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## Introduction

Neonatology is a subspeciality of paediatrics that focuses on the neonatal period (Chen, Oetomo, & Feijs, 2010), understood as the period extending up to 46 weeks' postmenstrual age. This period is particularly important because of its impact on the way children develop and their subsequent quality of life as adults (Stevenson & Cooke, 1998), and doubly so in the current situation of longer life expectancy and greater demands on health services (Guerra de Hoyos & de Anca Contreras, 2007). The neonatology service is provided in the neonatology unit. The unit provides assistance with birthing and reanimation. It covers healthy newborns and neonatal patients (Rite Gracia et al., 2013), who (especially premature babies) are particularly dependent and vulnerable to the background which supports their physiological and neurobehavioural organisation (Blackburn, 1998). Users of the unit are health staff, neonatal patients and their parents and other family relations. **The importance of the service and the wide variety of users, each with their functional and emotional needs, place great demands on the space at all levels.**

Many of these demands, however, are not always met. For example, some studies show that the stress inherent in this type of scenario can cause long-term damage to health if it is moderate and continuous, as in the case of the hospital staff (Cohen, Tyrrell, & Smith, 1991; Fliege et al., 2005); it has negative consequences for recovery, of chronically ill patients, anticipating painful processes (Ward, Brinkman, Slifer, & Paranjape, 2010), and of temporary patients separated from their parents in an unfamiliar environment (Jessee, Wilson, & Morgan, 2000; Yip, Middleton, Cyna, & Carlyle, 2009). Furthermore, numerous studies highlight problems stemming from environmental factors, for example, excessive noise (Jonckheer, Robert, Aubry, & De Brouwer, 2004), inadequate lighting (Blackburn, 1996; Robinson, Moseley, & Fielder, 1990) and insufficient hygiene (Dicko-Traore et al., 2011). Excessive noise has a negative impact on newborn behaviour, altering sleep and causing agitation and crying (Blackburn & Vandenberg, 1993; Thomas, 1995; Zahr & de

Traversay, 1995), and at physiological level, it increases intracranial pressure and reduces oxygenation (Long, Lucey, & Philip, 1980). Inadequate lighting negatively affects growth and development (Blackburn, 1998); and lack of hygiene causes numerous nosocomial infections, increasing morbidity and mortality and costs (Pittet, Allegranzi, & Widmer, 2008). It therefore seems clear that neonatal departments can be improved by designing the areas to fulfil users' physical and utilitarian needs (Rite Gracia et al., 2013). It is also essential and possible for that design to support their emotional needs as well (Leather, Beale, Santos, Watts, & Lee, 2003). These issues must therefore be resolved in order to deliver quality health care (Lawson, 2010).

With the progress in medicine and applied technologies, technical solutions have provided substantial improvements to satisfy users' physical and medical needs. Some of these improvements include technical standards and protocols that regulate space-related aspects from a medical perspective (e.g., Rite Gracia et al., 2013; White, Smith, & Shepley, 2013; for a review see García del Río et al., 2007). In addition, there have been numerous design-led efforts to develop patient-focused health care models (Schattner, Bronstein, & Jellin, 2006). Patients record their experiences (Britto et al., 2004; Grol et al., 2000) or how they use the space (Battisto & Allison, 2008), so this information can be used to design health care services (Christenson et al., 2010; Coad & Coad, 2008; Moules, 2009). This process can also adopt an iterative design and correction procedure to refine the design and reduce costs by avoiding changes at advanced stages of execution (Nielsen, 1993). It has been used in particular to address the utilitarian needs of adult (Dijkstra, Pieterse, & Pruyn, 2006), and adolescent patients, as well as children and newborns (Boswell, Finlay, Jones, & Hill, 2000; Eisen, Ulrich, Shepley, Varni, & Sherman, 2008). Focusing on paediatric patients, this type of research provides recommendations like providing parents with overnight stay facilities (bedrooms or suitable chairs) so they can become more involved in the treatment (Vavili, 2000); increasing the sensation of control over the health care process to reduce

the family's stress (Acton et al., 1997); satisfying the need for privacy in adolescence (Wolfe & Laufer, 1974) with measures for increasing children's perceived intimacy in bathrooms and permitting access to audiovisual and online content (Blumberg & Devlin, 2006). The use of technical and utilitarian solutions to resolve functional aspects is immensely important and numerous contributions have helped to improve healthcare services.

**However, less attention has been paid to the more purely emotional aspects of the environment.** Studies show that physical and psycho-social aspects of the environment interact on the sensation of wellbeing (Evans, Johansson, & Carrere, 1994), and may alleviate or worsen existing psychological stress (Leather et al., 2003). This relationship is paramount in health care spaces, where it has been found that stress associated with the stay stems not only from the illness itself (Cohen & Lazarus, 1979), but also from adaptation to an unfamiliar environment (Shumaker & Reizenstein, 1982). Thus a project that takes into account the patient's need for comfort through its design characteristics can mitigate the sensation of stress during a hospital visit (Zimring, Carpman, & Michelson, 1987), and inappropriate design can contribute to anxiety (Ortega-Andeane, 1991); especially in the case of children who are particularly sensitive to the situation they find themselves in when in hospital (Blumberg & Devlin, 2006).

Increased interest in the emotional dimension of hospitals in recent years (Blumberg & Devlin, 2006) is clear from the portrait of the way these environments have evolved (e.g., Devlin & Arneill, 2003). Although such studies are largely based on self-reports, other more in-depth approaches have been gradually incorporated (Blumberg & Devlin, 2006), such as Evidence-Based-Design (Ulrich, Quan, Zimring, Joseph, & Choudhary, 2004). This approach links architectural design parameters to user responses, and has been profusely applied in the area of hospitals (Leather et al., 2003) since Roger Ulrich presented the influence of surroundings on patient wellbeing and recovery. Findings from studies that focus on the emotional experience include, for example, a

relationship between number of windows and wellbeing (Verderber, 1982); scenes visible from rooms and anxiety in open-heart surgery patients; and the design of rooms, lobbies, operating theatres and corridors from the perspective of adolescents' preferences (Blumberg & Devlin, 2006; Ullán et al., 2012). Complete fulfilment of the needs of different patient profiles is therefore not simply a question of medical and utilitarian factors. Emotional factors must also be directly addressed, with particular attention to issues like stress (Evans, Crooks, & Kingsbury, 2009).

A common feature of these studies is that they usually evaluate patients' impressions through questionnaires or multiple choice tests; experts decide on the relevant attributes of the space and relate them to an analytical variable. This approach, however, means that the mental scheme of the non-expert may be distorted or not taken into account. This risk exists even when dimensions already defined from different stimuli or other geographical and time contexts are used. Although the results of these works are undoubtedly plausible and their approaches present certain specific benefits, studies using variables that reflect the affective and emotional mental structure of specific users are also needed.

**This study aims to identify the set of affective and emotional factors behind users' assessment of the space in a neonatology unit and to propose design guidelines based on these findings.**

This goal is broken down into four sequential objectives: (a) identify, from the qualitative perspective, users' needs in neonatal wards, in order to find the concepts for the next sub-objective; (b) identify the affective structure related to the description of these wards; (c) identify the influence at quantitative level, of the affective and emotional structure on the assessment of the space; and (d) identify the relevant design parameters in users' assessments. Kansei methodology was used to achieve these objectives.

Kansei engineering was developed in the 1970s at the Kure Institute of Technology (Hiroshima, Japan). It is a method for developing consumer-friendly products that translates emotions,

concerns and needs into design parameters (Nagamachi, 1995). Two stages are used to achieve this objective. The first stage uses the semantic differential method to identify and quantify users' perceptions of a product or stimulus in their own language; and in the second stage, the relationships between subjective responses and the design characteristics are determined qualitatively (Nagamachi, 1989). It has been applied to different sectors, including the car industry (Jindo & Hirasago, 1997), and acoustics (Kang & Zhang, 2010); and has proven to be an advantageous technique for the design of user-friendly products.

The semantic differential procedure, developed by Osgood, Suci, & Tannenbaum (1957), assumes an underlying structure in the semantic evaluation of products or stimuli. This structure can be found by evaluating a set of stimuli (which must have general characteristics of the type being studied) using adjectives and expressions defined by users on a Likert scale. If factor analysis of the valuations shows that a limited number of factors (called semantic axes) is sufficient to differentiate between the meanings of the entire set of concepts (called semantic space) then these axes define the semantic basis for expressing any product of the type. It is currently the most powerful technique available for measuring the affective meaning of concepts (Ishihara, Ishihara, Nagamachi, & Matsubara, 1997).

Evaluation of the set of stimuli by semantic differential requires identification of the concepts that represent the specific needs of the users being studied. To that end, the qualitative research technique of a focus group was used, consisting in carefully planned and directed group discussions to obtain information on the subject of study through participants' experiences and opinions (Krueger & Casey, 2000). This group interaction is the main difference with other qualitative techniques and although the technique has some drawbacks (Reed & Payton, 1997), it does offer advantages in certain situations. For example, it can be used to inspect the nature of social dynamics (Kamberelis & Dimitriadis, 2005) and thus improve their portrayal (Morgan &

Krueger, 1998). As a joint effort it helps to generate new ideas (Krueger & Casey, 2000) and recall aspects that would be difficult to achieve with individual interviews (Kamberelis & Dimitriadis, 2005). Also, the interviewer does not have such an important role as in individual interviews (Madriz, 2000), making the process less intimidating (Morgan, 1997), creating a familiar atmosphere (Steward & Shamdasani, 1994) that encourages the expression of points of view. It is particularly effective for examining the relationship between user and product (Morgan & Krueger, 1998) when, as in our case, there is limited literature (Hsieh & Shannon, 2005); and the technique has demonstrated its validity for evaluating attitudes and experiences (Kitzinger, 1996) in order to improve design, for example, operating theatres (Watkins, Kobelja, Peavey, Thomas, & Lyon, 2011), waiting rooms for children (Biddiss, McPherson, Shea, & McKeever, 2013) and toilets (Fink, Pak, & Battisto, 2010). For these reasons the technique was considered ideal for an initial diagnostic of the needs of the service being studied and to collect the concepts used to subsequently identify the affective structure through semantic differential.

**The combination of semantic differential and focus group permits identification of user needs at different levels.** Firstly, the focus group qualitatively studies users' opinions and attitudes and secondly, semantic differential quantitatively models the observers' mental view of this service which can then be related to their attitude towards the service and even its design parameters.

Despite the advantages of Kansei Engineering, it is not widely used in architecture. Some studies have focused on specific aspects of architecture such as the design of doors (Matsubara & Nagamachi, 1997a) and kitchens (Matsubara & Nagamachi, 1997b), but there are very few studies on a broader truly architectural or urban scale. Such studies include applications to the design of facades (Sendai, 2011), dwellings (Enomoto, Nagamachi, Nomura, & Sawada, 1993; Llinares & Page, 2007; Nagamachi, 1998), urban environments (Kinoshita, Cooper, Hoshino, & Kamei, 2006; Llinares & Page, 2008), and the identification of differences of perception between architects and

non-architects (Llinares, Montañana, & Navarro, 2011; Montañana, Llinares, & Navarro, 2013); although scanty, these studies show that the method is valid for determining design parameters with a positive influence on user emotions towards architecture and urban surroundings. However, to date, Kansei Engineering has not been applied to health care spaces or neonatal wards in particular.

### Materials and Methods

The methodology is structured in two stages based on two field studies (Table 1). [insert table 1]

#### *Stage 1. Exploratory analysis of the aesthetic and functional needs of neonatology ward users.*

Before starting the first stage, approval and consent were obtained from the Institutional Review Board. Information was provided on the specific objectives within the complete research context, detailing the methodology and structure used to achieve them.

The objective at this stage was to extract recommendations for the project and gather the concepts to be used in semantic differential, through focus group sessions with the main profiles of users involved in the service: doctors, nurses and parents. Two sessions were carried out with each profile, to give a total of six. All the sessions and the pre-analyses were carried out at a metropolitan hospital between January and April 2014.

#### *Recruiting participants, forming and convening the groups.*

The coordinators of the neonatology service and the research team recruited the participants. They did so using the hospital database of users and professionals, choosing those who could be most useful for the study objective in the focus group environment (Curtis & Redmond, 2007; Morse, 1991). General inclusion criteria were that participants had to be of legal age and participate in group contexts. Specific user profile criteria were: (a) professionals (doctor and nurses) with a minimum experience of 10 years in neonatology services and five in the hospital being studied, and (b) parents who were or had been users of the neonatology service within six months from the

time of the search. In addition, there could be no more than one member from the same family unit to avoid redundant information, and there had to be the same number of participants from each gender to avoid gender distortion. Finally 32 participants were chosen, but only 31 (eight doctors, eight nurses and 16 parents) agreed to participate (Table 2). [insert table 2]

Participants were grouped according to the following guidelines in order to facilitate the focus group. The first grouping was according to the user profile in the neonatology service (doctors, nurses and parents). Health professionals were distinguished according to rank or experience in the service, attempting to avoid participants whose position of much greater leadership might intimidate other participants in the group (Krueger & Casey, 2000), maintaining the same number of participants of each gender. The parent profile was separated by gender, because many of the mothers' experiences may be retracted in a unisex environment. And finally, it was ensured that each group had between four to 12 participants (Greenbaum, 1988; Kitzinger, 1995). According to these, two groups per user profile (6 groups in total) were formed with four, seven or eight participants in each (Table 3). [insert table 3]

All the groups were led by the same two interviewers following the recommendations by (Krueger & Casey, 2000): one of the members had focus group experience and intervened as moderator, and the other as assistant. The focus group sessions took place in a meeting room provided by the hospital and located within the studied neonatology service. The place was chosen because it was not a threatening context and also offered the opportunity to recall experiences (Godden & Baddeley, 1975) during use of the service.

#### *Structure and preparation.*

The Focus Group consisted of two sessions per user profile (doctors, nurses and parents) to give a total of 6. All the sessions were structured in four stages. (1) Stage 1: free discussion, dealing with general issues concerning daily use of the service. (2) Stage 2: free discussion, focused on more

specific spatial and emotional aspects. In this stage post-its were distributed to stimulate the discussion (Peterson & Barron, 2007). (3) Stage 3: guided discussion, in which nine colour photographs of neonatology spaces, chosen in an attempt to present sufficiently differentiated design aspects, were assessed. (4) Stage 4: guided discussion in which three of the previous pictures chosen at random according to a list of attributes were evaluated. The questionnaire was a list of 33 attributes (chosen from a compilation based on the literature on neonatology ward projects and professional journals) to evaluate on a Likert-type scale ranging from -2 (totally disagree) to 2 (totally agree). The participants had to complete it individually and then present their difficulties.

Before holding the focus groups, the research team produced some guidelines. These guidelines consisted in a series of short questions (Krueger & Casey, 2000) to direct each stage promoting participation and feedback. The questions-guide (Table 4) was tested in a simulated focus group with participation from a mixed group of health professionals and parents (two doctors, two nurses and two parents). [insert table 4]

#### *Conduct.*

Before starting the sessions, the moderator presented the main objective of the focus group and its dynamics. Next, the participants' signed consent documents were collected. Then the session began following the questions-guide. When the questions-guide ended and the discussions were deemed exhausted, there was a brief review of the data felt to be most relevant in case any participant wished to add or qualify any aspect. Then the session was closed. Total duration of the focus group sessions was from 74 to 89 minutes which was sufficient to saturate the information contemplated in the questions-guide, without causing fatigue (Llopis, 2004). The conversations were audio-recorded for subsequent analysis, enabling information to be gathered on nuances of voice, tone and pauses.

*Analysis.*

The analysis of the sessions was conducted as follows:

(1) Pre-analysis. Immediately after each focus group session, group dynamics and the consistency of comments were analysed in order to detect any handicaps to be corrected in the focus group structure. It was found unnecessary to vary the structure or repeat any session.

(2) Transcription. All focus group sessions were transcribed verbatim. Transcriptions were done by two members of the research team: one of them was the assistant interviewer. All the information that could provide identification was eliminated. Then, the transcriptions were revised by the rest of the research team who listened to all the recordings and agreed the result. The final texts were taken as the basis for analysing the focus groups (Krueger & Casey, 2000).

(3) Structure of the analysis. In order to gather the concepts for use in semantic differential (Stage 1.1), the analytical method was organised in three phases. (a) First, a simple summative content analysis (Hsieh & Shannon, 2005) strictly recording the expressions from all the stages of the sessions; (b) second, sifting through the attributes from the questionnaire from stage 4 of the sessions; (c) third, grouping and filtering the expressions obtained in the previous stages. The first two stages were carried out independently by two members of the research team. The third stage, was carried out independently by two mixed groups formed by a doctor, a nurse, a parent and one of the interviewers. Subsequently, each researcher shared his/her analysis with his/her counterpart and presented a summary to the rest of the team to discuss discrepancies until a consensus was reached. In order to compile project recommendations (Stage 1.2) conventional content analysis (Hsieh & Shannon, 2005) was chosen because of the scanty literature available. Therefore, there were no initial categories. The procedure was carried out according to Graneheim & Lundman (2004), taking into account the content analysis techniques described by Krueger (1997).

*Stage 2. Identification of the relevant design parameters in the assessment of the neonatology ward.*

The general aim of this stage is to identify the relevant design parameters in the assessment of the neonatal space. For this purpose, a field study was conducted between April and October 2014.

*Subjects.*

The sample comprised 144 subjects of whom 34% were men and 66% women. 45% of the subjects who took part in the study were healthcare professionals (medical and nursing staff). The average age of participants was 37 years (Table 5). More women participated in the study than men because they are the majority users of this hospital infrastructure. [insert table 5]

*Stimuli.*

A set of 18 pictures of neonatology wards (Figure 1) was produced and each of these was assessed by eight participants. [insert figure 1] These pictures were obtained from different hospitals and medical product catalogues. These wards were chosen because they provided sufficient variability in the set of relevant elements identified in the focus group study. The elements considered were: predominant colour in the department, separation between posts or cots, the availability of chairs or armchairs for family and companions, the possibility of natural light and the existence of purely decorative elements on floors and walls. It was then attempted to relate these elements to the defined affective and emotional variables. Given that all these variables are difficult to control in a study of real spaces, an attempt was made to randomise and thus avoid possible nesting. The affinity diagram technique was used to organise the information and find affinities in the chosen pictures after reducing the initial number to the final amount.

*Questionnaire.*

The aim of the questionnaire was to collect subjective information on user perception of neonatology wards. This questionnaire collected four types of variables: (1) information on the

subjects in the sample: gender of the users, age, number of children and profession (professional user profiles involved in the service, if applicable). (2) 25 adjectives or expressions that described the affective impression of ward users. These expressions were obtained after analysing the results from the focus groups with parents and medical and healthcare staff. The idea was to obtain a series of expressions able to describe perception of the study space. (3) Three emotions that the ward transmits, such as pleasure, arousal, dominance. These emotions come from the work by Mehrabian & Russell (1977). (4) Furthermore, the questionnaire collected a global evaluation variable from neonatology ward users and then divided it into aesthetic and functional levels.

The assessment was based on a 5-point Likert scale to assess each image in relation to each of the chosen expressions: totally disagree, disagree, indifferent, agree and totally agree.

#### *Data processing.*

After creating the database of user responses, statistical software SPSS 17.0 was used to process the data in three stages.

(1) Identification of the affective structure (Stage 2.1). To identify users' conceptual structure of this architectural space, principal component factor analysis was used to identify and extract the semantic axes. The number of components was chosen on the criteria that the eigenvalue of the components had to be greater than one because in that way it would provide more information than the original variables. After deciding the number of components the explained variance and the contribution of each original variable to each component were obtained. The components were interpreted using the Varimax rotation method. The interpretation was based on consideration of the original variables with the highest scores for each factor.

Each component or semantic axis included a combination of adjectives from the original set that were highly correlated with each other and independent from other axes. These axes represent the user's conceptual structure and are used for the affective description of neonatology wards. Then

Cronbach's Alpha was applied to measure the consistency of each factor (George & Mallery, 2003).

Additionally, in order to test the relationship between the affective structure identified and the emotional structure (Mehrabian & Russell, 1977) the Spearman correlation coefficients between both structures were calculated.

(2) Impact of the affective and emotional structure on the evaluation of the space (Stage 2.2). The impact of affective and emotional factors on the global evaluation of the space was quantified using linear regression analysis. In this case the global assessment variable was taken as the dependent variable and the set of affective factors and emotional factors (arousal, pleasure and dominance) were the independent variables.

(3) Identification of the design parameters in the evaluation (Stage 2.3). Spearman's non-parametric correlations analysis was used to determine which design parameters had greater influence on perceptions. The set of design parameters and affective impressions to be taken into account in this analysis were identified as relevant in the previous stages.

## Results

*Stage 1. Exploratory analysis of the aesthetic and functional needs of neonatology ward users.*

*Stage 1.1. Compilation of concepts to be used in Semantic Differential.*

Analytical phase (a) provided 65 results and phase (b) reduced the initial 33 attributes in the questionnaire to 25. The 90 resulting attributes were reduced in phase (c) to a set of 25 that were not considered redundant and were sufficiently descriptive of various aspects of the space in neonatology wards and could be estimated through photographs by the general public. The final number in this reduction depends on the field study (Marco-Almagro, 2011), and in our case, it is the same order of magnitude as other studies with a similar scope (Mackrill, Jennings, & Cain,

2013; Mourshed & Zhao 2012). Table 6 shows the result for each phase. [insert table 6]. By way of example, quotes from two of the results obtained in phases (a) and (b) are listed below:

- Phase (a), attribute 32a. Informant P-2-7's memories about her experience: "I just remember feeling cold in the ward... I kept covering the child with a blanket".

- Phase (b), attribute 16b. Informant P-2-6's assessment of one of the photographs of neonatology spaces: "I love this room... It is huge. For me it is crucial, because you can leave the purse, the child's things... Without disturbing the nurses".

### *Stage 1.2. Compilation of project recommendations.*

The analysis provided six main categories: sensation of privacy, colours, design, lighting, spaciousness and equipment. Although each user profile had a focus characteristic of its specific use of the ward, there were no discrepancies between or within them and possible measures for satisfying requests were always compatible. Generally, we found intense demand for privacy on the part of parents, not always referred directly to the design of space. The group of healthcare professionals already knew about this and attempted to satisfy that demand. Focusing on more spatial aspects, there is a shared preference for colours other than those commonly used in hospitals, like white and green; for environments with carefully designed interiors and a child-friendly theme, not necessarily by using drawings and well-known characters; and for warm lighting, although more in reference to the temperature of the colour of artificial lighting or the colours of the interior itself, because, contrary to expectations, windows were usually the source of negative comments. All the user profiles emphasised the importance of more space. Parents asked for more space between cots and when discussing equipment, they suggested the need for separation between cots, usually after appraising privacy. This group also repeatedly requested comfortable chairs in which to spend the night (they did not consider beds to be essential) and to include toilets nearby, with showers if possible. Doctors also asked for sound-proofed bedrooms

where they can rest while on duty, and nursing staff wanted staff rooms where they can meet and prepare food; both rooms need to be separate because in practice the two professional user profiles work at different rhythms. All user profiles agreed that the existence of individual lockers separated by user profile would be useful. **Despite the shortfalls in design aspects found by the group of parents, there was intense appreciation of the staff and absolute approval of the treatment received thus providing further support for the irreplaceable nature of this aspect.**

Table 7 shows the categories and quotes assigned to them. [insert table 7]

*Stage 2. Identification of the relevant design parameters in the assessment of the neonatology ward.*

*Stage 2.1. Identification of the affective structure.*

Factor analysis reduced the 25 adjectives or expressions that described users' affective response to five independent factors that explained 69.72% of the variance of the original variables. Table 8 shows the factors chosen, their correlations with the original adjectives, and the percentage of variance explained and Cronbach's Alpha. [insert table 8]

The factors or semantic axes represent the affective structure of neonatology wards. These axes represent concepts related to the privacy of the rooms, their functional and professional aspect, spaciousness and non-claustrophobic nature of the space, lighting and cleanliness.

From this semantic structure, the interest focuses mainly on Axis 1 which reflects the sensations related to privacy. This axis has the greatest variance explained (21.83% of the variance in the sample) and it is the initial perception that users use to distinguish or differentiate one neonatology ward from another. It reflects concepts such as intimacy, child-friendly, homely, comfortable, exclusive, among others. Axis 2 explains 19.98% of the total variance and reflects aspects like the functional and professional nature of neonatology wards including equipment, the sensation of safety and quality, and so on. Axis 3 is able to explain 11.07% of sample variance with aspects

related to the perception of claustrophobia, spaciousness and so on. Axis 4 is related mainly to lighting and explains 8.69% of the variance. Finally, Axis 5 reflects the cleanliness and simplicity of the neonatology ward, also linked to accessibility. This last axis explains 8.15% of sample variability.

Cronbach's Alpha was used to measure the consistency of each factor and enabled us to estimate the reliability of each semantic axis through the variables that define it. All the semantic axes had a Cronbach's Alpha of more than 0.7, making them acceptable according to George & Mallery (2003).

Afterwards, Spearman's non-parametric correlations analysis was run to identify the impact of the affective structure on the emotional structure. The results show that the axes of privacy, functional-professional, and spaciousness, have a significant influence on the emotional response (Table 9). In particular, the importance of privacy on the generation of pleasure, the positive contribution of the functional-professional aspect in dominance, and the relevance of the spaciousness in stress reduction. [insert table 9]

#### *Stage 2.2. Impact of the affective and emotional structure on the evaluation of the space.*

(1) Impact of affective factors on the evaluation of the space. Linear regression analysis identified the relevant factors in the global assessment of a neonatology ward ( $p < 0.05$ ) (Table 10). The factor with the greatest influence on the global assessment is privacy, followed by aspects related to the perception of functionality and professionalism as well as spaciousness. Perceptions of luminosity ("sunny-light") and the cleanliness of the ward were not statistically significant. [insert table 10]

(2) Impact of emotional factors on the evaluation of the space. Linear regression analysis was also used to identify the emotional factors with the most influence ( $p < 0.05$ ) on the global assessment variable. In this case, the factors that reflected the emotions of dominance and pleasure had a significant influence. (Table 11). [insert table 11]

*Stage 2.3. Identification of the design parameters in the evaluation.*

Spearman's non-parametric correlations analysis was used to determine which design parameters had the greatest correlation with users' affective-emotional response. The perception of privacy correlated ( $p < 0.05$ ) with separation between different posts or cots, the existence of decorative elements and the availability of chairs or armchairs for companions. The perception of a functional and professional neonatology ward was negatively correlated with the presence of natural light, that is, closed wards, with artificial light are perceived as more professional. Finally, the perception of space was correlated with the presence of armchairs for family members as merely decorative elements with a slightly higher level of significance at 0.05, as well as with the separation between cots and the existence of natural light. (Table 12). [insert table 12]

Furthermore, for the factors reflecting the emotional response, Spearman's correlations analysis determined that the emotion of pleasure was correlated with separation between cots, decorative design elements in the wards and the presence of armchairs for family members to rest in. The sensation of dominance was positively correlated with decorative elements and negatively with the availability of natural light. (Table 13). [insert table 13]

## Discussion

This present study attempts to identify the set of affective and emotional factors behind the assessment of a Neonatology Unit space and propose design guidelines based on these factors.

The results have significant implications on two levels, contributing to the methodology and application. Figure 2 shows a diagram of the most relevant results. [insert figure 2]

From the methodological point of view the most outstanding contribution is the combination of focus group and semantic differential in the context of Kansei Engineering. In the healthcare field, several studies have applied the focus group technique to extract recommendations for the design of waiting rooms (Biddiss et al., 2013), operating theatres (Watkins et al., 2011), nursing stations

(Zborowsky, Bunker-Hellmich, Morelli, & O'Neill, 2010), wards (Lavender et al., 2015), and bathrooms (Fink et al., 2010). No works, however, have been found that apply Kansei Engineering as a stage prior to semantic differential. Furthermore, although semantic differential has been used to collect user responses to a variety of stimuli in hospitals like hospital sounds (Mackrill et al., 2013), the outside space (Fan, Kim, & Kim, 2012) or the treatments themselves (Ochiai et al., 2015), most of the questionnaires were produced directly by the investigators. Our main contribution is the combination of both techniques. Focus groups are used to make an initial diagnostic of service needs, extracting initial design recommendations based on user needs and collecting concepts for subsequent identification of the affective structure through semantic differential. Schütte, Eklund, Axelsson, & Nagamachi (2004) and Schütte & Eklund (2005) have argued that the use of both these techniques is ideal for obtaining the information required to build the semantic space. In turn, in our case, the focus group has also been used for contrast, by overlapping qualitative and quantitative data to produce reliable results.

**The findings of this study make an important contribution to application.**

Firstly, six main categories from the user view have been identified: sensation of privacy, colours, design, lighting, spaciousness, and equipment. Although it has been observed that the different user profiles have different needs, solutions to meet those categories are not mutually exclusive, supporting the idea that it is possible to achieve an optimum design common to different types of users (Day, 2003).

Secondly, in relation to the evaluators' affective structure. Five independent concepts have been identified which are able to explain 69.72% of the variance. These axes or factors are by order of explained variance: (1) privacy (21.83%), referring to an intimate and comfortable room; (2) functionality and professional nature (19.98%), related to the equipment and the sensations of safety and quality; (3) spaciousness (11.07%), related to the perception of claustrophobia; (4)

lighting (8.69%), related to the bright and sunny look of the room; and (5) cleanliness (8.15%), that reflects simplicity and clean shapes and, to a lesser extent, accessibility. Similar results have been found in other works. Thus the axis “privacy” has been identified, among others by Leino-Kilpi et al (2001). These authors relate this sensation with room design, noise level, colours, temperature and the presence of other people. In the present paper, factor analysis also groups other terms such as “child-friendly”, “homely”, and “comfortable”. There is a relationship with the study by Payne, Mackrill, Cain, Strelitz, & Gate (2015) in this line, which identifies atmosphere as an important dimension in the design of well-being centers. This dimension gathered aspects like “homely”, “comfortable”, and “cheerful. The concept of “spaciousness” is also identified in other studies in, for example, Codinhoto, Tzortzopoulos, Kagioglou, Aouad, & Cooper (2009) and “spatial” and “maintenance” factors in Mourshed & Zhao, (2012). Generally, spaciousness has been much studied, for example analysing the relationship with medical outcomes (Hellier, Edworthy, Derbyshire, & Costello, 2006; Hignett & Masud, 2006; Zimring, Joseph, Nicoll, & Tsepas, 2005) stressful environments (Stamps, 2007) and even user satisfaction (O’Neill, 1994). “Lighting” has also been the subject of many studies. Mourshed & Zhao (2012) combine it with noise in the "environmental" dimension and Codinhoto et al. (2009) in the factor labelled as fabric/ambient which also includes materials, acoustics, temperature and humidity. “Cleanliness” is labelled as the "maintenance" dimension in Mourshed & Zhao (2012) and Codinhoto et al. (2009). This aspect has been assessed in hospital environments mainly because of its relationship with infections (Dancer, 2011). Finally, “functionality” is the only factor which does not appear in other studies in a healthcare setting, but it is a relevant concept in studies on the assessment of space and appears to reflect the ability to understand the environment. It is labelled as “functionality”, “comprehension” (Bishop & Rohrman, 2003; Rohrman & Bishop, 2002; Wergles & Muhar, 2009) and “legibility” (Kaplan, 1987, 1992).

Thirdly, in relation to the importance of affective and emotional factors with the overall assessment of the space, the results show that the perception of privacy and sensations of dominance and pleasure are fundamental for a positive assessment of the space. These findings are in line with Williams (1987) and Davies & Peters (1983) who highlight the importance of privacy because of its impact on patient stress, with noise identified as a fundamental component of privacy. Furthermore, Lambert, Coad, Hicks, & Glacken (2014) relate privacy with degree of control or sensation of dominance and highlight the importance of both aspects.

Fourthly, in relation to design elements, the results show six main aspects:

- (1) Provide spacious surroundings which could be related to the explicit need for personal space (Evans & Howard, 1973), defined as the area surrounding individuals which they try to preserve to feel safe (Dosey & Meisels, 1969; Sommer, 1959), and is related to the next recommendation.
- (2) Facilitate sufficient separation between posts or cots to improve privacy and the sensation of pleasure. Barlas, Sama, Ward, & Lesser (2001) studied the advisability of separations between patients to conserve privacy, with solid walls being better than curtains. Lambert et al. (2014) also report a similar finding.
- (3) Use different colours from those usually found in healthcare centres, as some aversion was found to white and especially green. This result is comparable to Park's (2009) finding that users of paediatric services preferred blue and green to white; Lambert et al. (2014) conclude that children prefer primary colours like green and yellow; and Christenfeld, Wagner, Pastva, & Acrish (1989) who found that flooring tiles with the best assessments were light coloured.
- (4) Design areas with childhood themes, to improve the sensation of privacy, spaciousness and the emotions of pleasure and dominance. The use of childhood themes without explicit distinctive elements is in line with the studies by Ullán et al., (2012) and Blumberg & Devlin (2006) of adolescents in relation to hospitals.

(5) Use warm artificial light which, unlike natural light, is related to professionalism and dominance. In this case, our findings differ from other works which report that natural light usually scores better than artificial light (Beauchemin & Hays, 1996, 1998; Lambert et al., 2014; Walch et al., 2005), but it may be related to the presence of windows. Although it has basically been demonstrated that light has a positive effect on patient experience (Ulrich, 1984; Verderber, 1986; Verderber & Reuman, 1987), the relationship is more complex (Aries, Veitch, & Newsham, 2010); and bearing in mind the “prospect and refuge theory” (Appleton, 1975), in certain cases (mobility difficulties and a marked need for privacy), light could also provoke a sensation of invasibility or lack of dominance related to the factors of "being alone" and "fear of strangers" that Russell (1979) identifies.

(6) Choose user-friendly equipment: for family members, comfortable armchairs in which to spend the night, personal lockers and bathrooms with showers near to cots, sound-proofed bedrooms where doctors can rest when they are on call and multipurpose meeting rooms for nursing staff. Other works have identified that rooms with better quality, modern, attractive furniture, sofas, bathrooms with baths, sound-proofed walls and living rooms with a dining room for families generate greater satisfaction (Janssen, Klein, Harris, Soolsma, & Seymour, 2000; Olsen, 1984).

The limitations of this work are given by the stimulus used. The sample of neonatology wards presents a broad range of variability because we have attempted to show a set of spaces or wards that are representative of the true situation. However, this approach may lead to a given combination of design elements in the images. To control for this effect would require an excessively large sample of images to reflect all the possible combinations of attributes. The solution adopted in this case has been to include these attributes in a random manner (Kish, 1995). In future works it would be interesting to analyse the effect on the user of each determinant design parameter in isolation using virtual images of spaces rather than real spaces. Furthermore, it would

also be interesting to validate the results obtained in this study through pre- and post-occupancy evaluation during the design of a new Neonatal Unit.

#### Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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