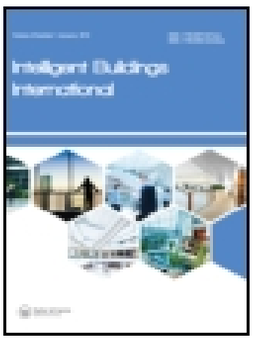

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Substantiation of home occupant archetypes with the use of generative techniques: analysis and results of focus groups

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ABSTRACT

A previous study clustered home occupants into archetypes with a questionnaire. This study uses qualitative methods to strengthen those previously-found archetypes with data pertaining to the participants' home experiences. Focus groups were carried out where generative activities were conducted involving the generation of collages. The first activity dealt with the expression of 'meaning of energy use at home' and the second one with the 'ideal home experience'. Analyses were done with content and thematic analysis. Codes were drawn from the data and were assimilated through an affinity diagram. The diagram produced two categories: building themes and human themes, along with five sub-categories (home, financial, energy, psychological, and behavioural aspects). The outcome shows that each archetype expresses needs and meanings of an ideal home experience and energy use differently from each other. The results provide evidence that generative techniques can be used in energy research. In this case, to validate and substantiate the quantitative archetypes previously produced with a questionnaire. Interpretive knowledge in energy research allows for a better understanding of occupants' differing behavioural patterns in regards to energy use and comfort. It allows customizing interventions to the archetypes' specific needs to decrease energy consumption while maintaining comfort.

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Energy saving; occupant comfort; environment and behaviour; user experience design; human behaviour

Introduction

To reduce energy consumption, it is necessary not only to understand energy-consuming technologies but also energy-consuming behaviours. Compared to energy-efficient technologies, knowledge as to how home occupants consume energy in their residences could be improved (Sovacool 2014; Gaffigan 2008). This lack of knowledge of energy behaviours is partly caused by how comfort is understood in the indoor environmental quality field (IEQ) and how comfort-offering technologies are developed (Majcen, Itard, and Visscher 2013).

IEQ has traditionally been investigated from a technology-driven approach, with a focus on the building, its characteristics, and the physical environment. This process has been done by establishing and following standards and guidelines based on the appropriate amounts (dosages) of stressors to maintain an arguably healthy and comfortable environment for any occupant (Bluyssen 2014, 2009). Research has shown that comfort is a multidimensional concept not limited to the four individual IEQ factors (air, acoustical, visual, thermal), but should rather be considered as a

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psychobehavioral phenomenon instead of limiting it to a perceptual one (Hong et al. 2016; Hong et al. 2015; Ortiz, Kurvers, and Bluyssen 2017).

On the other hand, building systems, installations, and appliances are researched and developed in such a way that they will satisfy the IEQ standards and guidelines, in an energy efficient manner. Yet, despite the technological developments, energy consumption is not decreasing at the rate it should for the Europe 2020 and 2030 targets (Tsemekidi Tzeiranaki et al. 2019). Although factors affecting energy consumption are complex, one that seems to be particularly influential are the occupants' home comfort-making behaviours. Several behaviours at home are exercised to achieve comfort (such as cooking, bathing, watching TV, reading, working, digital entertainment, etc.) and several of these activities consume electricity or gas (Ortiz and Bluyssen 2018; Ortiz, Kurvers, and Bluyssen 2017; Aune, Ryghaug, and Godbolt 2011). Consequently, it is important to investigate such behaviours but also the motivations and intentions behind them.

A past study that aimed at understanding such motivations was performed by Ortiz and Bluyssen (2018 and 2019). The authors developed a questionnaire to better understand personal differences of comfort-making behaviours and the influence of those behaviours in energy consumption (Ortiz and Bluyssen 2018). The present study complements those results with further qualitative data.

The aim of this study is to better understand home occupants' unconscious models about two subjects: energy use in their homes and their ideal home experience. Specifically, this research will explore the home occupants' 'interpretive knowledge' regarding comfort (ideal home experience) and energy use in their homes. Eliciting this type of knowledge allows to further complete and improve with qualitative data the previously found archetypes. The qualitative data in this study is gathered from their more concealed needs, as opposed to process knowledge data that was elicited in the interviews of the previous study (Ortiz and Bluyssen 2019).

Interpretive knowledge is a type of knowledge that is gained in functional contexts and is shaped by the subjectivity of the person experiencing the contexts. In other words, it is the way in which a person interprets experiences and the objects of experiences, through their emotions and intuitions (Bogner, Littig, and Menz 2009). An effective way of tapping into interpretive knowledge is with the use of generative techniques. Generative techniques are methods in which participants generate artefacts through the aid of visual stimuli. By avoiding initial verbal explanations – such as in interviews-generative techniques allow expressing knowledge that is more difficult to express. Figure 1 shows the way in which data from a certain type of knowledge can be gathered.

The study performed by Ortiz and Bluyssen (2018 and 2019) involved a questionnaire to assess the psychological motivations behind comfort behaviours of home occupants. The variables comprising the questionnaire evaluated the constructs of emotions towards their home environment, locus of control in their home, comfort affordances (home features needed for the occupant to create comfort), and attitudes towards energy. Seven hundred and sixty-one participants responded to the questionnaire and the data was analysed with the TwoStep cluster method. The method groups

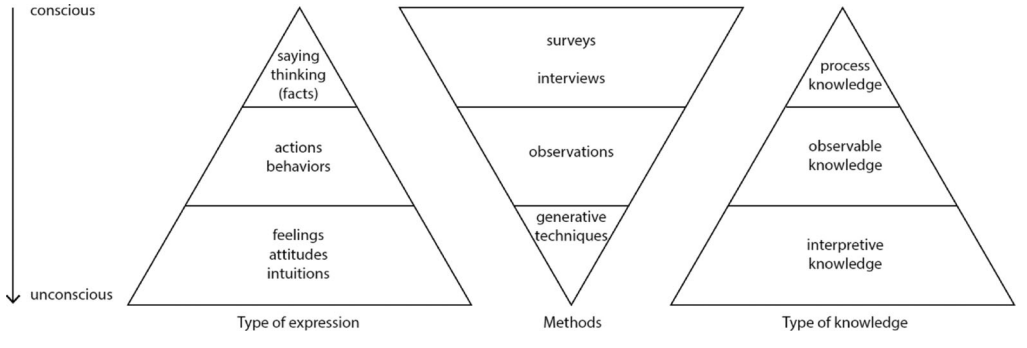

Figure 1. Knowledge levels and respective eliciting methods (adapted from Bogner, Littig, and Menz 2009; Visser et al. 2005).

respondents into similar responses and produces an output in the form of clusters (Norušis 2012). Five statistical clusters were determined, which were then substantiated with the data from a field study (Ortiz and Bluyssen 2019). In this field study, fifteen of the questionnaire respondents were interviewed, the IEQ parameters of their home were measured, an energy-related building checklist of their home was filled out, and actual energy readings were taken. The results were integrated into those of the clustering analysis to complete the clusters and to create archetypes.

The final archetypes that were found in that previous study were named as follows: Restrained Conventionals, Incautious Realists, Positive Savers, Sensitive Wasters, and Vulnerable Pessimists (Ortiz and Bluyssen 2019). Table 1 shows the key characteristics of the archetypes.

Materials and methods

To tap into the interpretive knowledge, focus groups were developed with projective activities (such as collage making, adopted in this study) drawn from techniques used in clinical psychology. Such projective techniques typical require to ask participants to interpret visual stimuli or use different visual cues to answer questions. The objective of these techniques is to bypass conscious defences and gather the tacit knowledge; therefore, the participants can provide unchanged views of their feelings and attitudes, which is not possible with more direct questioning. For the creative process, these aforementioned projective techniques drawn from clinical psychology have been used as they enable researchers to gain information that would otherwise be filtered through the participants' social desirability bias (Boddy 2007; Hibbard 2003).

Table 1. Key archetypal characteristics according to cluster analysis and field study.

Archetype name	Data source	Summary of results
Archetype 1: Restrained Conventionals	Questionnaire data	Low positive emotions, high negative emotions
		High external control, and low internal control
		Medium sensitivity
	Field study data	Second highest saver
		Positive sentiments of energy, control, comfort, but neutral about affordance needs.
Archetype 2: Incautious realists	Questionnaire data	Low positive emotions and highest negative emotions.
		High external control and lowest internal control
		Doesn't care about affordances
	Field study data	Second highest waster
		Negative sentiments about comfort, positive about energy, affordances, and control.
Archetype 3: Positive savers	Questionnaire data	Second Highest positive emotions and lowest negative emotions.
		Lowest external control, and high internal control
		Slight affordance indifference
	Field study data	Highest energy saver
		Positive sentiments about affordances and comfort, negative about energy and control
Archetype 4: Sensitive wasters	Questionnaire data	Highest positive emotions, second lowest negative emotions
		Low external control, and highest internal control
		Affordances are very important
	Field study data	Highest waster of all
		Negative about energy, ambivalent about affordances, and positive about control and general comfort.
Archetype 5: Vulnerable pessimists	Questionnaire data	Lowest positive emotions, high negative emotions.
		Highest external control, low internal control
		Affordances are not important
	Field study data	Third highest waster
		Positive about comfort and control, ambivalent of energy and affordances.

Participant selection

Participants in this study were selected from the respondents who had taken part in the proof-of-concept study (Ortiz and Bluyssen 2018). From October 2016 to October 2017, links to a survey were sent to different types of participants. Respondents volunteered to participate in the focus groups as a follow-up to the questionnaire by providing their email addresses. Seventeen participants, consisting of eight women and nine men, were contacted and took part in the focus groups. Generally, they were in their last year of their masters studies and a few were in their bachelors. Ages ranged between 22 and 31 and they resided in Rotterdam, Delft, and The Hague in the Netherlands.

Procedure

As suggested by Visser et al. (2005), we divided the focus group study into a sequence of three research phases: sensitization, sessions, and analysis.

Sensitization

Sensitization is a process that gradually immerses the participants into the topics of the focus group. According to Visser et al. (2005) sensitization triggers the participants to start reflecting, cogitating, pondering, and exploring features of their personal experiences in their own environment. In order to achieve this, the sensitizing package which contained a booklet, pencils, markers, stickers with words, and an information sheet explaining the goal and purpose of the research was distributed to the participants one week before their corresponding sessions. The booklet (refer to the Appendix) contained seven short daily activities to ease them into the context: introduction about themselves, word associations with comfort, three-day activity diary, and 'memory-work' writing activity; in which they wrote about their most significant stress-free related memory. The objective of this phase is to let participants start accessing their experiences about topics that they normally do not think about, so that the quality of the data produced during the sessions is wider and deeper.

Sessions

The sessions took place in the Multisense Lab in the faculty of Industrial Design Engineering of the institution in which it was performed, from November 2018 to December 2018. The Multisense Lab consists of an observation room and a control room. The observation room is equipped with

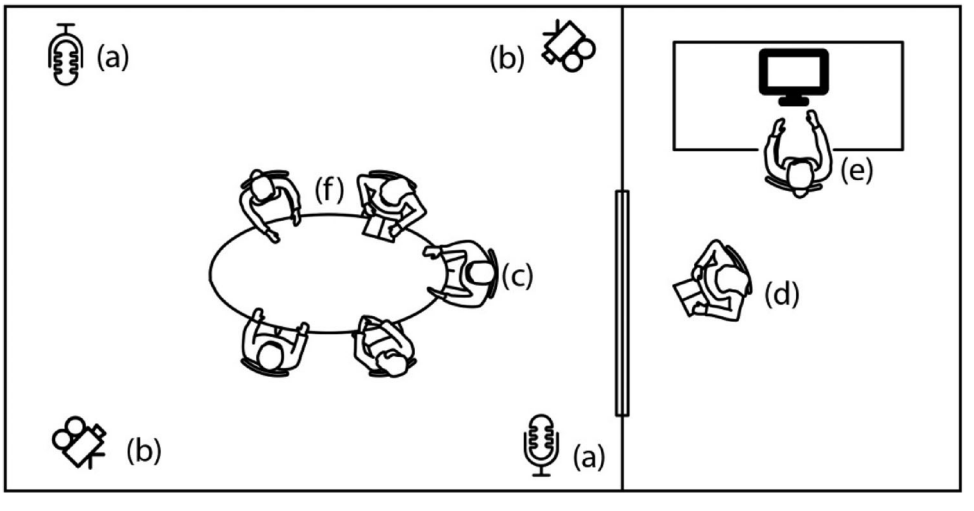

Figure 2. The floor plan of the Multisense lab: observation room and the control room (a) microphones, (b) cameras, (c) moderator, (d) observer in one-sided mirror, (e) camera controller, (f) participants).

microphones, cameras, and a one-way mirror (to the control room), which allowed facilitator to record the sessions and take observation notes from the control room (see Figure 2).

The sessions were moderated by a facilitator with prior experience in focus groups. Two more researchers were taking notes and controlling the technical aspects of the session from the control room (camera panning, zooming, volume setting, time tracking), which was connected via the one-way mirror. As Table 2 shows, each session lasted approximately one hour and half. The duration of each task was checked by a pilot session with researchers from the Chair Indoor Environment. Before the session started, all participants were given a consent form to sign, informing them about the recording of the session and that if they felt uncomfortable, they could cease their participation.

During the sessions, participants were asked to produce two separate collages: (1) 'Meaning of energy use at home' and (2) 'Ideal home Experience'. Collages were chosen as a method that allows participants to express experiences through pictures and words, rather than verbalizing them. The method is particularly effective in eliciting interpretive knowledge (Sanders and William 2003).

Participants were provided with a collection of photos, pictures, newspapers, magazines, journals, and materials for joining and linking (Velcro, glue, staples, tape); colours, markers, glittery tape, coloured and corrugated cardboard, chenille, sticky notes, differently-shaped stickers, and felt. The materials were the same or similar for each of the sessions. For each collage activity in the same session, a different package of materials was provided, to not repeat the stimuli. Magazines with indoors or home pictures were avoided to prevent from leading the participants into certain ways of thinking. Participants were given an A3-cardboard canvas on which to create the collage. The instructions were given as follows: 'Here are various materials and visual stimuli. Try to use them in any way you want to express what it means to you to use energy at home / what the ideal home experience for you is. You have up to 20 min. Please do not talk with the other participants during the activity.' If participants requested to have extra time, it was granted. Participants were given maximum freedom, the moderator only stayed in the room during the first and last 3 min of the activity; the rest of the time, the moderator observed the participants from the observation room. If participants seemed stuck or had questions, the moderator would return to the session room to clarify.

The study was reviewed and approved by the ethics approval committee of the research institution in which it was performed.

Data analysis

After each session, a diverse range of qualitative data was collected: verbal protocol (audio and video) and artefacts (collages). The collages corresponded to stories, tales, and narratives related to comfort at home and the meaning of energy use. As a result, collages and verbal protocol were qualitatively analysed together as (a) verbal protocol and (b) artefact analysis in a seven-step process (Figure 3).

Table 2. Timetable of the group session.

Duration [minutes]	Activity	Details
0–5	Introduction	Explaining set-up session, goals and emphasizing that they are experts of their own experiences.
5–25 (4 per participants)	Warm-up – story/thoughts	Participants introduce themselves and the booklet story.
25–30	Introduction to collages	Explanations of what collages are, their purpose. Providing materials.
30–50	Meaning of energy use at home	Production of collage of the Meaning of Energy Use.
50–60 (2 per participants)	Presentation	Each person explains and presents the artefacts.
60–70	Break	Snacks and refreshments. Arranging table and materials for next exercise.
70–90	'Ideal home Experience'	Produce collage of an 'ideal home experience.'
90–100	Presentation	Each person explains the artefacts.
100–105	Wrap-up	Thank you and final remarks

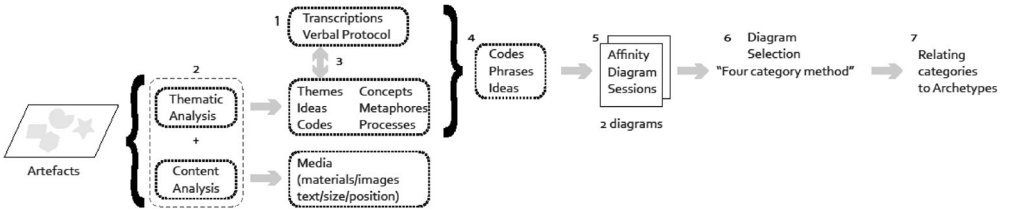

Figure 3. Seven-step analysis process.

Transcriptions

First, an investigator produced verbatim transcriptions from the session speeches. Then each collage explanation was analysed according to Polkinghorne and Arnold (2014) by using the recursive abstraction approach (Hershkowitz, Schwarz, and Dreyfus 2001; Polkinghorne and Arnold 2014). This technique allows reducing and condensing the verbal data into codes, phrases, and ideas, giving the possibility of identifying patterns within the data that would otherwise not be easy to identify. To reduce the verbal data into codes, five steps are required: 1 – after transcription of the answers, the main parts of the answer are highlighted. 2 – the highlighted data is transferred to a table with question topics on the left, and the highlights on the right. 3 – highlighted data is abridged so as to make more manageable. 4 – if possible, questions are combined on similar topics, creating themes. 5 – responses are coded by condensing the data into keywords, as codes are easier to compare than sentences.

Content and thematic analysis

The collages were analysed with the content and thematic analysis approaches (Crowe, Inder, and Porter 2015; Vaismoradi, Turunen, and Bondas 2013). Both content and thematic approaches are suitable to analyse exploratory data in fields in which information is scarce (Vaismoradi, Turunen, and Bondas 2013). The content analysis is a descriptive and quantifying analysis of the artefact, while the thematic analysis takes an interpretive and qualifying angle. The content analysis shows what type of materials, media, and physical visual objects the participant chose to express his or her experiences. The thematic analysis is done in conjunction with the transcriptions, and it allows understanding the symbolic meaning, concepts, feelings, experiences, ideas, stories and themes, that the participant is expressing (Stappers and Sanders 2003; Sanders and William 2003; Sanders and Stappers 2008).

To conduct the content analysis, every element of each collage was thoroughly described by dividing the description into four parts as shown in Table 3.

Subsequently, the thematic analysis was performed in a similar fashion, per object on the collage. The parts extracted in the thematic analysis are shown in Table 4. Once the content and thematic analyses were finalized, two pieces of data were used for the subsequent step: the words and phrases under the 'theme or idea represented' and the 'participant explanations'. These were transferred into a spreadsheet, and combined with the codes of the recursive abstraction from the transcripts of the verbal protocol. This spreadsheet was a list of codes, phrases, and ideas, reflecting the participants' experiences, and they were used as tags for the next part of the analysis, finally, global frequencies as well as per archetype were produced.

Affinity diagrams

When the codes are produced, they are made into physical tags to create affinity diagrams. An affinity diagram is a tool that allows organizing large numbers of qualitative ideas and data into groups in order to see the natural relations between pieces of data (themes or explanations) pertaining to two or more topics; in this case, the two topics were the meaning of using energy at home and the ideal home comfort experience.

Table 3. Content analysis description.

Content Analysis	Characteristics
Media used on the collage	Materials, images, written text, shapes
Position, Size and Shape.	Size of the objects, position on canvas
Description of image	Description of what the object is
Category of the description	What type of thing is objectively shown (i.e. nature, humans, food, etc.)

Two sessions were required to produce a final diagram with the final categories. In order to select one of the two diagrams for further inspection, the 'four-category method' was used as described by the Interaction Design Foundation (Dam and Siang 2018). This method requires the two resulting diagrams to be rated based on objectivity and concreteness, so as to avoid unrealistic or improbable categories. This is done by rating the diagrams categories and sub-categories with a 4-point scale from the least concrete to the most concrete. The diagram of the first session was chosen as it had more concrete categories.

Finally, the factors of the affinity diagram were associated with the archetypes to which the participants belonged. This was done by referring the individual pieces of data making up the affinity diagram's sub-categories back to the contents of each of the artefacts.

Table 5 presents an overview of the three research phases in this study, along with their purpose, methods, materials, and other characteristics.

Results

Thematic analysis

Thematic analysis yielded 74 codes in the 'ideal home experience' topic, while the most common factors amongst all of the archetypes were 'nature', 'social interaction', 'connectedness', 'food', 'safety', 'space', 'furniture' and 'freedom'. For the 'meaning of energy use at home', there were 58 codes for all participants. Tables 6 and 7 show the ten most recurring codes for each archetype for 'the meaning of energy use at home' and 'the ideal home experience', respectively. The tables suggest that archetypes have different mental models regarding the two topics, in terms of what they value higher for such topics. However, it can be seen that there are still collectively shared values and needs, especially in terms of nature, energy, comfort, and control.

Affinity diagram categories

The affinity diagram (Figure 4) produced two categories: the occupant-related category (divided into behavioural sub-categories and psychological sub-categories) and the building-related category (subdivided into home sub-categories, financial aspects, and energy sub-categories). In total there are 24 factors making up the sub-categories. One 'uncategorized' factor was also included with codes that did not belong to any of the sub-categories.

Charts were produced for the two topics of the collages. Figure 5 shows how frequently a code belongs to an archetype for the 'Meaning of energy use at home' and Figure 6 shows it for the 'Ideal home experience'. They show the percentages that a code, phrase or idea is mentioned by

Table 4. Thematic analysis description.

Thematic Analysis	Characteristics
Theme or idea represented	Main theme or idea as the participant explained of the object
Processes represented	Processes represented by the object
Metaphors or symbols	Whether the object is a symbol for another concept
Participant explanations (with transcripts)	Verbatim excerpts of transcripts for each object

Table 5. Three research phases in this study.

	Sensitization	Sessions	Analysis
Purpose	Enable participants to access their experiences about topics that they do not normally think about in order to enrich the quality of their data from the sessions.	To obtain participants' interpretive knowledge of 'Meaning of energy use at home' and 'Ideal home experience'	To interpret qualitative data that were obtained from the recorded audio and from the collages and to link to the five archetypes.
Method	Conducting short daily activities for seven days (see the Appendix)	Production of two collages (A3 size) per participant and verbal explanations of their productions (see the Appendix)	Transcriptions, Content analysis, Thematic analysis and affinity diagrams
Materials	A booklet, pencils, makers, stickers with words and an information sheet	A collection of photos, pictures, newspapers, magazines, journals, and stationaries	
Duration	1 week	Approximately an hour and a half (see Table 2 for more details)	
Location	No particular location was set (preferably at home)	An observation room of the (name of the lab) at TU Delft (see Figure 2)	
Timeline	Started 1 week prior to their corresponding sessions	November 2018 to December 2018	

an archetype: the frequency (percentage) is interpreted as the meaningfulness or the need of the theme for the specific archetype.

Figure 5 shows when using energy at home, archetype 1 expressed experiences mainly related to the factors personal space, neutral energy concepts, and having positive emotions in their homes. Archetype 2's main concerns are related to factors of aesthetics, location, and feeling safe. The highlights of the experience of archetype 3 in regards of energy use concern factors of cleanliness, maintaining control, and doing activities in the home. Archetype 4's meaningfulness lies in experiences regarding factors of control, using the lights, and a concern for wasting energy. Finally, Archetype 5 expressed mainly ideas concerning factors of social interaction, lifestyle principles, and the use of lights as highlights when using energy.

For the 'Ideal Home Experience' (Figure 6), the factors of home aspects are important for Archetype 2; 3; and 5. Specifically, archetype 5 shows highlights with 'home features and décor', 'aesthetics', 'contact with nature', and 'size and layout'. Archetype 2 finds important 'areas and zones', 'lights', and 'size and layout'. Archetype 3 expressed value in the 'location of the home' and a need for 'outside view'. Archetype 4 values 'softness' and 'outside view' and Archetype 1 values the same ones. Archetypes 3, 2, and 1, regard the financial aspect with an important role in the ideal home experience.

In energy aspects, archetype 5 has technology as an important need for an ideal home experience, as well as having renewable energy sources. Archetype 2 is concerned with the drawbacks of using energy, and Archetype 4 would prefer to have renewable energy sources.

Table 6. Percentage frequency of ten most recurring codes for 'meaning of energy use at home' per archetype.

Archetype 1		Archetype 2		Archetype 3		Archetype 4		Archetype 5	
Code	%	Code	%	Code	%	Code	%	Code	%
Nature (conserving)	9.3	Energy	9.6	Lack of control	17.4	Energy	9.5	Lights	5.9
Forces of nature	8.0	Scale (large)	5.2	Lost	13.0	Costs	7.1	Relaxing	5.2
energy	6.7	Comfort	4.3	Control	13.0	Controlling	7.1	Entertainment	5.2
Saving planet	5.3	Waste	3.5	Awareness	13.0	Comfort	7.1	Energy	4.4
Water use	4.0	Use	3.5	Powerlessness	8.7	Sustainability	4.8	Breeze	4.4
Time	4.0	Future	3.5	Chaos	8.7	Discomfort	4.8	Wasting	3.7
Feeling	4.0	Worry	2.6	Watching	4.3	Wrong	4.8	Nature	3.0
Environment	4.0	Nature	2.6	Taking care	4.3	Warming	2.4	Water	2.2
Battle	4.0	Electricity	2.6	Caring	4.3	Turn	2.4	Using	2.2
Watched (being)	2.7	Vision	1.7	Action	4.3	Quick pleasure	2.4	Night	2.2

Table 7. Percentage frequency of ten most recurring codes for 'the ideal home experience' per archetype.

Archetype 1		Archetype 2		Archetype 3		Archetype 4		Archetype 5	
Code	%	Code	%	Code	%	Code	%	Code	%
Nature	10.8	Nature	8.2	View	9.7	Privacy	7.7	Nature	8.4
Rest	6.2	Freedom	4.9	Minimalism	9.7	Spacious	5.8	Connectedness	5.0
Food	6.2	Space	4.1	Urban	6.5	Furniture	5.8	Love	3.4
Cosy	6.2	Social	4.1	Sharpness	6.5	Artistic	5.8	Colours	3.4
Aesthetics	6.2	Interaction	4.1	Investment	6.5	Worriless	3.8	Automation	3.4
Interaction	4.6	Small	3.3	industrial	6.5	Travel potential	3.8	Social interactions	2.5
Furniture	4.6	Food	3.3	Connectedness	6.5	Sustainable	3.8	Pets	2.5
Entertainment	4.6	Closeness	3.3	Central	6.5	Stress-free	3.8	Water natural	1.7
Connectedness	4.6	Water	2.5	Artistic	6.5	Safety	3.8	Sustainable	1.7
Social	3.1	Safety	2.5	Vegetables	3.2	Relax	3.8	Stargazing	1.7

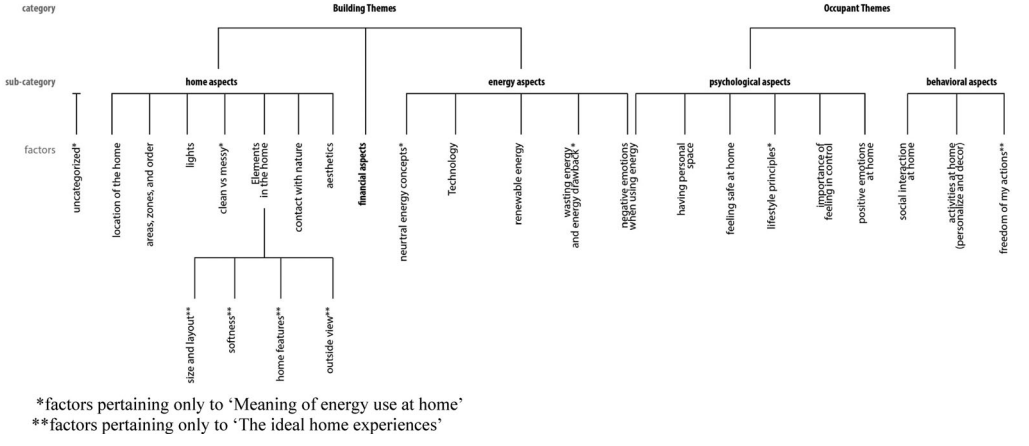

Figure 4. Categories, sub-categories, and factors of affinity diagram. *factors pertaining only to 'Meaning of energy use at home'. **factors pertaining only to 'The ideal home experiences'.

For the psychological aspects, archetype 4 expressed the importance of feeling in control, personal space, and safety. Archetype 2 regards safety highly, and all archetypes want to have positive emotions in their future homes. For the behavioural aspects, Archetype 2 needs freedom of actions, and Archetype 1; 4; and 5, need to be able to do the activities they like, like hobbies.

Supporting Figures 4 and 5, is Table 8 presenting for each archetype the main factor of importance for each of the five subcategories (home aspects, financial aspects, energy aspects, psychological aspects, and behavioural aspects) in terms of their combined home experience (using energy and ideal situation).

Discussion

Implications and relevance

Generative techniques are a useful method to gain knowledge from users that would otherwise not be possible to elicit through questionnaires or interviews. As is the case with qualitative techniques, large amounts of data are produced, and need to be processed pertinently. The value of analysing the data with the affinity diagram technique is that it allows assimilating large amounts of qualitative data produced on the focus groups, and to see new patterns and groups in it. Some of the connections that appeared are the following: 15 of the 25 factors overlap between the two topics (location of home; areas, zones, order; lights; contact with nature; aesthetics; financial aspects; technology; renewable energy; negative emotions when using energy; importance of personal space; feeling

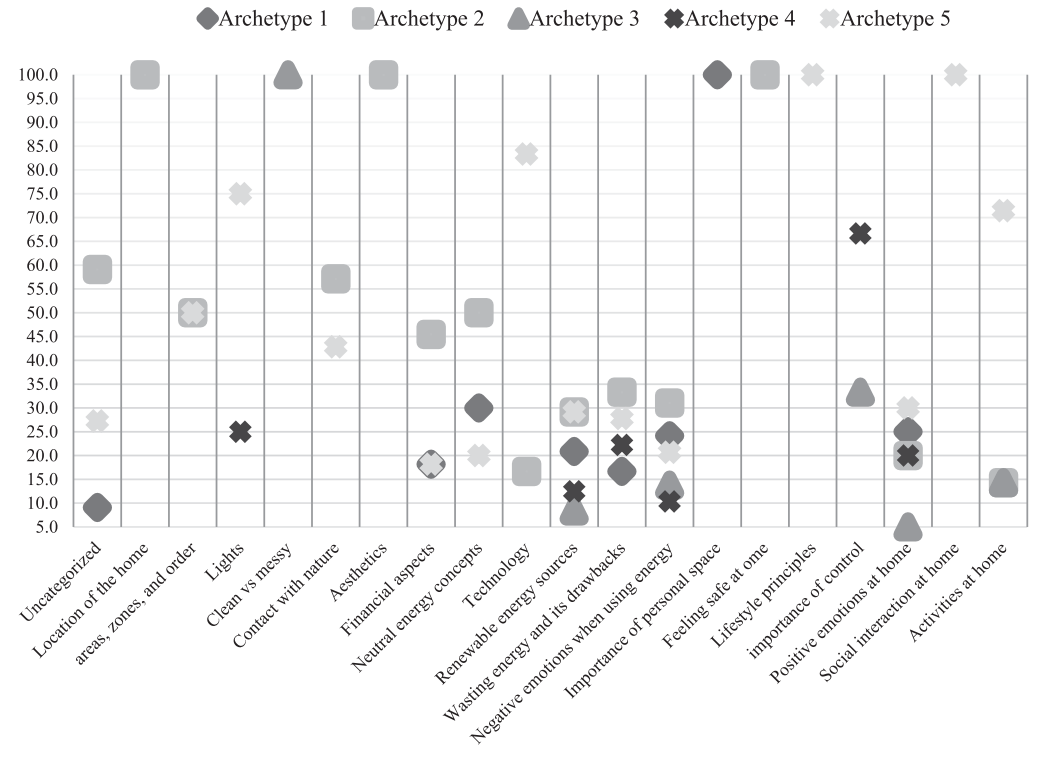

Figure 5. Results 'Meaning of energy use at home'* per archetype in percent. *1: home aspects; 2: financial aspects; 3: energy aspects; 4: psychological aspects, 5: behavioural aspects.

safe at home; importance of control; positive emotions at home; social interactions at home; and activities at home). The factors that only pertain to the meaning of energy use at home are 'neutral energy concepts'; 'wasting energy and energy drawbacks', 'lifestyle principles', 'cleanliness and messiness'. While the factors that only belong to the 'ideal home experiences' are: elements of the home (comprising size and layout, softness, home features, and outside view), and freedom of my actions at home.

Building upon the questionnaire results and the field study results from Ortiz and Bluyssen (2019), where text mining from interviews, environmental monitoring, actual energy use readings,

Table 8. Number one factor per archetype for the five subcategories.

	Subcategory				
	Home	Financial	Psychological	Behavioural	Energy
Archetype					
Archetype 1: Restrained Conventionals	Outside view	Medium concern	Importance of personal space	Importance of social interaction	Neutral energy concepts
Archetype 2: Incautious realists	Size and layout	High concern	Feeling safe at home	Freedom of my actions	Neutral energy concepts
Archetype 3: Positive savers	Cleanliness and orderliness	Not concerned	Importance of feeling in control	Activities at home	Renewable energy sources
Archetype 4: Sensitive wasters	Softness	Low concern	Importance of feeling in control	Activities at home	Wasting energy and its drawbacks
Archetype 5: Vulnerable pessimists	Home features and décor	Low concern	Home matching one's lifestyle principles	Activities at homme	Using technologies

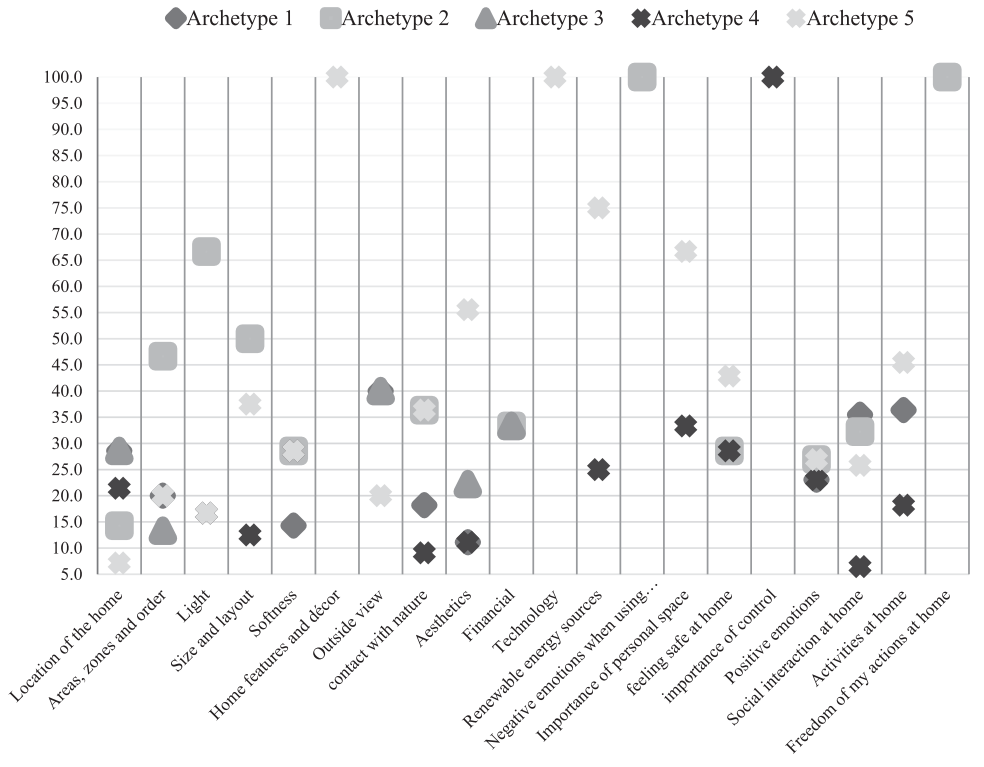

Figure 6. Results 'Ideal Home Experience'* per archetype in percent. *1: home aspects; 2: financial aspects; 3: energy aspects; 4: psychological aspects, 5: behavioural aspects.

and building characteristics checklists were performed, and the results of the generative techniques, the following archetypes are presented:

Restrained Conventionals (archetype 1) are the largest archetype as of the results of the cluster analysis. In this study, they relate the meaning of energy use at home particularly to the drawback of wasting energy and the negative emotions when using energy, and the fact that the use of energy is done at the expense of nature and the environment. In the second collage of the 'ideal home experience', they expressed three main needs for the future: social interaction, contact with nature, and being able to do certain activities at home. In the previous study, they reported higher-than-average positive emotions, high external control, and low internal control; while expressing positive attitudes about energy and sense of control during the interviews, but neutrality about comfort needs. Energy reading averages showed that they are the second largest saver.

Incautious Realists (archetype 2) described their experience mainly with 'neutral energy concepts' and they tend to focus on the future of energy use by observing future possibilities of cleaner energy. For the ideal home experience, their main ideal future need is a home with contact with nature, in which social interaction is possible, and with the right size and layout. In the previous study, the outcomes show that they have high negative emotions about their homes; they score lowest in internal control, and high in external control. Yet, during interviews, they expressed positive attitudes for affordances and psychobehavioral topics of home comfort (using appliances, feeling in control). On average, the energy readings showed that they are the second largest wasters.

Positive Savers (archetype 3) recall mainly the negative emotions about using energy, but also propose that using renewables can bring a more positive experience. Furthermore, for the ideal home experience, they put more emphasis in a need for aesthetics of the home and the location in which it is found. In the questionnaire study, it is shown that they have the second highest ratings

for positive emotions and lowest in negative; lowest external control and second highest internal. In interviews, they expressed positive attitudes for affordances, and negative ones about comfort and energy. Energy readings reflect them as the least consuming of all groups.

The Sensitive Wasters' (archetype 4), past experience deals mainly with the drawbacks of wasting energy and with the financial side of using energy. For the ideal home, they have a higher value for feeling positive emotions in general in their future home, which should also be a place where they have their own privacy. According to the previous study, they have the highest scores in positive emotions and second lowest in negative ones. Similarly, they have the highest internal control and the second lowest external control. In the interviews, they expressed positive opinions about comfort and control of the environment but negative ones on energy awareness. Readings show them as the highest energy consumers of all the archetypes.

Finally, Vulnerable Pessimists (archetype 5) generally express that using technologies in the home is the main experience of energy use and, that such technologies allow for improved standards of living. Their principal needs are to own a home where they have contact with nature and that allows for social interaction. They have, according to the cluster analysis, the lowest scores in positive emotions about the home, and second highest negative emotions. They also present the highest external control and second lowest scores in internal one. Interviewees generally expressed emotional ambivalence in energy awareness, control of environment, and affordances, but positive emotions with general comfort. According to their energy readings, they are the third largest waster.

Practical significance

The archetypes can be used in the energy engineering field for improved and more accurate simulation and building prediction models and outcomes. Furthermore, the occupants pertaining to a certain archetype can be invited to take part in co-creation sessions in the design process of systems, appliances, or interfaces, to design possible custom-made products or environmental features for each archetype. In other words, the specific characteristics of an archetype can be translated into design parameters (interfaces, products) that will support their mental models in a more energy-efficient fashion. This would then enable developing customized products or interfaces that will offer a more personalized comfort while saving energy. For the development of such user-centered products or systems, further analyses are needed such as brainstorming sessions, concept formulation, prototype building, etc. and eventually user-testing and iterative improvements the concepts to arrive to final designs customized for the archetype.

Finally, models pairing archetypes with specific environmental characteristics can prove interesting for architects, contractors, engineers, or housing associations in order to provide the specific archetype with the adequate features that will support more efficient behaviours, while maintaining customized comfort.

Strengths and limitations

One limitation of this study is that due to the number of participants, the results should be interpreted as case studies, rather than as representative of each archetype. Another limitation is the fact that all focus group participants were students and with no large age variations: for such a study it would be ideal to recruit different types of people from each archetype. In general, limitations that can occur in this type of research are the following. Although the technique is powerful and can produce invaluable data that cannot be accessed with any other method, it has also the risk of not producing the depth of data. Instead, shallow data can be obtained. Such a risk exists, particularly if the participants have not been sensitized to the topic beforehand. This can also occur if the participants do not feel at ease during the session and ready to share their emotional experiences with strangers or the moderators.

Conclusion

This is, to the knowledge of the authors, the first attempt to investigate the energy use at home and its relation to comfort, by using focus groups – and more specifically generative techniques – in a qualitative way.

This study shows how generative techniques can be a valuable tool for delving into the interpretive knowledge – the why's – of the behaviours and mental models of home occupants' past experiences and potential future wishes in terms of comfort and energy use. The study also shows how different home occupant archetypes have clearly distinct needs and how they give different meaningfulness to past experiences of using energy in their homes and to what an ideal home experience is. In particular, this data is valuable to complement quantitative data to strengthen home occupant archetypes. The aim of improving quantitative archetypes with qualitative data regarding energy and comfort, is to ultimately help engineers, architects, and designers to develop technologies that will support the archetypes' behavioural patterns, so that energy consumption reduction can be achieved, while maintaining or improving comfort and health levels.

The results of the present study show that each of the five archetypes has different mental models, different needs in terms of comfort, expectations, and different ways of understanding energy in their own homes. The findings of this study specifically show that for energy aspects, Sensitive wasters (Archetype 4) is concerned about wasting energy, Vulnerable pessimists (Archetype 5) about the technologies surrounding energy, while Incautious realists (Archetypes 2) and Restrained Conventionals (archetype 1) are neutral, and Positive savers (archetype 3) is focused on renewable sources. For behavioural aspects, freedom of action is important for Incautious realists (Archetype 2), while Sensitive wasters (Archetype 4) values social interaction and the rest of the archetypes put importance on the activities carried out at home. Psychological aspects, Vulnerable pessimists (archetype 5) values their lifestyle principles, Sensitive wasters (archetype 4) and Positive savers (archetype 3) having sense of control, Incautious realists (Archetype 2) finds feeling safe important, and Restrained Conventionals (archetype 1) needs personal space. In the home aspects category, Restrained Conventionals (archetype 1) needs view to the outside; Incautious realists (archetype 2) needs right size and layout, Positive savers (archetype 3) about cleanliness, Sensitive wasters (archetype 4) about softness of materials, and Vulnerable pessimists (archetype 5) about décor. Finally, only Restrained Conventionals (archetypes 1) and Incautious realists (archetype 2) find finances important. Understanding this information is a first step to implement lines of action at home or to design interventions tailored to the archetypes understanding of energy and needs of comfort. Finally, the use of generative techniques, in particular that of collages, seems to have been an appropriate technique; a technique that is normally used in the field of user-centered design, in order to better understand users' mental models. With the data gathered in this study, along the one collected in the previous studies, and with further analyses, it is possible to develop design concepts for each archetype, to offer them products that will satisfy their comfort needs while supporting their specific behavioural patterns.

Further developments that can be made by building upon the results of this study, is to reduce the entire process into a single questionnaire. The aim of that questionnaire is that it works as a tool that can be applied when retrofits to a home will be done, when new systems will be installed, or when new occupants will move in to a new home. it can be developed into a profiling tool that gives occupants a personal profile, a comprehensive report that explores behaviours and composite data regarding their comfort and energy mental models. It could help individuals such as architects, energy engineers, or industrial designers, to understand the motivations behind the occupant, to know which environmental features, types of feedback, or energy retrofits are best fitting to a certain archetype. Therefore, architects and contractors can be assisted by the knowledge of the archetypes they are designing for, to firstly, have a more inclusive design process, and to secondly, have more accurate solutions, answering real needs, thus removing eventual biases. Knowing occupant archetypes is advantageous for the housing industry, especially to reduce performance gaps with

retrofitting or for the design of future buildings. They can allow to produce more accurate energy use prediction models. In the existing housing stock, environmental features as well as elements of energy retrofits can be customized to best fit the type of occupant.

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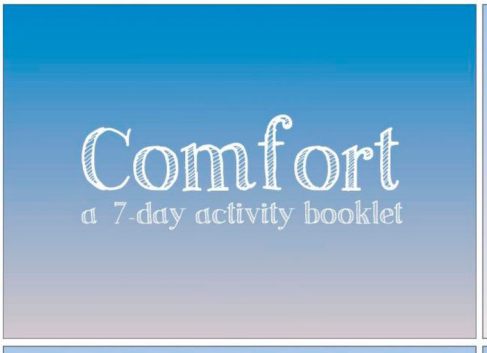
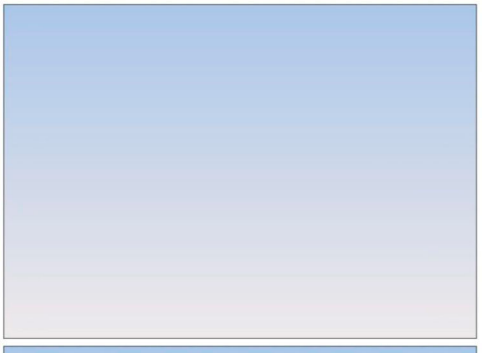
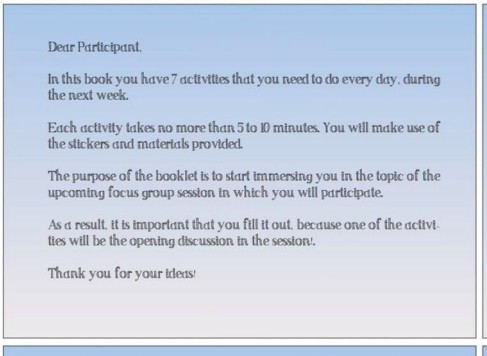
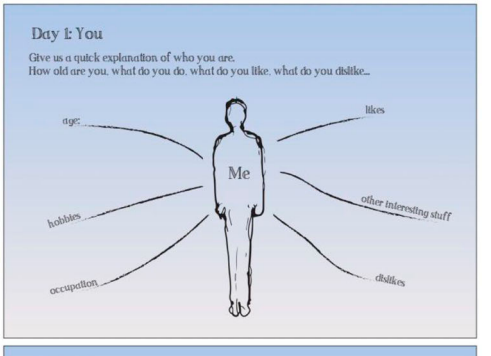
Appendix:

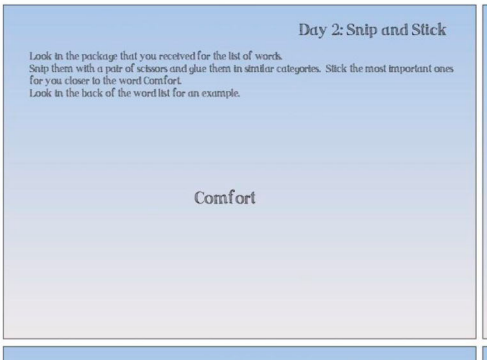
sensitizing booklet

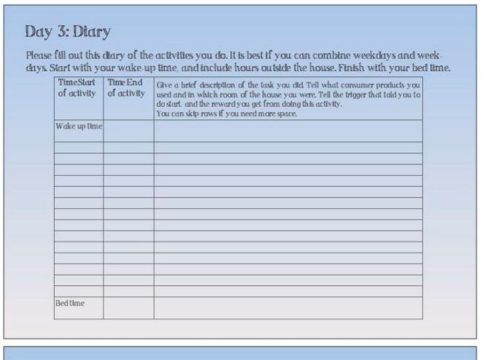


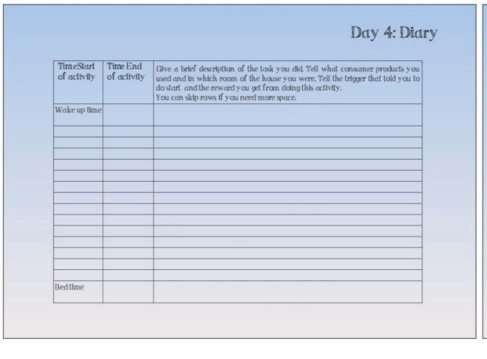


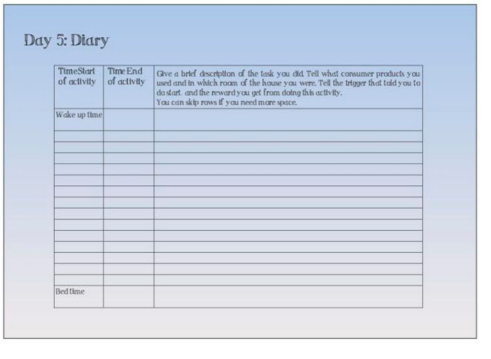












Day 6: Comfort

Have a look at the activities of your diary, and think which ones of those are comfort related activities.

Day 7: Storytelling

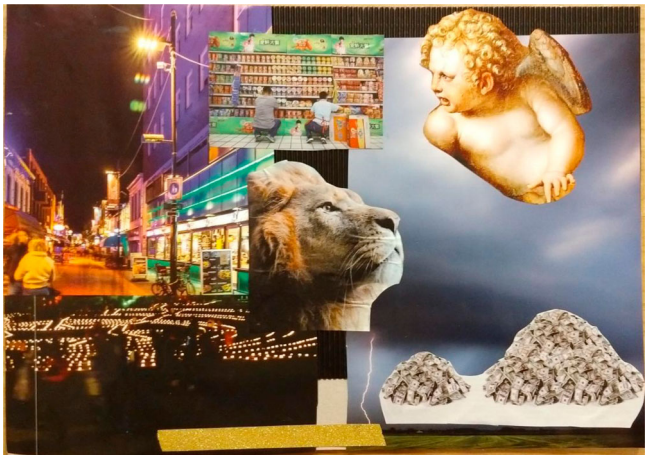
Please write down a particular episode/routine/action/event of your recent or distant past, that you associate with being comfortable. Write it in the 3rd person (he or she). Be as detailed as possible, but describe it as an outsider. Explain in detail about the context: when does it happen, what do you use, who else is there, what triggers it, how is the full process. Focus on the emotions you feel as the event unfolds. Drawing a timeline can be useful.
You can support your story with drawing, images, or stickers.

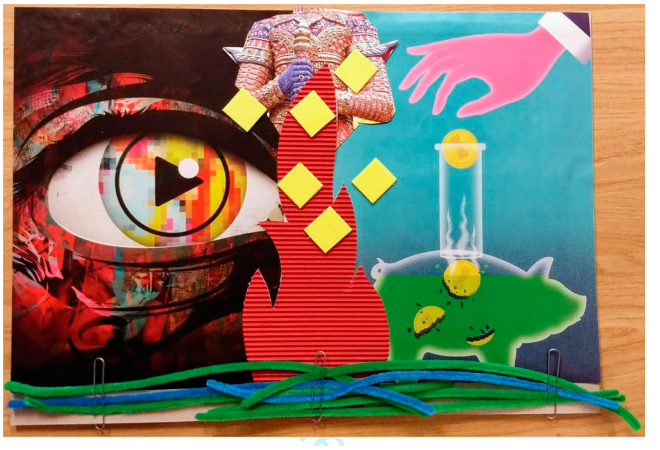
Thank you for your time!

Please bring the booklet and the rest of the materials to the session!

TU Delft Delft University of Technology

Example ‘meaning of energy use at home’.





Example ‘ideal home experience’