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Will smart homes improve our lives? A design perspective towards effective wellbeing at home

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Abstract: New solutions for home automation show novel approaches to the design of products and systems for domestic use, and promise innovative performances. Nevertheless, there is still a gap, that is worthwhile to investigate, between the state of the art of technology-based solutions and what is actually adopted at home. This paper discusses this topic from a design point of view. The research is based on cross-examination of case studies and the results of extensive ethnography in domestic environments. We discuss the tangle of practical and non-functional needs that characterize the experience of users at home in an ampler way, aiming at effective wellbeing. To synthesize the results of ethnography, we introduce the concept of resilience in domestic environment arguing that, in the design of solutions for home automation, we must consider home as a dynamic place, apt to support the continuous change of needs and lifestyles of users.

Keywords: Home automation, design principles, wellbeing, design for experience, ethnography for design, resilience of domestic environments.

1. Introduction

In the last decades and for more than a century now, the vision of fully automated domestic environments inspired designers and engineers, but also writers and filmmakers. Indeed, the quality of domestic comfort is one of the most important factors influencing human lifestyles and wellbeing. Some inventions, such as washing machines, provided efficient solutions for practical needs but also lightened cumbersome burdens and supported social changes. More recent home automation solutions provide the technical support to promote independent living, to improve safety, to optimize energy and water consumption, and to create pleasurable and desirable living contexts. On the other hand, in several countries, among which Italy, smart home solutions still do not encounter a significant success and there is a huge gap between the potentialities of the existing offer in terms of products and systems, and the attitude of consumers and interior designers towards digital innovation at home.

The research reported in this paper is aimed at critically investigating this gap between technological potential and real adoption from a design perspective, and it is based on a number of activities including case study collection and discussion, ethnography for design, and education experiences.

1.1 Technology potential and design role

Digital technologies are rapidly evolving and we are now witnessing a blooming of tech-based products and systems, several of which promise to improve the way we live in domestic environments. A growing number of companies are promoting future domestic scenarios based on Internet of Things, cloud computing, Artificial Intelligence and smart control systems: digital technologies seem on their way to produce disruptive innovation. However, although these scenarios envision new interesting possibilities, many of them appear to be designed pursuing goals of domestic efficiency or the creation of end in itself entertaining experiences, and are not fully convincing within a real-life approach. Moreover, working on technology for home has deep implications from the individual and social viewpoints, as innovation should respond to criteria of individual and common convenience, far beyond the goal of wellbeing intended as automation of practical tasks. The technological revolution can lead us to live better and more efficient lives, but it can also have negative impacts (Dertouzos, 2001), which are often overlooked.

In facing these future scenarios, a number of questions arise: as designers, how can we design smart systems that effectively improve wellbeing and life quality at home? How can we interpret the technology potential in order to produce desirable and convenient new domestic scenarios? What new design competences are needed to deal with these emerging technological opportunities?

We believe that design can offer alternative innovation paradigms in the field of smart home by providing suitable interpretations of the concept of domestic wellbeing and by paying attention to ethical issues. These are essential skills that designers should develop in facing the tech-driven revolution. In order to do that, we assume that design should enforce user-centred techniques and methodologies and make them evolve, considering not only users' practical needs but also their psychological wellness, desires, emotions, and social relationships, therefore focusing on the creation of overall positive experiences (Desmet&Hekkert, 2007; Hassenzahl, 2010).

This paper addresses the identified open issues by offering a twofold discussion.
In the first part, we propose a critical framework to interpret and analyse the newest smart home solutions on the market, based on case-study analysis, which includes main trends and critical issues. In the second part, we propose a novel approach to the design of smart home solutions consisting of experience-oriented ethnography in domestic environments. We also describe an educational activity in which we asked design students to apply this approach, with the aim of improving their skills and sensitivity towards experience in designing with technology. This research activity brought to new insights for the meaningful integration of technology into home.

In the conclusions, we introduce the concept of "domestic resilience" and we point out the importance of developing new skills and innovation paradigms to design innovative tech-based domestic solutions with people's experience and effective wellbeing in mind.

2. Case-study analysis: smart solutions for domestic environments

As a first step of our research, we performed a qualitative case-study analysis with the aim of providing a framework of design trends and critical issues in the realm of home automation. The

analysis was performed within a collaboration with *XXX (The name of the telecommunication company we have cooperated with will be added after the final review and acceptance of the paper).*

2.1 Case studies selection and analysis

We collected and analysed 28 case studies selected among prototypes present on crowdfunding platforms and final products on the market. They include both central control hubs or systems (e.g. Amazon Echo, Google home, Apple Home) or smart products or appliances focused on specific functions (e.g. Nest, Nuimo, Juneoven).

The main criteria used to select case studies were: i) novelty; ii) disruptiveness with respect to traditional ways of performing activities in domestic environments; iii) attempt to solve specific needs (i.e. independent living, energy saving, remote control, improvement of safety); iv) users' involvement (we discarded solutions based exclusively on the improvement of technical performance of appliances/systems).

In selecting case studies, we considered as a main value the interoperability and the compatibility with other solutions and with different cloud and operating systems; therefore, we took into account only solutions and products that fulfil the needs of flexibility, continuous re-design, re-organization, updating and modification that are characteristics of every domestic environment.

The analysis of the collected case studies was based on the products' descriptions and demos reported on official websites or crowdfunding platforms. The analysis consisted of the categorization of the case studies according to a number of criteria (i.e. addressed need, system typology, degree of automation, interaction modality), which helped us identify some emerging trends.

2.3 Emerging trends and critical issues in home automation

From the analysis of the selected case studies, it was possible to identify some trends and values that correspond to a number of topics discussed in scientific literature in the last few years. The main identified trends are reported below and represent common values and principles guiding the development of new solutions.

- **Producing "natural" languages** so to enable a direct interaction between users and smart products/systems within a "natural" or, at least, "easy to learn and remember" interaction system (e.g. Google home, Amazon Echo).
- **Centralizing personal information**, ensure interoperability between devices and memory supports; make all information available everywhere and anytime.
- **Centralizing control** on physical devices and environments, and support remote control.
- **Reducing physical and cognitive efforts** associated to daily activities (such as those required for leaving and closing home, preparing the list of goods to buy, remembering the week schedule for the family and so on).
- **Reducing the number of interactions** between the user and the smart product/system in accomplishing some specific activity such as the automatic optimization of lighting or heating conditions.
- **Supporting awareness** about remote and local environments and about personal wellbeing in such environments through numerical data collection, storage and representation on personal devices or dedicated appliances.

The collected case studies show a great creative and research ferment in the field of smart home, and offer suggestions about future scenarios for home automation that try to improve everyday life on different levels. Most solutions we considered in our analysis aim to respond to relevant practical needs, are optimized with respect to usability and accessibility, and are qualified from the aesthetic point of view. However, still it is an open question whether these solutions actually represent a meaningful contribution to the improvement of lifestyles and domestic wellbeing and if they will be interpreted as useful and desirable by final users. We believe that, in order to improve our capability to design smart products and systems, we should be able to criticize the state of the art in the field of home automation, and bring to light some logic, ethic and aesthetic contradictions that characterize the present solutions. In analysing these products, we identified at least four main issues that should be discussed and investigated further, and that may potentially undermine the acceptability of smart products/systems:

- **The issue of dematerialization**. The pervasive diffusion of electronic technologies increases the amount and variety of information that is made available to us; at the same time, the digitalization of data and centralization of control system is accompanied by a trend of dematerialization, which makes controls and information available on screen-based interfaces. Does this trend really encounter human cognitive and experiential needs?

- **The issue of resilience**. The introduction of electronic and digital solutions for sensing and controlling traditional domestic systems (i.e. lighting or heating systems), and the use of cloud systems produce valuable functional innovation, but may also reduce the robustness and resilience (intended as the ability to cope with change) of domestic environments. For instance, several domotics systems allowing the personalization of interdependent automatisms through scenarios, imply rigid schemes of behaviors and require a predefined model of ideal setup conditions, thus reducing flexibility. How can we evaluate the tradeoff between advantages and criticalities?

- **The issue of privacy and personal information**. As we move from physical and local interaction with objects and systems, to the dimension of digital interaction, every gesture and action becomes observable, measurable, recordable and traceable. How do we deal with ethical and practical issues related to the basic right of privacy?

- **The issue of *effective* wellbeing**. Homes are not only shells where people perform activities. They are the representations of our values, emotions, memories and social relations. While designing new smart home solutions, these elements should be taken into great consideration, as they concur to people's wellbeing, beyond a functional approach, and determine the acceptance of new technological solutions. How can we leverage technology to design smart homes having effective wellbeing in mind?

In this work, we focus on the last point, effective wellbeing, with the intent to explore what contribution design can provide and what methodologies can help to achieve meaningful and acceptable technological innovations in domestic environments, which improve user's overall wellbeing. We start from the assumption that wellbeing is strictly related to aesthetic, functional, emotional and cognitive factors. These are all elements that, in design, belong to the concept of user experience (Desmet & Hekkert, 2007).

For this reason, we intend to explore how design for experience and interaction design methodologies can contribute to explore and support a critical thinking about the topic of effective wellbeing at home.

3. Designing for *effective* wellbeing at home

The second part of our research focuses on the investigation of people's emotional needs, desires, and symbolic meanings attached to the domestic environment. Our hypothesis is that most of smart home solutions are developed keeping in mind functional and technical performances, leaving apart all the soft aspects (meanings, values, emotions) of the real life in our homes. This might be one of the reasons why smart home solutions are not encountering the success that many expect. In order to contribute to solve this challenge, we stress the importance of focusing user studies, in particular ethnography, on the softest aspects of the human experience, and we present a peculiar kind of ethnography that may be used to guide the development of innovative solutions in the field of smart home. Finally, we intend to evaluate if ethnography for experience can help designers to understand user's symbolic values and emotions in domestic contexts, in order to create meaningful smart solutions that produce overall and effective wellbeing.

3.1 Beyond function: values and emotions at home

Interaction design methodologies, as they have been on the scene since some decades ago (Rogers 2011, Benyon 2005, Cooper 2007) are mainly based on iterations of activities involving user studies, concept generation, prototyping and testing. In this approach, user studies are meant to investigate user needs (in the amplest sense), design constraints connected to the context, mental frames (Erwin 2014); the final goal is to produce knowledge supporting the development of a useful solution (which fulfils a need), and to ensure comprehensibility, usability, accessibility and acceptability of the innovative products and services.

In order to reach acceptability of new products, design should not only focus on the fulfilment of practical needs (e.g. having a more monitored and secure home), but should analyse and consider the emotional and symbolic implications of each new solution that is introduced in the domestic environment. Indeed, smart home solutions affect our perceptions, interactions and relations with the environment, as well as the boundaries we create with it and the internal and external social relations. For instance, the possibility to talk to a virtual home assistant such as Alexa or Google, can replace our direct interaction with other family members, and becomes, in the view of the developers, an additional member of the household: the effects on our social relations at home could be huge and should be considered by a correct design practice.

Moreover, in designing solutions for domestic environments, we should consider that, depending of the specific culture of the inhabitants, the functional issues may be harmonized with other needs that are not practical and material, yet often are perceived as very important. As an instance, in Italy several buildings contain pieces of furniture and decorations that have historical and/or affective values and that, consequently, should be conserved with no alterations.

In order to better understand the different values at stake when we design products for home, we can refer to the work of some Italian design masters such as Mari, Mendini, Sottsass, Branzi: for them, a domestic space should never be simply interpreted with respect to its practical functions and needs. A house should instead be understood as a complex context where people experience and express some of the most important and basic dimensions of human existence. A house is a shelter and a place where to sleep, rest, eat, and work; but is also a social place, where we grow and develop some of the most important relationships of our life. A house is a place where we can express our personality, but also where we can feel free to behave and conduct our preferred lifestyle; it is the

space where we can preserve memories, search for intimacy with people we love and with ourselves, build our experience out of the frames of social constraints.

Starting from these considerations, we understand wellbeing at home not just in terms of reduction of physical and cognitive efforts and insulation from risks and exterior challenges, but mainly in terms of opportunities for activities, lifestyles reinforcement and positive emotions, both from the individual and social viewpoints.

3.2 Open ethnography for effective wellbeing

In order to achieve effective wellbeing through smart home solutions, we propose a design approach that starts from the investigation of users' habits, desires and emotional needs at home, through a form of *open* ethnography. In our view, open ethnography is a form of ethnography not aimed at the design of a specific product or service (e.g. a smart fridge or a smart shopping solution), but one that investigates the complexity of the human experience around an *activity*, with respect to several different dimensions. Such dimensions are summarized in the experience map we propose (Fig. 1). The map derives from our study of literature on domestic spaces and individual and social needs and emotions at home, as well as from the previous case-study analysis. It aims at providing designers with a guide to collect and frame information while performing ethnography on domestic activities. By using this map, designers can be more aware of the complexity of the issues at stake in the domestic space, and can orient their research activities toward the exploration of these elements, so to emphasize the relevant factors.
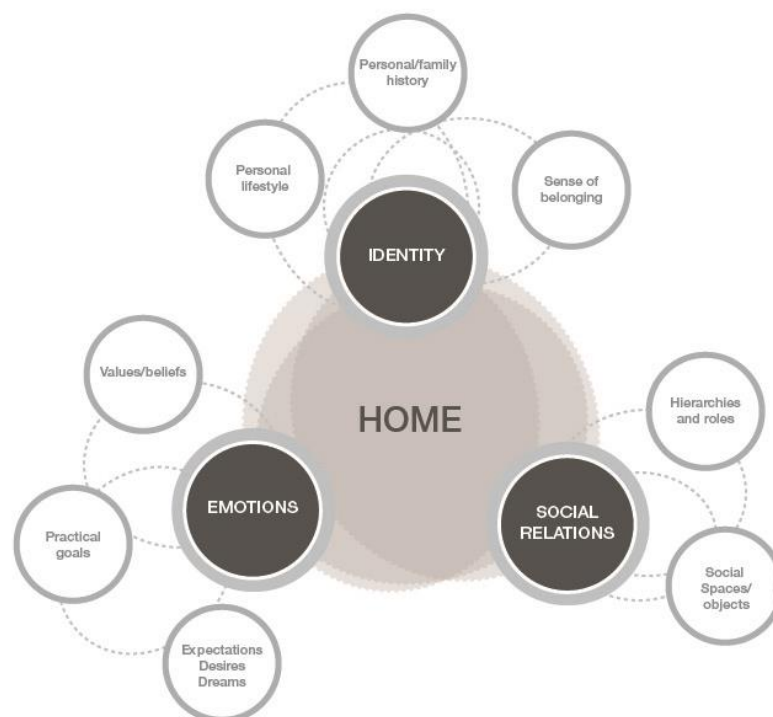

Fig. 1. The map shows the components of the human experience that should be explored when investigating behaviours and activities at home. This analysis should guide the design of new smart home solutions so to consider how these elements can be reinforced/improved by new smart products/systems.

In the approach we propose, we start from the assumption that a correct ethnography for the design of smart homes can be carried on only if three basic conditions are met by designers conducting the research on field:

1. Awareness about the complexity of mental processes associated to experience, also including emotional, cognitive and dissonant processes; in particular, we refer to brain sciences, and to literature on experience and semantic design (Desmet&Hekkert, 2007; Hassenzahl, 2010; Krippendorff, 2005).
2. Suitable framing of the complexity of the context under analysis (which the map we propose intends to support).
3. Freedom to observe contexts and behaviors without stressing the results in terms of finalization and design outcomes.

3.3 User study: applying open ethnography

We tested this approach in an education activity carried on with the students of XXXX *(details will be provided after the final blind review)*, involving eighty students in ethnography observation in domestic environments. Before this activity, students followed lectures about interaction design methodologies, theories on design for experience, brain sciences and design culture.

Students were asked to focus on one activity that is frequently carried on in domestic environments, such as coming back or leaving home, eating, or relaxing. They were asked to investigate such activities without focusing on possible solutions, but with the aim to collect data and insights and empathize with the final users. Students were divided into groups of three people each and carried on ethnographies by using videos, notes and recorders. In particular, two methods were applied: Narration and Behavioural archaeology, inspired to the IDEO methods. Narration requires the designer to follow the users in their activities, and ask them to describe what they are doing. A video records the activity and the user's account. Behavioural archaeology requires to take pictures of all the objects the user interacts with while performing an activity; subsequent analysis is carried on to understand motivations, meanings and emotions attached to such objects.

Students collected a huge amount of data and visual materials that were used for subsequent analyses. As a result, main insights about user's emotions, values and habits around each specific activity they explored were extrapolated and mapped.

3.4 Results: emotional and symbolic factors

Thanks to this activity, we identified four categories of soft values, which represent factors that should be taken into consideration in the analysis of domestic activities and in the design of smart home solutions.

3.4.1 Social and emotional factors

Results show that every activity is complex and, in order to be suitably interpreted, it should be framed with respect to different facets composing what we call experience. Beyond the functional issues, the facets include the realm of emotions, the realm of social interaction, the domain of self – respect and sense of self, the dimensions of personal values, the sense of personal convenience.

As an instance, an apparently simple activity like preparing the list of goods to buy, should be also framed as a social activity since the enquiry about what foods are needed can be intertwined with affective and symbolic interactions between the member of a family. Basic actions such as preparing

to leave the house or entering the house, came out to be activities rich of emotions and often accompanied by anxiety. Fig. 2 shows how the recurrent organization of objects was used by one person to remember to take certain objects while leaving home. Beyond being functional, this activity has strong emotional meanings, since it decreases the anxiety connected to forgetting things.
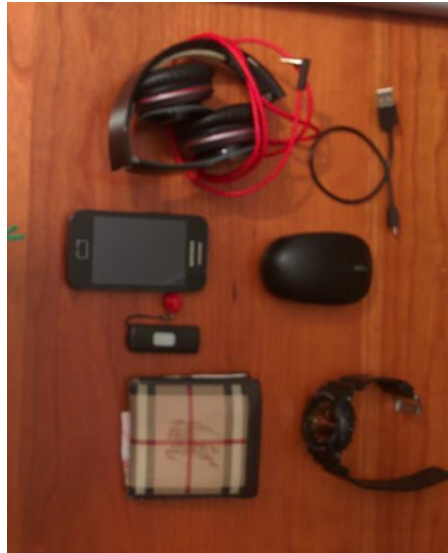

Figure 2. The picture shows the specific arrangement of objects performed every day when entering home by the person interviewed. (Image produced by Mastrantuono, Mustapha, Torrione)

3.4.2 Symbolic values

Every single task is often interpreted, in a conscious or unconscious way, as symbolic and affective: the way people prepare meals for themselves of for other members of the family is tightly connected with the feelings involved in the interpersonal relationships or with the framing that people have of personal needs. As an instance, a family mother that was observed in her housekeeping activities at night, was mumbling about the number of tasks she was facing; most of these tasks were presented as "services" dedicated to specific members of the family.

3.4.3 Rituals

In domestic environments, rituals play a very important role for people of each age, education and social status; rituals govern a number of activities such as "preparing to go to bed", "making laundry" and "managing clothes". For this reason, smart solutions should support specific rituals and should be flexible to adapt to personal sequences of activities. As an instance, during interviews, many people showed a number of objects they gather on their bedside tables, which are associated both to practical needs (i.e. a book, a glass of water, fig. 3), and to affective tasks (a phone for sending a "goodnight" kiss to someone).

Figure 3. Objects connected to the ritual of "going to bed" (Image produced by Hartz, Iacomino, Lanzani)

3.4.4 Self-reflection

We noticed, as a diffuse and common need, the exigency of "being in control" on the environment. This need should not just be intended in terms of having information about the state of the different parts of the house (as an instance, on electrical consumption, or doors being locked/unlocked), but also and maybe mainly in terms of physical and visible organization of spaces. Such spatial arrangement, indeed, should reflect aesthetic personal requirements and also individual and social activities that are considered as relevant, such as receiving hosts, training at home, access some entertainment, relaxing and so on. The space becomes a mirror of our activities, interests, and values. As an instance, some senior people describing their entertainment activities at home showed the physical environments and objects they use as a demonstration of the suitability of their arrangements to this purpose (Fig. 4).

Figure 4. The organization of objects for activities like relaxing reflects the personal attempt to increase comfort and pleasure at home. (Images by Atzori, Aquilani, Caimi)

We believe that, in order to be accepted and appreciated, any smart product, service and system meant for the domestic environment, should meet or, at least, should not conflict, with most of the facets that concur to define the experience in domestic environments.

4. Resilience of domestic environments

On the basis of the two different analyses performed – on existing systems and users' profound needs – a number of considerations can be made.

First, the analyzed existing solutions are strongly directed towards solving specific functional needs (e.g. starting cooking before coming back home), without addressing the emotional and social needs and values implicated in each domestic activity. The focus on practical functions hides the complexity of experience at home and can produce a mismatch between technology driven innovation and user values. Furthermore, most solutions do not manage relevant concerns such as those involving privacy issues and robustness requirements.

Moreover, we learned to consider as a value and main goal the *resilience* of domestic environments, intended as the capability of the environment to be flexible with respect to the changes of needs, habits and lifestyles of the inhabitants. From our ethnography at home, we learned that people tend to consider their homes as private territories where they express personal values, identity and tastes, where they conserve memories and develop the most valuable social interactions, and where it is possible to behave in a free way within an intimate shelter. Therefore, in designing a solution for home automation, we should take into account continuous changes in individual and social activities that take place in domestic environments. Thereafter, the ability to be flexible and to address non-practical needs should be seen as one of the factors that concur to the "resilience" of domestic environments in the technological revolution.

We find ourselves in the same situation that previous generations of designers faced when moving from products' functionalities to products' symbolic values, meanings and emotions: we know what smart systems can do, their technical potential. However, the acceptability of such solutions cannot be delegated to their technical performances or functions. As long as we do not consider the deep implications that technology can have in our lives when entering our homes, smart home solutions will continue to be - more or less - functional add-ons to existing environments, with a critical level of acceptance.

Designers should leverage the latest technological trends, developments and directions to design experiences that take into consideration and reinforce the social and emotional factors, symbolic values, rituals and self-reflection practices.

5. Conclusions

Our research is aimed at producing knowledge that supports the design of smart products and systems for home, in order to encounter users' needs and to better fulfill tacit requirements of quality.

In our study, we analyzed a number of case studies in order to highlight the weaknesses of present solutions, among which the functional approach and the lack of attention towards effective

wellbeing at home. We stressed the importance of referring to the whole experience, taking into consideration emotions, meanings and relations, as well as ethical consequences. We then propose a design approach based on open ethnography to investigate the soft aspects of experience at home, and we present a map useful to collect ethnography insights. This approach was tested through an educational activity, which let us identify four elements that concur to affect the human experience in domestic environments. Furthermore, we enlightened the need of consider the quality of the automatic solutions in terms of resilience of domestic environments.

This work intends to lay the basis for more human experience-oriented works in the development of smart home solution, which put at the center the effective, complex, and multi-faceted issue of user's wellbeing, in order to provide solutions that really help us to live better lives.

References

Benyon, D., Turner P., Turner, S. (2005). Designing Interactive Systems. People, activities, contexts, technologies. Edimburgh: Addison-Wesley.

Bergen, D. (2002, Spring). The role of pretend play in children's cognitive development. Early Childhood Research & Practice, 4(1). Retrieved February 1, 2004, from http://ecrp.uiuc.edu/v4n1/bergen.html.

Chen, C.-w., You, M., Liu, H., & Lin, H. (2006). A usability evaluation of web map interface. In E. Koningsveld (Ed.), Proceedings of the 16th World Congress of the International Ergonomics Association [CD ROM]. New York: Elsevier Science.

Cooper, A. (2007). About Face 3: The essentials of interaction design. Indianapolis: Wiley Publishing Inc.

Dertouzos, M. (2001). Unfinished revolution: human-centered computers and what they can do for us. HarperCollins.

Desmet, P. M. A., & Hekkert, P. (2007). Framework of product experience. International Journal of Design, 1(1), 57-66.

Erwin, K. (2014). Communicating the new. Methods to shape accelerate innovation. New jersey: Wiley and sons.

Hassenzahl, M., Diefenbach, S., & Göritz, A. (2010). Needs, affect, and interactive products–Facets of user experience. Interacting with computers, 22(5), 353-362.

Khalid, H. M. (2001). Can customer needs express affective design? In M. G. Helander, H. M. Khalid, T. M. Po (Eds.), Proceedings of Affective Human Factors Design (pp. 190-198). London: Asean Academic Press.

Krippendorff, K. (2005). The semantic turn: A new foundation for design. crc Press.

Rogers, Y., Sharp, H., Preece, J. (2011). Interaction design. West Sussex, UK: Wiley and sons.

Schifferstein, H. N. J., Mugge, R., & Hekkert, P. (2004). Designing consumer-product attachment. In D. McDonagh, P. Hekkert, J. Van Erp, & D. Gyi (Eds.), Design and emotion: The experience of everyday things (pp. 327-331). London: Taylor & Francis.

Wu, J. T., & Liu, I. M. (1987). Exploring the phonetic and semantic features of Chinese words (Tech. Rep. No. NSC75 0310 H002-024). Taiwan National Science Council.

Wundt, W. (1905). Fundamentals of psychology (7th ed.). Liepzig: Engelman.

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