

# Patient-centred materials selection for healthcare design

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## Introduction

Numerous health geographers, architects and environmental psychologists have demonstrated that the design of healthcare products and environments can make significant differences to the health and wellbeing of patients and staff (Lawson 2010); affecting factors as varied as patient satisfaction and staff retention, treatment times and levels of medication, sleep patterns and infection control (Ulrich 1995; Hewitt 2002; Wojgani et al. 2012). Whilst the impact of views of nature, visual art, museum objects and lighting and colour (Ulrich 2001; Lankston et al. 2010; Thomson & Chatterjee 2016; Dalke et al. 2006) on patient and staff experiences have received a lot of attention, so far there has been little or no systematic research into the positive and negative impacts of using different materials (e.g. stainless steel, concrete, copper, silicone rubber) in healthcare products and environments.

Design researchers and sensory scientists have shown that the materials choices we make not only determine the functionality or structural possibilities of an object or building, but also define our sensory and aesthetic experiences, elicit emotional responses and contribute to product personality or character (Spence & Gallace 2011; Ashby & Johnson 2013; Karana et al. 2010). Wastiels and Wouters (2009), for example, have studied how architects select materials; considering both the technical performance of a material (e.g. its durability or compressive strength) as well as those aspects that influence the users experience of a space, contributing to a 'formal', 'clinical' or 'homely' atmosphere for example. Materials developers, healthcare architects and designers therefore play a crucial role in producing and selecting materials that 'please users' and 'touch them emotionally in some way' (Van Kesteren et al. 2007).

## Case Study One: Prosthetic Limbs

The selection of materials for prosthetic limbs has implications for the wearer beyond function and comfort: Cairns et al. (2013) and Sansoni et al. (2015) have demonstrated that the appearance of a prosthesis affects its acceptance, and that improving aesthetic qualities can help to improve the body image and psychological wellbeing of the wearer.

However, despite an increasing number of private initiatives that provide wearers with more materials choice (e.g. The Alternative Limb Project, Open Bionics), relatively little research has been done to systematically explore wearers' material, aesthetic and sensory preferences. There is therefore a need for evidence-based, user-centred research that explores what materials and surface finishes amputees want in their prosthetic limbs.

## Method

This study took a participatory approach: starting from the sensory and materials preferences of amputees and people with limb difference, with the aim of encouraging more user-centred selection of materials for prosthetic limbs. This involved developing a method to enable us to translate amputees' materials and sensory experiences into specific materials requirements for designers, engineers and prosthetists.

On the basis of a pilot session that explored materials in prosthetics with amputees, we developed 6 specially made sets of cubes that varied along one material property (see Fig. 1). These were used for a series of individual sessions where participants were asked to handle materials, complete a questionnaire and take part in a semi-structured interview. The questionnaire element used the cube sets to look for patterns in people's materials preferences. The interviews explored a wider selection of materials and discussed the rationale behind peoples preferences and the properties they thought were most important.

Those participants who experience phantom limb sensations or pain were also asked to say whether any of the materials elicited phantom phenomena.

## Participants

**Total number: 32**  
**Male: 17; Female: 13; Non-binary: 1;**  
**Below knee amputee: 21; Above knee amputee: 5; Below elbow: 4; Quadruple amputee: 1;**  
**Aged 18-24 (2); 25-34 (5); 35-44 (4); 45-54 (9); 55-64 (4); 65+ (4)**  
**Phantom Limb Sensation: 26; No Phantom Limb Sensation : 2**  
**Phantom Limb Pain: 22; No Phantom Limb Pain: 6**

## Materials Preferences

Materials	% Like	% Dislike
Silicone	33	67
Foam	0	100
Metal	67	33
Carbon	75	25

- **Most liked:** most matte; least dense.
- **Most disliked:** most dense, stickiest, roughest.
- **Most divisive:** most elastic silicone rubber

Table 1: Materials in current prosthetic

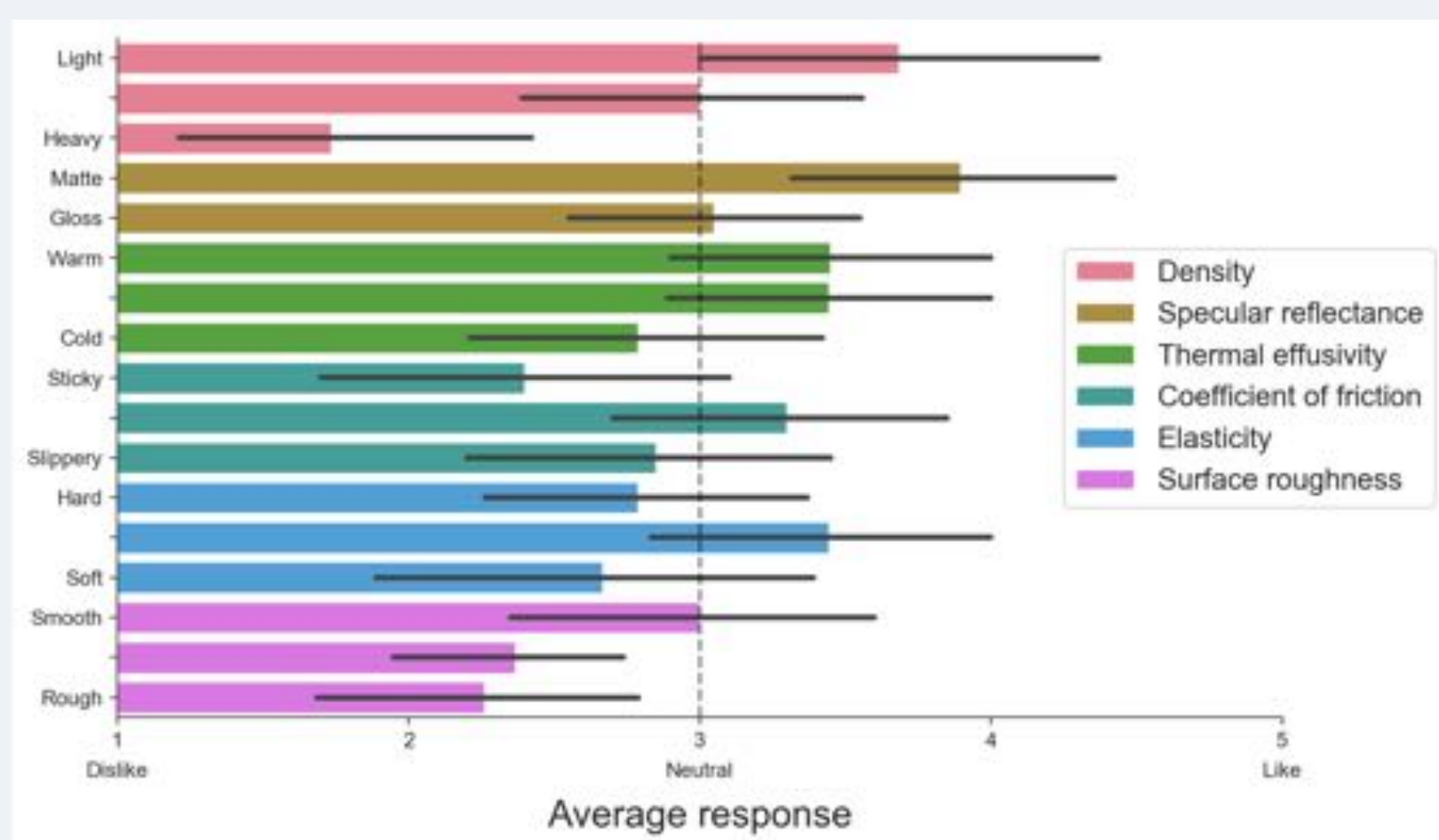


Table 2: Cube set questionnaire responses

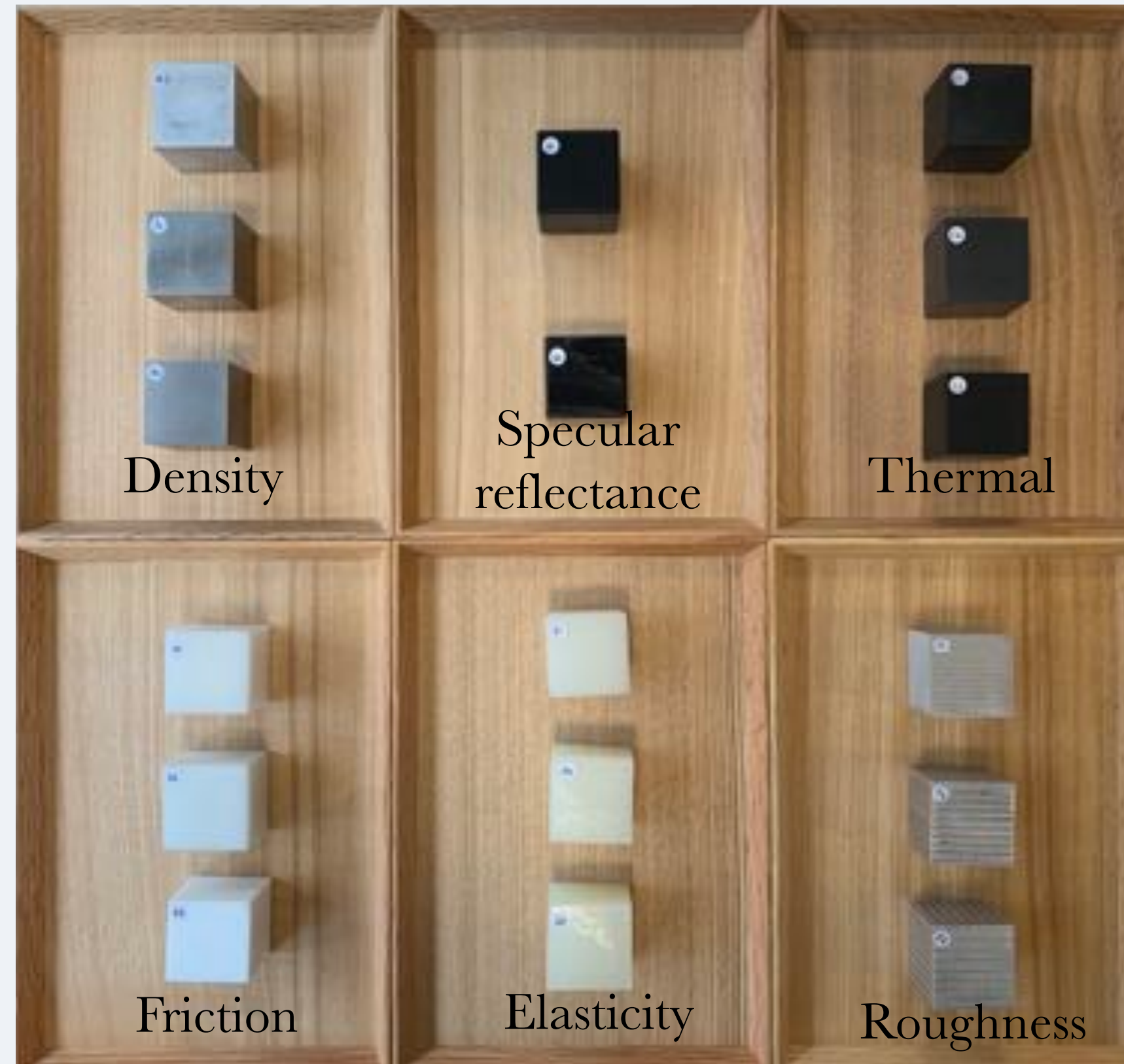


Figure 1: Cube sets for Sensory Preference in Prosthetics study.



Figure 2: Handling wider selection of materials during interview.

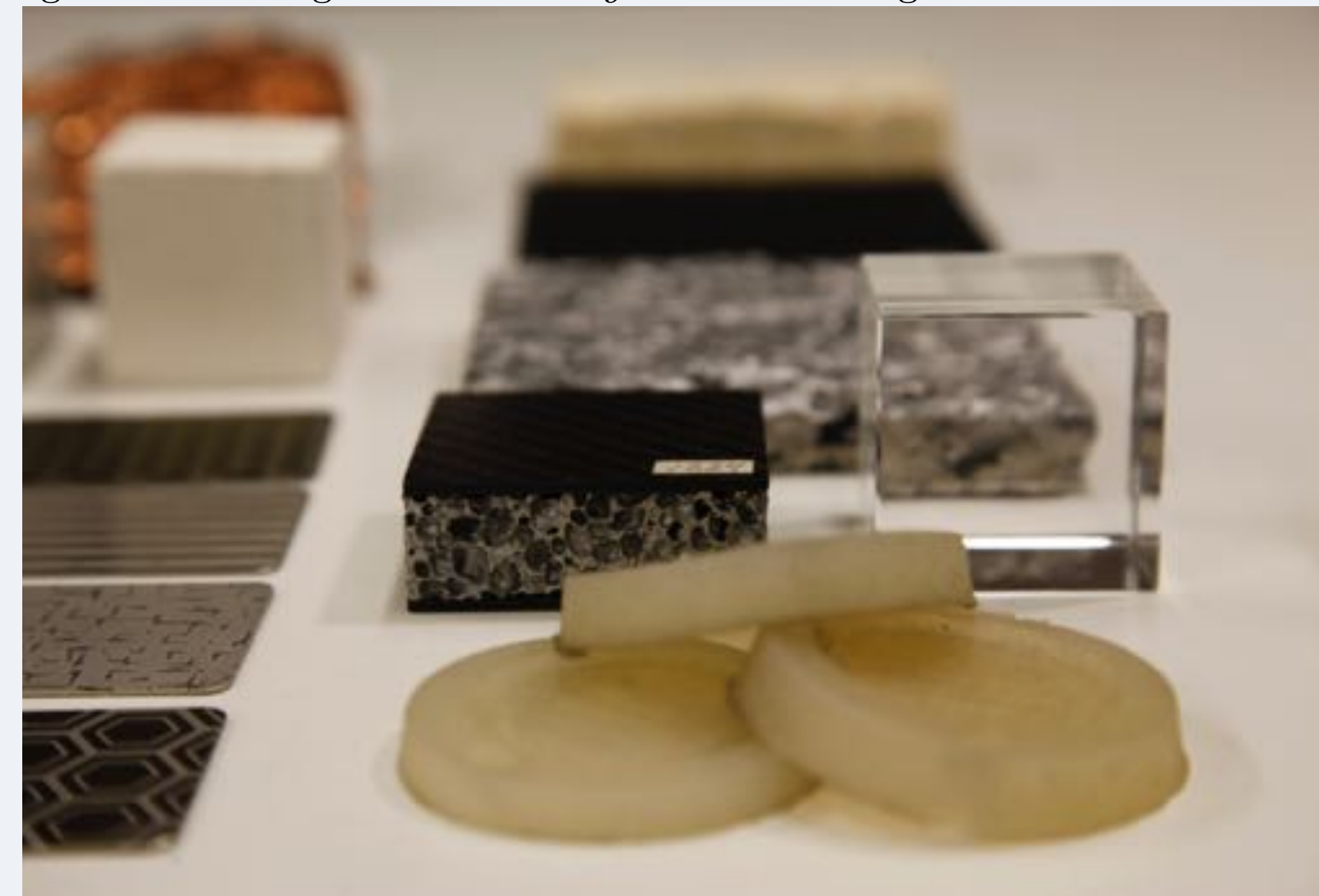


Figure 3: Selection of materials during semi-structured interview.

## Property Priorities

Material preferences varied from one individual to another, but it was possible to look for trends in the materials properties that people thought were most important in their prosthetic limbs.

In terms of materials used in current prosthetics, participants comments were largely negative overall (65%) and the most commented on property was warmth (15%):

*"One thing that really stands out is that it is cold. It's a lot colder than an actual living thing. My prosthetic tends to be cold to the touch".*

In discussions of future materials for prosthetics, weight was the most commented on property (22%) with lightweight materials being viewed more positively. Qualitative data showed that finding the right density for a prosthetic is more complex, however:

*"Mainly what he said about most of these was the weight, but even though he likes the lightness of some, but also if they are too light then it doesn't feel stable".*

## Individual Materials Experiences

The interview portion of the study also allowed us the capture the diversity of reasons why people liked or disliked materials in prosthetic limbs, with comments about the stiffness, roughness and stickiness for example:

*"The stickiness of it. It's just stuff like whenever you are taking your trousers off you have to keep your sock on your foot, 'cos it'll not come off otherwise; it just sticks to your clothes".*

One theme that came out strongly from the qualitative data was the importance of materials choice in building a relationship with your prosthetic:

*"It's rough, sharp, harsh and for want of a better word it doesn't feel very friendly... It's a very personal thing: you're putting it at the end of your body, - it's supposed to be your arm or your leg... you want to be able to have a relationship with your prosthetic".*

*"Because a prosthetic is an object, it's nice to feel that connection with it as well, so if you do find materials particularly comforting and friendly that's really important... to get a better connection to your prosthetic, so that when you pick it up you do find that comfort within it as well".*

*"Wood is a very unthreatening material... as it ages it sometimes even gets even more - sense of being you. So there's a real sense that this is part of me if you like. There's a warmth in wood: I think any time you touch wood you never shiver or anything like you would when you touch metal".*

## Case Study Two: High-Touch Furniture

This second case study that aims to involve children and young people in the participatory design of high-touch hospital interiors.



Using materials handling activities, focus groups and questionnaires this project will explore what kind of material properties patients at GOSH prefer in high-touch hospital furniture and hardware (e.g. bedside chairs, grab rails and overbed tables) and how those materials choices contribute to a formal, homely or familiar environment. The results of this study will be used to make recommendations to improve the selection of materials for hospital interiors and ensure that they meet the needs of patients whilst also meeting infection control and clinical requirements.

## Conclusions

- These studies take a user-led approach to materials selection for healthcare design.
- They use a multidisciplinary mix of methods to explore what materials patients want, and why:
- Quantitative data to look for patterns in peoples materials preferences, and qualitative data to better understand patients' needs.
- This understanding can be used to support healthcare designers, manufacturers and materials researchers to identify and develop materials that better suit the needs of patients. -
- Physical collections of materials play a pivotal role in enabling this kind of research.

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