing distance from the monitor. In order for them to feel at ease and as comfortable as possible, a desk-mounted chinrest was not provided, being only asked to keep still throughout the study. Stimuli were presented using OpenSesame 2.9.7, a graphical experiment builder [42], and PyGaze 0.51, a software package designed for creating eye-tracking experiments [43], both open-source. Gaze data storage and communication with the eye-tracker was handled by the manufacturer's software development kit, formerly known as Tobii Pro Analytics SDK. Therefore, gaze data collection was always performed as intended by the manufacturer.

Participants were taken through a calibration procedure. If an error occurred or the calibration results were not satisfactory, they were required to go through the procedure again until the results were acceptable. Participants were then given a series of 12 trials. Each trial consisted of 3 steps. In the first step, a scale indicating the artifact's size relative to an adult human was shown. When ready, participants then proceeded to the next step, in which an image was displayed for 10 seconds. During that time, the eye-tracker recorded their gaze. On trials 1 to 4, participants were given *set A* in a random order. These trials were used as warm-up so participants would be able to familiarize with the experiment's structure and have an idea of what to expect. Results from these trials were discarded. Trials 5 to 12 corresponded to *set B*, which was also randomly ordered. After 10 seconds, the image faded away and the eye-tracker stopped recording. Then, participants moved to the third step to answer the following questions: (a) *what would you most likely do with or to this object?*; (b) *why would you do that with this object?*; and (c) *what came to your mind when you first saw this object?*. The first one was a multiple-choice question, which dealt with the affordance of the artifact. The next two questions were open-ended and sought to identify whether the individual thought of its affordance in answering the question. For the first question, participants were asked to select from 1 of 6 options. Amongst them, 2 options were always present: *I don't know*, and *other*, the latter requiring an open response. The remaining 4 options were dependent on the artifact depicted by the image, and each one represented a different but plausible type of affordance in relation to a human being: (a) small scale (e.g., hand movement is required), (b) medium scale (e.g., arm movement is required), (c) large scale (e.g., full-body movement is required), and (d) complex (e.g., additional artifact is required) actions. There was only one correct option, the intended affordance. Aside from other, which was always in the last position, options were randomly arranged.

For instance, in the first trial, in which the image of a glass was displayed, in addition to *I don't know* and *other*, the options presented in the first question were *shake it*, *throw it*, *put it on top of my head*, and *put something into it*. The last response is the intended affordance.

Design and analysis

Gaze data were analyzed using MATLAB R2016a along with EyeMMV toolbox, an eye movement post-analysis tool [44]. Gaze data collected from each trial were individually analyzed and grouped by fixation duration, according to 2 minimum thresholds: 100ms and 500ms, which in our experiment were categorized as *any fixation duration* (even though fixations < 100ms were discarded) and *long fixation duration*, respectively. While the former may require some level of cognitive processing, the latter suggests top-down processing. For each fixation duration group, the following variables were calculated: (a) number of fixations (discrete variable), (b) number of fixations in the AOI (discrete variable), (c) time to first fixation in the AOI (continuous variable), and (d) first fixation in the AOI (dichotomous variable), that is, whether or not the first fixation occurred in the AOI. Therefore, a total of 8 eye-tracking variables were calculated.

With regard to the questionnaire, responses were organized into the following categories:

a. Intended affordance: what a user is expected to do to/with an artifact in a given environment;
b. Plausible affordance: what a user can do to/with an artifact in a given environment, which is constrained by both artifact and user;
c. Function: what an artifact is capable of being used to accomplish, which refers to the artifact's designed purpose [11, 45];
d. Semantic category: what an artifact is.

Based on the categories above, we assigned a total of 6 questionnaire variables, all dichotomous: (a) perception of the intended affordance, (b) perception of any plausible affordance (which includes the intended affordance), (c) mention of the artifact's function, (d) mention of the artifact's semantic category, (e) mention of either the artifact's function or semantic category, and (f) identification of the artifact's intended affordance, function or semantic category.

Overall, any answer similar to the expected one was considered a positive response. For example, in the first trial, where the image of a glass was displayed, *pour a beer* would be considered a correct intended affordance response. On the other hand, an answer such as *turn it upside down* would be deemed incorrect as an intended affordance, albeit acceptable as a plausible affordance response.

Although the first question was placed to capture the perceived intended affordance of the artifact, the open-ended questions were also used to extract that information whenever responses given through the open-ended option *other* were ambiguous or unclear. Mention of the function or the semantic category of the artifact did not suffice for the purpose of identifying its affordance and, thus, neither were considered a response to perceived affordance.

Back to the first trial, *drink* and *store liquid* were considered a positive mention of the artifact's function, while *cup* and *vase* were considered a positive mention of the artifact's semantic category.

For the first hypothesis (*H1*), we expected a correlation between perception of the intended affordance and number of fixations in the AOI, regardless of the fixation duration. For the second hypothesis (*H2*), we expected (a) a correlation between perception of the intended affordance and number of long-duration fixations, whether in the AOI or not, and (b) a correlation between perception of the intended affordance and first long-duration fixation in the AOI.

Results

A total of 488 responses were collected (Table 1), in which each questionnaire variable was compared to the corresponding eye-tracking variables. SPSS 23.0.0.0 was employed for the entire statistical analysis.

	+	-
Intended affordance	201	287
Plausible affordance	288	200
Function	61	427
Semantic category	65	423
Function or semantic category	96	392
Intended affordance, function or semantic category	241	247

Table 1: Correct and incorrect responses – which are represented by + (plus) and - (minus), respectively – organized by variable.

A point-biserial correlation, which is a special case of the Pearson's product-moment correlation aimed at measuring the strength and direction of the association that exists between one continuous variable and one dichotomous variable, was calculated between the non-dichotomous eye tracking variables – that is, number of fixations, number of fixations in the AOI, and time to first fixation in the AOI – and each questionnaire variable. In order to do that, all the data related to our non-dichotomous variables were log-transformed, so as to make them follow a normal distribution.

For the remaining eye tracking variable – that is, first fixation in the AOI – which is dichotomous, a 2×2 contingency analysis using chi-square test was conducted against each questionnaire variable.

Results showed that perception of the intended affordance was correlated with number of fixations of any duration (r=-0.093, p=0.041), while not correlated with any other eye-tracking variable (Figure 13). Perception of any plausible affordance correlated with number of fixations of any duration (r=-0.133, p=0.003), number of long-duration fixations in the AOI (r=0.102, p=0.024), and time to first long-duration fixation in the AOI (r=-0.129, p=0.043). In addition, the chi-square test indicated a dependence between perception of any plausible affordance and first long-duration fixation in the AOI (p=0.009), with an odds ratio of 1.798.

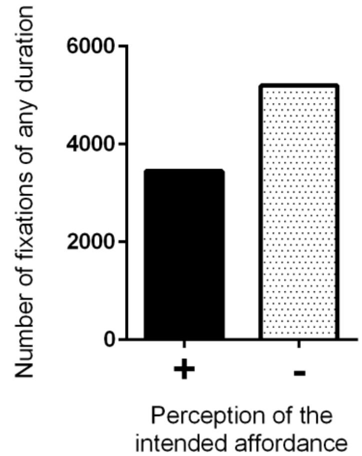

Figure 13: Correlation between perception of the intended affordance and number of fixations of any duration (r=-0.093, p=0.041), where + (plus) and - (minus) correspond to correct and incorrect responses, respectively, in regard to perception of the intended affordance.

Mention of the artifact's function correlated with number of fixations of any duration in the AOI (r=0.114, p=0.012), and number of long-duration fixations in the AOI (r=0.121, p=0.007). Also, the chi-square test indicated a dependence between mention of the artifact's function and first long-duration fixation in the AOI ($p < 0.001$), with an odds ratio of 3.083. Mention of the artifact's semantic category correlated with time to first fixation of any duration in the AOI (r=-0.142, p=0.005).

Mention of either the artifact's function or semantic category correlated with time to first fixation of any duration in the AOI (r=-0.120, p=0.017). In addition, the chi-square test indicated a dependence between mention of either the artifact's function or semantic category and first long-duration fixation in the AOI (p=0.008), with an odds ratio of 1.898. Identification of the artifact's intended affordance, function or semantic category correlated with number of fixations of any duration (r=-0.099, p=0.029).

Due to the unexpected results, we decided to investigate further and run a chi-square test to identify any potential dependence among the questionnaire variables themselves. The one worth pointing out was between perception of the intended affordance and mention of either the artifact's function or semantic category (Figure 14), which was considerably high ($p < 0.001$), with an odds ratio of 2.385.

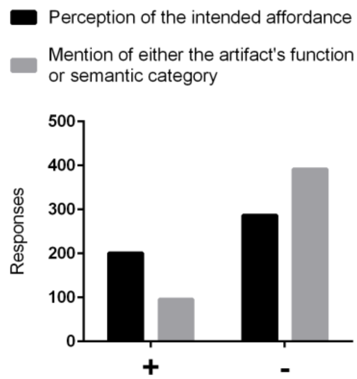

Figure 14: Dependence between perception of the intended affordance and mention of either the artifact's function or semantic category ($p < 0.001$), with an odds ratio of 2.385, where + (plus) and - (minus) correspond to correct and incorrect

Because of the strong association between intended affordance, function and semantic category of the artifact, a binary logistic regression was performed using an enter method to find the predictors of (a) perception of the intended affordance, and (b) identification of the artifact's intended affordance, function or semantic category. Perception of the intended affordance was entered as a dependent variable, while all the corresponding eye-tracking variables were entered as independent variables. In this model, no significant predictor was found.

Then, identification of the artifact's intended affordance, function or semantic category was entered as a dependent variable, whereas the eye-tracking variables were entered as independent variables. With a prediction power of 56.9%, this model revealed a significant predictor ($p=0.012$): first fixation of any duration in the AOI, with an odds ratio of 2.341. This indicated that individuals who first gazed in the area of interest were 2.3 times more likely to identify the artifact's intended affordance, function or semantic category.

DISCUSSION AND CONCLUSION

Although the results did not support our first hypothesis (*H1*), we found that the number of fixations of any duration on an artifact may negatively affect the perception of its intended affordance. Overall, this means that (a) in regards to perceiving intended affordances, the location where the first interaction between user and artifact is supposed to occur is not as important as the artifact as a whole, and (b) people successfully perceive the intended affordance by looking at only a few of the elements of an artifact; on the other hand, looking at too many elements of an artifact may be just a sign that the intended affordance could not be perceived. That said, when it comes to successfully identifying the artifact's intended affordance, function or semantic category, the location where the action is supposed to be taken upon the artifact seems to be critical to users. Therefore, we recommend caution to practitioners when designing such a sensitive area of the artifact.

Based on the above, we can infer that perception of intended affordances would most likely require low cognitive effort. That said, even though none of the results supported our second hypothesis (*H2*), being inconclusive as to which eye-tracking variable entails a successful identification of intended affordances, we found some clues about the underlying perception processes. First, although we did not explicitly ask about the artifact's function or category, participants still mentioned them as a way to make sense of what they have perceived. This shows how strong those concepts are when people externalize their thoughts around the perception of intended affordances. Second, there were 36 cases (7.38% of all responses) in which either the function or the semantic category of the artifact was mentioned believing it to be the intended affordance. For instance, where the image of an ice hammer was displayed, *climbing*, which is the artifact's function, was among the intended affordance responses expressed by participants; similarly, answers such as *use it as an ice hammer* were also given. Third, the strong correlation between perception of the intended affordance and mention of either the artifact's function or semantic category means that a positive identification of either the function or the semantic category of an artifact may entail a successful identification of its intended affordance, and vice-versa.

Given that the concepts of function and semantic category were concurrently used as a way to convey the notion of affordance, it became clear that these three concepts were intertwined in our experiment. That was the risk of using explicit measures, such as questionnaire responses, in the study. Nevertheless, this behavior and the results suggest that the intended affordance is *perceived and conceived* in conjunction with the artifact's function and semantic category. Consequently, intended affordances may not play a significant role, at least not just by themselves, in understanding how an artifact should be used. If by any chance the artifact's function and semantic category are unknown to the user, however, the intended affordance may be the last resort in recognizing how the artifact should be used.

Furthermore, if we assume that an artifact gives off information about its intended affordance, function and semantic category, all at the same time, and that that information is perceived as a whole, it is reasonable to consider that this process involves a top-down process, particularly analogical primed recognition.

It is likely that, through analogical primed recognition, people look for similarities in their repertoire when attempting to figure out what they should do to/with an artifact (i.e., intended affordance), in just the same way as they would do to identify what it does and what it is. Similar to skeuomorphism – which transports visual cues from real-world physical artifacts to screen-based interfaces to make interactions with screen elements more evident – novel or surprising artifacts should contain certain elements or features to which users have been previously exposed in order to be transferred, so as to help them recognize and use those artifacts as intended by the designer.

Hence, as a design principle, the concept of affordance should be viewed as a means to prime users, so as to ensure a successful recognition and operation of artifacts. By consciously providing intended affordances that users are familiar with, design practitioners may be able to conceive products and interfaces that are less prone to misuse.

ACKNOWLEDGMENTS

Leonardo Burlamaqui gratefully acknowledges the financial support of CAPES Foundation, Ministry of Education of Brazil (Grant Process BEX 1079/13-1).

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