

A Toolkit to Explore Lived Experience of Motivation: When Words are Not Enough.

Lesley Axelrod

User Centred Technology Lab, Interactive Systems
Informatics, University of Sussex,
Falmer, Brighton, BN1 9QH UK

Geraldine Fitzpatrick

Human Computer Interaction Group
Technical University of Vienna
Favoritenstrasse 9-11, A-1040 Vienna, Austria

Madeline Balaam

Culture Lab, Newcastle University
Newcastle upon Tyne NE1 7RU UK

Sue Mawson

Centre for Health and Social Care Research
Sheffield Hallam University, Sheffield S10 2BP UK

Jane Burridge

School of Health Sciences, University of Southampton
Southampton, SO17 1BJ UK

Ian Ricketts

School of Computing, University of Dundee
Dundee DD1 4HN, Scotland, UK

Penny Probert Smith

Dept Engineering Science, University of Oxford
Oxford OX1 3PJ UK

Tom Rodden

Dept. Computer Science, University of Nottingham,
NG8 1BB UK

Abstract— Designing to support motivation is an increasingly important issue, especially as pervasive technologies are used to facilitate various healthy behaviour changes. There are many motivation theories but these do not map specifically to inform design. In ‘Motivating Mobility’ we explore the lived experiences of motivation of people with stroke, in order to design rehabilitation technologies. Motivation varies between people, between contexts and over time and can be ‘difficult to express’, particularly for those with communication problems. We describe development of a theoretically based toolkit, principled in both content and form, and using multiple modes of communication, aimed at gathering motivational requirements in order to inspire design. We show use of the toolkit, discuss the rich data collected and reflect on how well the approach works and ties requirements, via their elicitation tool, back to theory. This toolkit has potential to inform design for motivational effect in similar pervasive health applications.

Keywords- motivation; HCI; communication difficulty; affect; user requirements; cultural probe; rehabilitation; stroke; design

I. INTRODUCTION

As technologies merge into everyday lives, understanding user motivations to engage with them in different contexts is increasingly important for design of systems. Systems designed to support behaviour change are needed in order to meet the global challenges associated with increasing numbers of people living for longer, with long-term conditions e.g. with diabetes regimes [27] losing weight, exercising, or stroke rehabilitation. Stroke is described as a ticking time bomb, due to increased survival into old age with increased levels of disability.

Government initiatives to support post-stroke independent living, involve rehabilitation and a move to home-based self-care, where engagement with pervasive technologies can support compliance and play a key role.

‘Motivating Mobility’ is a project concerned with design of innovative interactive experiences to motivate people with stroke to practice rehabilitation exercises at home. Each stroke experience is different and impairments include loss of strength and dexterity, reduced mobility, balance and muscle weakness. Communication difficulties (*dysphasia*) affect a third, leaving problems in understanding and expressing by spoken and/or written language. A growing evidence base suggests rehabilitation exercises done regularly and well can reduce disability [32] and increase independence. Rehabilitation exercises involve challenging, demanding, time consuming, boring repetitions of basic movements that must be practiced correctly. It is not unusual to see non-compliance rates with physiotherapist-prescribed home exercises at 65% [5].

Technologies have potential to support home exercise. Some approaches make use of VR and robotics systems [21], but can be costly and difficult to use. More generally, technological aids in the home often end up unused in cupboards and motivation for individuals to engage with pervasive technologies and then to persist in using them is key, if they are to be useful. Our alternative aim was to develop low-cost scalable interactive technologies to support self-managed rehabilitation at home. Since users have autonomy within their own home to do what they like, the key challenge is developing systems that users are really *motivated* to engage

with. Working in a multidisciplinary team, the physiotherapists relatively easily determined clinical requirements, in terms of correct movements to be encouraged. Technologists were also able to identify candidate technologies, in terms of sensors and interactions. However, understanding user needs, focusing on personalized motivation, and looking beyond simple fun to provide engaging *and* correct movements and activities was a much more difficult challenge. Firstly, motivation is a nebulous topic, difficult to establish, understand, formulate and discuss for individuals in any case. It is further complicated when need for behavior change is enforced by sudden illness, such as stroke. Secondly, with stroke, communication and cognitive difficulties create particular problems for users understanding typical ‘user requirement’ questions or articulating answers, especially as many abstract concepts associated with motivation can be hard to capture in words.

In this paper we present a principled approach to understanding lived values and experiences of motivation by people with stroke with a view to designing rehabilitation technologies with care [30], using a toolkit for elicitation of motivational issues. We briefly review motivation in HCI and motivation theories in general, and explain how pilot work illustrated the enigmatic and tacit nature of motivation and led us to seek a more principled process for elicitation. This underpinned the choice of *content* (based on motivation theories and cultural understandings). We show our multimodal approach to address communication challenges in the design of the *form* of the content-based tools and their deployment. Finally we reflect on this method for understanding personalized motivations. The focus of this paper is not so much on systems design to support motivation but on development and use of elicitation tools to understand the intangible issue of motivation, especially when working with people living with dysphasia.

The key contributions of this paper are: 1. the presentation of a principled approach to the content and form of elicitation tools in order to understand motivation and 2. reflection on how well the tools mapped from underlying theory to the data that we collected. This is important for two reasons: usual approaches to understand motivation rely on either interviews or direct interpretation of theories (e.g. [12]); and where elicitation tools are used, content and form tend to be informed by notions of provocation rather than theoretical underpinning or specific communication needs of the target user group.

II. MOTIVATION AND DESIGN OF SYSTEMS

One approach to designing systems to support motivation is to take a general approach by selecting a motivation related, theoretical underpinning and study the fit. Ludic and persuasive technologies draw on motivation e.g. [9,17]. Some designs aim to incorporate ‘fun’ or ‘ludic tension’ in the expectation this will prove engaging and motivational despite minimal theoretical basis. Other application designs rigorously incorporate motivation related elements e.g. Consolvo et al use goal setting theory, transtheoretical stages of change and presentation of self for technology design [12]. In games and learning, self-determination theory has informed design e.g. Chang et al’s toothbrush [10] and Denis and Jouvelot’s music learning application [14]. Matthew [28] uses positive

reinforcement and trans-theoretical model for a motivational environment to persuade people to use the stairs. Interactive ball games use self-efficacy theory and theory of planned behaviour [6]. Aesthetic persuasive agents have increased the power of messages [24].

However, as we wanted to support more individual than general motivation, we also need to understand *lived motivation* which is complicated, rather unformulated and imbued with many levels of meaning. *Elicitation methods* for insight into nuanced cultural and personal issues such as motivation include cultural probes [18] and their many variations [8,19,20], which give insight, raise design questions and sometimes (although this strays from Gaver et al’s intended usage) gather user requirements. The key aspect of probes that we draw on is their support for multimodal and non-verbal engagement, which is essential when words are difficult. Martin et al stress the need to understand *individual* needs in the medical devices domain [25] and this is where such multimodal approaches might well be able to contribute.

While such approaches might be important for reaching beyond functional requirements, it is not always clear *how* the structure of these approaches is decided upon. In particular, we lack principled ways to help us decide what assemblage of methods should be selected to understand and interpret individual motivation. This is in terms of both *content*, what the methods or tools are seeking to enquire about - as well as *form*, the physical and interactional form the tools take. For our users, communication issues challenge elicitation of ‘motivation’. For such a nebulous topic, even for the general population, a form that empowers narrative, becomes a critical element in the design of any elicitation method. The form can facilitate conveyance of abstract ideas around motivation via non-verbal or alternative sensory means. We next review how we informed content and form of elicitation tools by drawing together motivation theories and pilot study insights.

III. TOWARDS CONTENT AND FORM

A. Motivation Theories

Motivation concepts and theories have evolved from carrot and stick approaches in the workplace to a view of complex social processes in many settings. Current thinking considers motivation to be a complex evolutionary process that may be both the cause and consequence of different emotional events, linked to goals, cognition and actions and to factors such as individual personality, mood and physical and chemical make-up of the brain e.g. role of dopamine [31]. While a comprehensive review of motivation theories and their application to HCI is beyond our scope, it is important to be aware that different domains focus on different theories (for summary of theories see [22]). Uses of motivation theories in psychology, health and social care domains are inspiring. In the domain of technology design, self-determination theory has been used to relate social needs to motivation involving autonomy, competence feedback, and relatedness [13] Other relevant constructs include engagement and flow [11] (e.g. video gaming and online settings). In therapeutic domains motivation and adherence to regimes is seen as a dynamic variable relating to progress, skill, self constructs, beliefs, self-

regulation, expectations and feelings such as self-efficacy, aspiration and closely linked to hope. Goal setting theory has a well-established evidence base for effectiveness in physiotherapy [4,26] and trans-theoretical model of change is important in chronic disease management and behavior change [15]. In our pilot work (described below) it became clear that various theories and concepts might apply to a greater or lesser extent to different post-stroke individuals at different times and that relying on only one theory or concept could limit our exploration of the lived experience of motivation and decrease the motivational value of our system. There are numerous tools linked to theories for measuring motivational aspects, including self report and standardized assessments, e.g. readiness for change ruler based on trans-theoretical model [15]. We found many of these verbally challenging for people with dysphasia; limited, in that they look at motivation in specific terms; and they lacked nuanced insight for technology design in terms of design requirements and design inspiration. Hence our choice of multi-modal content for our tools was drawn from a range of theories as illustrated in Table 1 (next page).

B. Pilot studies

In parallel to a review of motivational theories, we conducted pilot studies to gain a broad experiential and cultural perspective of motivation. This included informal in-home interviews and photo tours with 7 stroke patients (and carers as available); observation and interviews with 6 stroke therapists/professionals; 3 focus groups in stroke clubs; and use of a sample of 200 Flickr photos tagged by their owners as ‘motivat*’. We carried out thematic analysis of the resulting data and summarize the key findings here.

Firstly, motivation indeed proved a difficult and nebulous discussion topic, particularly for people with dysphasia to define and discuss personal motivations. Direct questions led to situation-specific, superficial replies and did not provide a basis for design decisions. Photo walk-throughs of homes were revealing and useful, reinforcing the need to design technologies to fit into ‘everyday’ lived spaces [1]. Motivation was also difficult for the health professionals and voluntary sector organizers to articulate e.g. to explain exactly how they motivate individuals. Understanding of personal motivations was often tacit but critical for clients’ engagement.

Secondly, a need for multi-modal materials was apparent. Verbal methods used in stroke clubs such as brainstorming and group-passing techniques to create lists and mind maps of motivational issues proved problematic for members with dysphasia. Closed questions used to elicit simple verbal responses gave better results. Multimodal materials (e.g. clay and drawing materials) were also successful. In focus groups, helper-supported drawings gave unexpected insights via personally meaningful, rich, life narratives about motivation. We also learnt from how health and voluntary sector professionals used multisensory and multimodal activities to empower individual clients, to take part. They also used more than one method for positive reinforcement and encouragement, e.g. saying ‘good’, in conjunction with physical feedback, such as touching a limb.

Thirdly, varied cultural perceptions of motivation were illustrated in the Flickr photos. People associate motivation

with diverse abstract, rich, emotional concepts. Thematic analysis found: aesthetic images; natural phenomena, panoramas etc; inspirational figures; sensory pleasures and humour, such as a coffee cup tagged ‘motivational machine’; money; religion; charts, mind maps, graffiti, hand written lists; challenge or competition e.g. sporting effort; travel, distance and speed; ‘hygiene’ factors such as a picture of the messy room of someone who was seeking motivation to clear it up.

Our pilot studies gave us a baseline understanding of how to better engage with users to elicit motivation and we gained deeper understanding of the lived experience of stroke. We next consider the content and form for elicitation tools.

IV. PRINCIPLED CONTENT: WHAT TO ELICIT?

Literature and pilot research show motivation is a complex variable from person to person. Motivation may vary within an individual depending on context, for example at different stages of recovery, in different geographic locations, or depending on mood and fatigue (which is a common side effect of stroke). It is this lived experience that we need to understand for design of successful rehabilitation technologies. Content of a motivation elicitation tool kit should include a wide range of prompts relating to the self and these varying influences:

Motivation at different stages: We must elicit motivational needs and design requirements to support numerous decision points: the ‘prescription’ stage with the therapist; initiation of interaction; choice of input device, hardware and application software; and choice of feedback mechanisms.

Promoting rich personal stories through reflection, narratives and intangibles: We must consider wide-ranging motivational issues, many of which will be tacit and ‘difficult to express’ such as emotional, aesthetic and value preferences. We also want to know not only which activities are enjoyed but also the qualities of activities that appeal to individuals. Tools should stimulate explanations of rationales for example telling us stories behind why people value certain items. Rich reflections and narratives should yield insight into experiences, multisensory preferences, avoidances and personal journeys of individuals so that we can draw on relevant theories to address all motivation decision points. Understanding broader qualities will enable us to interpret and apply them to different levels of interaction, and across different types of content over time, and thus avoid boredom or demotivation.

Information on elements from a number of theories: Different motivational factors and theories might apply over time for different individuals. For example, our technology is for home deployment, and users’ views on home rehabilitation vary. Among our participants, one saw it as part of a daily workload, another as an enjoyable leisure activity; another as necessary to avoid disability; and another practiced to placate a spouse. We need a wide qualitative approach to explore relevance and draw out views relating to a motivational range. A system that is fixed on only one particular theory or premise might relate only to a few individuals or only to their motivational triggers at particular points in time. To support this, we drew on a range of theories, as reviewed in [22], and related literature to generate a list of motivational components.

Theoretical basis	Related concept from theory	Content: questions / statements	Form: means of elicitation	Sample responses from pilot studies
Self determination theory	Relatedness to objects and activities	Games I like to play...	Top trumps game	bowls, darts, rummikub, word search, guess the tune and when first heard, simple sums, recognize locations in pictures, nature quiz, cribbage, dancing, sailing, choir, drama, poetry, walking, gardening, history, football, puzzles, jigsaws, games you can play with children, matching pairs, soduko, music quiz
		Most important possessions	Clay impression	Model of a bottle of 'fine wine' from family vinyard Impression of a favourite necklace, bought with daughter
		The best bit of my day is.....	Diary prompt	at home with my family; driving - I couldn't drive when I had the stroke but now I do; when dad cooks breakfast;remembering
		The worst bit of my day is.....	Diary prompt	having dressed I am not satisfied with my appearance;I get tired;I wash up;afraid I'll fall - gettingto the shops is a problem
		My favourite things	Photo prompt	flowers in the garden, picture on the wall, embroidery of deceased wife, MBE, collection of badges to evidence charitable giving, CD collection, glass collection, family photos
Flow	powerful positive affectmakes me laugh out loud	Smiley toy	seeing my children and grandchildren and my sisters; Going to my clubs and mixing with others that are there; conversing with people who are considerate and give me time to express myself - when socialising being asked directly to myself what I would like to drink - not having the question put to my wife for a response; just sitting in the garden; getting everything organised; my son / daughter in law / grandkids / acknowledgement from people who know / breathing easily free from asthma / physical exercises / fresh air, countryside, seaside, camping out at Glen Miller festival.

We categorized and grouped these, resulting in 3 categories each with 10 elements: **Personal affect:** individual inner feelings: relatedness; sensory curiosity; enjoyment; self esteem; autonomy; security; effort; boredom; empowerment and fantasy. **Social interaction:** interaction with others: cooperation; recognition; belonging; affecting others; giving back; morality; respect of others; respect by others; praise and information; achievement and satisfaction. **Task related:** cognitive curiosity; learning; expectancy; productiveness; challenge; goals; skills; creativity; competencies; instrumentality; concentration. For each of these 30 elements, we devised 5 stimuli, relating to the motivational concept, to trigger rich relevant responses (see sample in Table 1, with concept and questions in columns 2 and 3 respectively, and related theory noted in column 1). By using mixed methods, including unfinished statements, tangible cues, and creative activities, we decreased reliance on the spoken or written word.

Having the content and categorized questions relating to elements of motivation from various theories, we turned our focus to the form tools should take in order to successfully elicit such information. Our diverse users need diverse means to fully participate in communicating complex motivations. For users with neurological motor and sensory impairment, participation is very much framed by the tools we present, to empower, rather than disable them. Consequently, we offered a range of multisensory multi-modal media and interaction techniques with alternatives for responses. Offering such a choice of response modes will broaden opportunities for data collection (we know participants will not be able to respond to all items, or in all modes).

In our pilot work, we had noted how tangible artifacts around the home stimulated personally meaningful narratives. We wanted to include tangible tools so that the toolkit should also suit people with different preferences or abilities. Some

tools better suit those who are more visual or like to create e.g. photos, drawing and clay; some suit those who like to write e.g. diaries or labels on artifacts; and so on. It is a difficult and delicate balance that we have tried to strike, to allow for inclusion without being patronizing.

Our Flickr analysis suggested the importance of aesthetic, sensory and emotional elements for motivation, complimentary to elements extracted from theories. Some aesthetic, sensory and emotional tools might be appropriate for tapping into these, in order to obtain data for design decisions.

V. FITTING FORM TO CONTENT

The next step was to bring these insights together into a set of principled elicitation tools. The pilot studies had demonstrated the value from photos, drawings and elicitation of peoples' stories and also pointed to potentially useful types of content and forms of elicitation tools. We also drew on a range of rich needs elicitation methods from an assemblage of cross-disciplinary domains e.g. mapping techniques from Rapid Rural Appraisal (RRA) [29] (used to understand needs in developing regions or where communication is in a second language), tools used in therapeutic settings (particularly with dysphasia), bespoke jewellery design [33] (where aesthetics are key), photo stories, and so on, as well as elicitation tools established in HCI such as probes [18] and sketching.

We mapped these forms of elicitation to the content questions that in turn mapped to theories (see column 4 of Table 1), offering a range of elicitation modes for each category. For example a plethora of motivation theories have concepts associated with 'relatedness' (an exemplar in Table 1, column 2). Relatedness can be applied to both people and to environmental objects and activities. Deci & Ryan [13] describe relatedness with the environment and social world as one of three universal innate motivational needs. We

categorized relatedness under ‘personal affect’ and designed five questions (content) to elicit the participants’ most related objects and activities, such as favourite games, possessions and best and worst parts of daily routines. We then assigned tools (forms), including reflective affective diaries, clay impressions, photos, mapping activities and a card game for ranking attributes of pastimes. Ideally each concept should have ‘create’ forms and ‘speak or write’ forms in the toolkit, so that users can select by their own preference.

VI. HOME STUDY METHODS

Participants To explore the use of these tools for eliciting understanding of motivation, we recruited 7 participants aged 60-85 from three different stroke clubs. Volunteers were vetted for suitability by their stroke club organiser, who knew them well and could judge them as suitable for taking part. All were several years post-stroke, living independently or with minimal support, and with impairments and co-morbidities typical for this group. All expressed desire for physiotherapy exercises and had a history of private, NHS domiciliary, or inpatient physiotherapy support. One had written exercises that she had difficulty in reading and did not practice. Some had no physiotherapy contact in the past year. With each participant we conducted interviews, undertook home tours (documented with images, maps and video) before leaving an activities box.

Semi structured interviews: We developed topics, based on our motivation categories to guide interviews and recorded ‘stroke journeys’, of rehabilitation and motivational aspects of life. Family, friends and carers took part as available.

Still images and videos: We conducted tours of homes to help us understand suitable placements of technologies, and give insight about motivation, lifestyle and attitudes [1], e.g. most comfortable or useful areas of the home, favourite places to sit, available work surfaces, notable possessions, etc.

Mapping: (after [29]). We used the domestic walkthroughs to prompt narratives about uses of rooms and histories. Emotion maps of the home were compiled and colour coded stickers were used to add ratings of affective states. We also asked participants to create Body Maps to reveal feelings and experiences about exercising different body parts.

Activities box: Participants were given sets of tangible elicitation activities with labels for completion, in a gift box intended to invoke reciprocal feelings of gift giving (see Fig. 1). Items related to wide-ranging elements of the self and motivation (as per Table 1, several inspired by [33] e.g. sensory cues and top trumps game). We included ‘red letter day’ cards for recording events; a wish upon a star list; a medal to trigger stories of achievement and fulfillment; scented pillows for recording of dreams and nightmares; a motivation mind map; a small ‘swimmer’ toy, relating to struggle; a version of a card game to rank pastimes; a disposable camera with motivation prompts [after cultural probes [18)]; an alien toy (after defamiliarizing the familiar [7]); negative and positive affect diaries; a folder for sketching and clay for modeling motivation related ideas; a smiley toy relating positive affect; and ‘five senses’ items. Participants were told there was no need to complete all items and the activities box was left with them for one month.

Activities box



VII. RESULTS

We recorded an hour-long interview (with audio tape as an aide memoire) for each person, collected 214 photographs (mean of 30 per participant) and emotion maps of body and home for each. Interviews evoked rich motivation narratives and personal stories. Participants reported enjoying taking part and using the activities box and were generous with their time, patiently sharing stories, despite verbal struggles at times. Items in the toolkit were completed to varying degrees with two participants completing very few due to health complications during the study period, two completing nearly every item and three between one and two thirds. Table 1, column 5, shows a sample set of responses. All responses were entered into a database and transcripts of narratives and annotated images and artifacts were thematically analysed.

A. Personalised Stories

People gave rich specific understandings exposing key personal motivational elements about what ‘made them tick’, to feed into design of personalized systems. Responses to artifacts led to fascinating insights. Take Irene, in her late 80s, who after two strokes still lived alone in the terraced house where she was born in 1920. Irene was a highly reserved individual who did not initially volunteer much information about herself. Her motivation for attending stroke club, despite difficulties with transport, was to act as a helper there to benefit others. She was reticent during interview, but was empowered during the mapping and tour of her home and her story started to unfold. A hand worked tapestry quoting William Morris summed up her attitude. ‘Have nothing in your houses that you do not know to be useful or believe to be beautiful’. It also demonstrated her social connectedness – she had decided she was too old for sewing such fine work and gave the half finished item to a neighbour along with all her sewing kit. The neighbour had completed the tapestry as a gift for her. One ornament prompted dreams of foreign lands and another evoked her MBE investiture. These reminiscences sent her into ‘flow’. Her comment when showing us her stairs, revealed her fear of falling (hygiene factor) ‘I might be one of those people they find lying dead after three weeks’. One candidate space for technology had negative connotations associated with her

parents' death. In response to a sensory activity, she told us she loved the touch of velvet and the sound of Rachmaninoff and Purcell. It transpired that music was central to her life, (and thus might prove intrinsically motivating). She had played piano semi-professionally and accompanied various groups, where she 'enjoyed seeing people smile when I played'. Since stroke affected one side, playing was 'not the same left handed'. She had no means of playing recorded music. Life was restricted and she longed for flow from music, engagement in familiar pastimes, opportunities to reminisce and social opportunities to 'give back'.

B. Emergent themes

From a thematic analysis of the data we gathered, against a background understanding of the literature on stroke and motivation theories, we identified sets of emergent themes. Consideration of these can help shape a design space with details relevant for tailoring designs for individuals. **Social connectedness**, themes: family, friends and references to wider society such as being a good citizen or group member and 'giving back' to others. **Home setting** themes were: the aesthetic fit to the home; the use of rooms and surfaces (liable to re-purposing); the importance of home aids and adaptations; feelings about spaces; prior technology experiences; maintenance and safety issues; memorabilia, clutter and reminiscence; individual differences; new or renewed interest in old pastimes; importance of social interaction. **Personal information** themes were individual differences; loss of autonomy; loss of things loved; negative views of self; fears and negative attitudes to technologies; barriers to uptake of technologies; independence and well being; social activity; desire to give back; aesthetic sensitivities.

VIII. DISCUSSION

Our focus here is on describing how useful our tools were as a principled method for understanding lived motivation in order to inform design, rather than producing full results around what motivates those living with stroke. The toolkit succeeded in eliciting rich information including illustration of abstract and intangible aspects of motivation for design inspiration as well as much opportunity for reflection on the approach.

Working with this user group proved challenging in many ways. Methods were time consuming due to the need for a slow pace, breaks and support, particularly for those with dysphasia. We might elicit knowledge about the user from a second party e.g. physiotherapist or stroke club organizer but ethical and confidentiality issues are a barrier to sharing such information. Input from carers is an issue for consideration. Few of our sample had spouses or 'live in' carers. Each participant had important relationships and more input from these contacts might have been very valuable and given us alternative or additional information. On the other hand, our methods fit well within a participatory design tradition as we have involved various stakeholders, including patients, carers and therapists and empowered users with a range of communicative needs to communicate their values and experiences. The understanding we gained from this approach was later carried through to design of prototype systems [2,3,23,34].

Reflecting on content: One aim with the toolkit was to go a step beyond motivation theories as a high level understanding of factors for motivation, because these lack the low level detail important for design. E.g. theories show the importance of intrinsic motivation (doing things because they are innately satisfying) but they do not tell us what activities or what quality of activities will offer intrinsic motivation to an individual. Our methods successfully uncovered this and other topics such as flow and engagement that are relevant to motivation but are not central to motivation theories. E.g. one theme emerged relating to sensory and aesthetically pleasing items. We obtained a lot of design inspiration and practical information about how to meet these needs. More work is needed, however, to establish the balance of content (see later discussion).

Reflecting on form: Using a mixture of visual, tactile and oral methods and allowing both written and creative responses worked well and enabled diverse participants to be included. Initial home visits were immensely worthwhile and helpful. Just stepping over the threshold was to step into the world of the participant (as is the case in much fieldwork of this kind). We were instantly struck by factors such as the condition of the home, reflection of aesthetic tastes, alterations to accommodate living with stroke and so on. There was a feeling of the researcher being treated as guest and looked after which gave power to the participant and seemed to predispose them to be helpful. Video recording was less successful and felt intrusive. In contrast individuals were keen for us to take still photos as they showed us around and presented their prized possessions.

The elicitation toolkit encouraged reflection and recording of thoughts associated with motivational elements. Elicitation activities acted as prompts for narratives and gave insights into personal journeys, experiences and multisensory preferences. Some items were more or less popular with participants than others. The disposable camera was not popular. One returned it unused saying it was a waste as 'cameras are so expensive', one could not understand how to work it despite instruction, one took a series of blurred and unusable prints. Our process, of visits and activities, was costly of researcher and participant time. Participants had individual difficulties unrelated to their stroke that we had not fully appreciated that affected their timely completion of the activities. One lady 'hid' the extent of her visual deficiencies, possibly intending to maintain face. Most users needed large print, which affected design of tools, e.g. disposable cameras as probes with prompts in small font would not work. Minor or routine problems, once added to existing conditions and daily struggles, could prove a tipping point. For example, one person needed dental work that meant they were unable to cope with any other tasks for some time. We had no knowledge of the order in which activities were undertaken, which might affect end data. Once started, individuals tended to run on the same train of thought e.g. relating to people or natural beauty. Just as in conversation, we are always reconstructing what we say, based on what has gone before, themes might have carried over to subsequent activities but we had no way of evaluating this. Some questions were undoubtedly leading e.g. asking about the five senses.

The choices participants made as to which items in the activities box to complete were interesting. In face to face interviews people tended to be upbeat in their responses, but

another, more intangible and often surprising side effect was revealed by responses to items from the activities in the toolkit - sometimes revealing what they felt they could not do. This supports the notion that probes can disrupt the everyday narratives that we tell ourselves about who we are and what we do. E.g. one man, asked about preferred activities in the interview, did not mention music. In the toolkit, asked what made him happy, he described listening to music 'as I can't play the piano now so I am limited to listening'. Several people revealed low self-esteem and expectations, e.g. annotating the medal with 'I don't deserve a medal because for the last few years I have done nothing of great repute'. When asked about personal interests in the interview, typically this resulted in a list of socially desirable activities, such as those carried out at the stroke club. When left with the toolkit, people went to a great deal of trouble to illustrate their feelings and motivations leading to more reflective responses, although items were not always used as intended or expected. E.g. one man lived on his family vineyard but did not emphasise this in our interview - it was just his address. Using the toolkit he crafted a clay model of a bottle of 'fine wine' and described wine as a 'sensory' stimuli which led us to reflect about his family life, everyday experience and interest was bound to wine making. This type of data can greatly inform motivational technology design.

In every case there were significant benefits from the follow on visits required to collect the toolkit. We capitalized on the fact that participants were keen to chat at this point. The time delay since the initial visit gave time to reflect - so we could listen to an extra narrative or clarify something that had initially seemed unclear. Participants had things they wanted to add: 'I've been thinking...', 'I didn't put this, but...'. For example one man had been thinking hard about how technology could motivate him to exercise. He remembered a 'wind up' torch that was charged by a squeezing action and on reflection thought that had huge potential for motivation - 'you could be storing up energy'. He thought that would be more motivating than a similar functional exercise (squeezing a rubber ball) that the physiotherapist had prescribed.

The amount in the toolkit needs consideration. Participants liked the activities and did not report feeling overwhelmed by them. Having an extended period of time allowed for reflection and participants had obviously put considerable thought into their responses. This method undoubtedly generated thoughts and narratives we would not otherwise have captured. We wanted to provide opportunities for different modes of response and build in redundancy for users. Although participants were told there was no need to complete all items, in their eagerness to please and help us several felt a need to try to do so and asked for extended time for completion. The understandable desire to complete the task is at odds with the design of this method. There may be disadvantages in having too many items but redundancy also means that if individuals use more than one of the tools, we can triangulate data and add power to our findings. E.g. one very independent lady saw exercising alone as a duty, but responses to the happy toy, red letter days and top trumps games, revealed a real joy in social interaction with her family. Her love of the great outdoors was revealed by her responses to what made her laugh out loud (playing in the sea), feeling free as a bird (riding her mobility

scooter along the beach) and the place she would most like to be (on a mountain). Sometimes remarkable agreement showed between participants, e.g. for the red letter day activity three people said that children playing made them 'laugh out loud'. This might be due to appearance of the tools (small toys might be viewed as childish). Tools to promote reflection are crucial and more work will identify most useful forms for elicitation.

Reflecting on the principled approach We were able to tie back participants' responses to the elements of motivation that we had categorized, and to the underlying concepts and theories of motivation. Our method allowed us to clearly relate narratives and information about individual motivations to theoretical aspects of personal motivation. E.g., in response to the request to make a clay impression, one lady made a clay impression of a necklace bought on a shopping trip with her daughter. She explained she frequently went shopping, as she found visiting the shops cheered her up (see sample in table 1). She clearly related to objects that related to social activities and that could be a design trigger, perhaps for a game involving shopping or an activity connected with shopping or linking her with other shoppers. This fits to relatedness to both objects and people that is an element in a number of theories, including self determination theory. We could fit this to social learning theory by allowing her to compare her 'shopping finds' to others. We could also build a reinforcement schedule around this theme. Another man told us the worst bit of his day was getting up as his disability meant that his routine of getting ready for the day was extremely tiring. According to needs theory he will not be ready to progress to rehabilitation tasks until this basic need of resting is satisfied. This might lead to design of activities where users determine the pace or pause the system for a rest. The sensory stimuli gave us information that we could incorporate in design that might lead to individuals feeling intrinsic motivation to use the technology, e.g. preferred textures.

By relating data to multiple theories of motivation and related issues such as hope, flow and change readiness [15] we were able to uncover elements of potential importance for practical design. E.g. a participant with short-term memory and other subtle cognitive difficulties found it very hard to initiate activities. In design of applications for individuals we can consider different aspects and evaluate their importance for adoption and use of applications in the home. In future work we can explore differences in data and design resulting from use of one, compared to multiple theories. We can experiment to identify the most useful elicitation tools to use for a refined version relating to refined set of questions and categories.

IX. CONCLUSIONS: DESIGNING FOR MOTIVATION

In this paper, we address the issue of how to draw on various theoretical, cultural and lived understandings of motivation in order to develop a motivation elicitation toolkit, principled in both content and form, suitable for people living with stroke. We describe our approach to developing the toolkit and discuss how it was used to understand motivations of individuals living with stroke, to engage with home-based exercise technology, despite dysphasic and other difficulties. We were able to use the findings from our methods in two ways. Firstly we were able to distill some general principles for our designs and secondly we were able to identify some

elements of motivation and specific questions and tools that were particularly relevant for our participants as individuals and the type of applications we wanted to build.

We enabled participants to communicate a diverse range of the motivational triggers in their lives and provide us with specific cases that we could use to inspire design, and that complement the abstract motivation described by theory.

We have already used data for iterative design of prototype applications to motivate people to practice rehabilitation exercises. We held a series of workshops with stroke survivors, carers and therapists, to discuss emergent themes, design storyboards and prototypes [16]. We have subsequently undertaken a trial study where we deployed four bespoke technologies with stroke survivors [2,3,23]. These will inform the design of a plug and play system (input devices, activities, and feedback mechanisms) that will take account of the most suitable levels of challenge, type of activity, reinforcement schedules, prompts, monitoring and feedback required for optimal motivation to rehabilitation exercises at different stages of lived experience of stroke and motivation to engage with rehabilitation technologies. Our principled approach tying elicitation back to theory, individual context and culture has potential to elicit motivation requirements in other domains and with other user groups and for exploring other 'difficult to express' topics in HCI design.

ACKNOWLEDGMENT

Many thanks to our participants. This work was funded by the UK EPSRC: Grant EP/F00382X/1.

REFERENCES

- L. Axelrod, G. Fitzpatrick, J. Burridge, S. Mawson, P. Probert Smith, T. Rodden and I. Ricketts "The reality of homes fit for heroes: design challenges for rehabilitation technology at home," *Journal of Assistive Technology*, 3 (2), 2009, pp. 35-43
- M. Balaam, S. Rennick Egglestone, A.M. Hughes, T. Nind, A. Wilkinson, E. Harris, L. Axelrod, and G. Fitzpatrick. "Rehabilitation centred design," *Proc CHI EA 2010*. ACM, New York, NY, 4583-4586.
- M. Balaam, S. Rennick Egglestone, G. Fitzpatrick, T. Rodden, A.M. Hughes, A. Wilkinson, T. Nind, L. Axelrod, E. Harris, I. Ricketts, S. Mawson and J. Burridge "Motivating Mobility: Designing for lived motivation in stroke rehabilitation," In press. *Proc CHI 2011*
- A. Bandura, *Self-efficacy: The exercise of control*. Freeman, NY, 1997.
- S. Bassett, "The assessment of patient adherence to physiotherapy rehabilitation" *NZ J. Physiotherapy*, 31(2), 2003, pp.60-66.
- T. M. Bekker and B. H. Eggen, "Designing for children's play," *Proc. CHI 2008*, ACM Press, 2008.
- G. Bell, M. Blythe and P. Sengers, "Making by making strange: defamiliarisation and the design of domestic technologies," *Trans. CHI (TOCHI)*, 12, 2, 2005, pp.149-173.
- K. Boehner, J. Vertesi, P. Sengers and P. Dourish, "How HCI interprets the probes," *Proc. CHI 2007*, ACM Press, 2007, pp.1077-1086.
- M. Blythe, K. Overbeeke, A. Monk, P. Wright, Eds. *Funology: From Usability to Enjoyment*. Springer Press, 2003.
- Y. Chang, J. Lo, C. Huang, N. Hsu, H. Chu, H. Wang, P. Chi, Y. Hsieh, "Playful toothbrush: ubicomp technology for teaching tooth brushing to kindergarten children," *Proc. CHI08*, ACM Press, 2008, pp.363-372.
- M. Csikszentmihályi, *Finding Flow: The Psychology of Engagement With Everyday Life*. BasicBooks, 1998.
- S. Consolvo, D. McDonald and J. Landay, "Theory-driven design strategies for technologies that support behavior change in everyday life," *Proc. CHI09*, ACM Press, 2009, pp.405-414.
- E. Deci and R. Ryan, *Intrinsic motivation and self-determination in human behavior*. Plenum, NY, 1985.
- G. Denis and P. Jouvelot, "Motivation-driven educational game design: applying best practices to music education," *Proc. ACM Press*, 2005, pp.462-5.
- C. DiClemente, J. Prochaska, and M. Gibertini, "Self-efficacy and the stages of self-change in smoking," *Cognitive Therapy and Research*, 9, 1985, pp.181-200.
- S. Rennick Eggleston, L. Axelrod, T. Nind, A. Wilkinson, Z. Robertson, I. Ricketts, G. Fitzpatrick, R. Turk, J. Burridge, S. Mawson, T. Rodden, P. Smith, N. Shublaq "A framework for a home-based stroke rehabilitation system,". *Proc 3rd Int Conf Pervasive Computing Technologies for Healthcare 2009*.
- B. Fogg, *Persuasive technology: Using computers to change what we think and do*. Morgan Kaufman, San Fransisco, 2003.
- B. Gaver, T. Dunne, E. Pacenti, "Design: cultural probes," *Interactions*, 6, 1, Jan./Feb. 1999, pp.21-29.
- C. Graham, M. Rouncefield, M. Gibbs, F. Vetere and K. Cheverst, "How probes work", *CHISIG2007*, pp.29-37.
- T. Hemmings, K. Clarke, A. Crabtree, T. Rodden and M. Rouncefield, "Probing the probes," *ACM Press*, 2002, pp.42-50.
- J. Hidler, D. Nichols, M. Pelliccio and K. Brady, "Advances in the understanding and treatment of stroke impairment using robotic devices," *Top Stroke Rehab*, Vol. 12(2) 2005, pp.21-33.
- S. Hollyforde, *The Motivation Handbook: Developing Practice*. The Chartered Institute of Personnel and Development, 2002.
- A. M. Hughes, J. Burridge, M. Balaam, E. Harris, S. Rennick-Egglestone, T. Nind, A. Wilkinson and S. Mawson "Motivating Mobility - An exploration of developing upper limb rehabilitation technology tailored to individual stroke patients needs," *Proc World Congress for Neurorehabilitation, 2009*, Vienna, Austria.
- I. Li, J. Forlizzi, K. Anind and B. Keisler, "My agent as myself or another: effects on credibility and listening to advice," *Proc. DPPI*, 2007, pp.194-208.
- J. Martin, E. Murphy, J. Crowe and B. Norris, "Capturing user requirements in medical device development: the role of ergonomics," *Physiological Measurement*, 27, 8, 2006, pp.R49-R62.
- N. Maclean and P. Pound, "Critical review of patient motivations in the literature on physical rehabilitation," *Social Science and Medicine*, 50 2000, pp.495-506.
- L. Mamykina, E. Mynatt, P. Davidson and D. Greenblatt, "MAHI: investigation of social scaffolding for reflective thinking in diabetes management," *Proc. CHI08*, ACM, 2008, pp.477-86.
- A. Mathew, "Using the environment as an interactive interface to motivate positive behavior change in a subway station," *Proc. CHI05 EA*, ACM Press, 2005, pp.1637-1640.
- D. Mercado, "A manual on processing and reporting of Participatory Rural Appraisal data", accessed 4.2.2011, www.spc.int/lrd/Publications/Fat/PRA_Manuals/PGRFP_PRAMan_010_6_lowres.pdf
- I. Mulder, Y. Schikhof, M. Vastenburg, A. Card, T. Dunn, A. Komninos, M. McGee-Lennon, M. Santcroos, G. Tiotto, M. vans Gils, J. van 't Klooster, A. Veys & M. Zarifi Eslami, "Designing with Care: The Future of Pervasive Healthcare," *IEEE Perv Comp*, 8(4) 2009, pp.85-88.
- T. Powlledge, *The Dope on Dopamine's Central Role in the Brain's Motivation and Reward Networks*, 2008, accessed 4.2.2011, www.scientificamerican.com
- J. Schreiber and P. Stern, "Review of literature on evidence-based practice in physical therapy," *Internet Journal of Allied Health Sciences and Practice*, 3, 4, 2005. Accessed 4.2.2011 <http://ijahsp.nova.edu/articles/vol3num4/schreiber.pdf>
- J. Wallace, J. McCarthy, P. Wright and A. Dearden, "The experience of enchantment in human-computer interaction," *Personal and Ubiquitous Computing*, 10,6, 2005, pp.369-378.
- A. Wilkinson, S. Mawson, S. Rennick-Egglestone, A.M. Hughes, T. Nind, M. Balaam and E. Harris "Using Motivational Theories to Inform Design of Assistive Technology for Motivating Rehabilitation," *World Congress of Neurorehabilitation, 2010*, Vienna, Austria.