Card Sorting for User Experience Design

**This paper reviews types and uses of card sorting and how a relatively unpopularised variation of card sorting - ‘repeated single-criterion sorting’, can be applied to the information architecture design of digital music services. 52 respondents were asked to sort, using their own choice of criteria, 12 popular songs using an online card sorting tool. Once respondents had chosen a construct for a particular sort e.g. “Genre”, they placed each card into a named category e.g. “Rock”, “Pop”, and were encouraged to repeat this process until they could think of no more constructs. High levels of agreement were found for a small number of constructs such as “genre”, “gender” and “speed of song” but the remaining constructs were individual to each respondent e.g. “songs that make me cry”. The results highlighted differences with current approaches to music categorisation, as well as the potential for repeated single-criterion sorting to be used to design faceted navigation structures and form part of the user-centred design process.**

Requirements Elicitation, Card Sorting, Information Architecture, Faceted Navigation, User-Centered Design (UCD), User Experience (UXD, UX).

1. Introduction

User experience design (UXD) and usability evaluation are supported by a range of tools and techniques. A number of these methods utilise attributes that are predetermined by the researcher such as heuristic assessment (Nielsen & Molich, 1990) and cognitive walkthroughs (Wharton *et al*., 1994) which may not be relevant to the intended audience. To tackle this, methods that elicit criteria from the users themselves such as think-aloud protocol (Nielsen, 1992), card sorts (Rugg & McGeorge, 1992), and laddering (Gammack, 1987) have been developed.

A popularised version of card sorting, termed “all-in-one” sorting has become one of the standard techniques in the User-Centered Design (UCD) process (Usability.gov. N.D). “All-in-one” sorting improves “findability” within a system and has been successfully used to determine the Information Architecture (IA) of websites (Spencer & Warfel, 2009) (e.g. Frederickson-Mele, 1997; Tullis, 2003; Tullis & Wood, 2004) and software menu systems (Tullis, 1985). A variation of card sorting ‘repeated single-criterion sorting’, has been highlighted (Maiden, 2009) for its potential in requirements elicitation, but few empirical studies investigate how this variation of card sorting relates to UXD and how it can be integrated into the UCD process.

In order to address this, this study has applied repeated single-criterion sorting to the problem of music categorisation and the design of digital music services.

This paper is structured as follows. Section 2 gives an overview of different card sorting techniques and work related to music categorisation. Section 3 outlines the method used, respondents and materials. Section 4 presents the results and Section 5 the analysis of these results. Section 6 discusses the implications of the study and Section 7 presents overall conclusions.

2. Background

This section describes current and historical card sorting methods with specific reference to Personal Construct Theory, the related RepGrid method, variations of card sorting and associated concepts such as categorisation. It also includes academic and commercial approaches to music categorisation (which is the application area of the study described later in the paper).

**2.1 Personal Construct Theory**

Card sorts are closely related to Kelly’s Personal Construct Theory (PCT), a constructivist approach based on the metaphor of people as scientists, who continually construct their own mental models of the world and test those models against reality (Rugg and McGeorge, 2002), described in Kelly’s key postulate as “a person’s processes are psychologically channelised by the ways in which he anticipates events” (Kelly, 1955). The theory states that each person has a point of view from which they see the world as being real and that their psychological processes are based on personal versions of that reality and these personal versions are personal constructs (Upchurch, 1999). A construct represents the view a person has constructed about the world as they experienced it and at the same time indicates how they are likely to construe the world as they continue to experience it (Enquirewithin, 2010). This means that different people categorise the world differently, with enough commonality to let us understand each other but enough differences to make us individuals (Upchurch et al., 2001). This dual support for both individuality and commonality has implications therefore for eliciting individual requirements from specific viewpoints as well as the aggregation of data elicited from a group.

The main postulate of PCT is supported by eleven elaborative corollaries, which are summarised below:

* Constructs make the world more predictable because they reflect people’s constant attempt to interpret observations of the world, draw conclusions and behave accordingly.
* Constructs are non-static and are continually challenged or confirmed.
* Constructs influence expectations and perceptions due to their relationship with past experiences.
* Some constructs are more important than others meaning that some constructs are fixed and others are malleable.
* A construct represents the truth as that person understands it.
* An individual’s constructs are not always internally consistent.
* The level that an individual is able to understand another individual’s constructs is related to how empathetic that individual is. (Enquirewithin, 2010)

One of the key assumptions of PCT is that the individual has access to the mental models that they have formed, even though they themselves may be consciously unaware of what their constructed models are (Rugg and McGeorge, 2002). These models can then be elicited using several approaches such as laddering (e.g. Gammack 1987; Rugg et al. 1992) and repertory girds (e.g. Shaw and Gaines, 1996). As stated previously, although the assumption with PCT is that each person has their own unique set of models, there is also the assumption that there is usually a fair amount of agreement and overlap between individual’s models. Without this overlap, people would be unable to understand one another. It is this ability to elicit these models and clarify what they mean is a key component of PCT and the reason why there has been a great deal of interest in developing PCT based techniques in requirements elicitation and evaluation (e.g. Upchurch et al., 2001; Maiden, 2009).

2.2 Repertory Grids

Repertory Grids, widely referred to as “RepGrids”, the complementary methodology to PCT developed by Kelly to elicit people’s constructs, have been described as “a means of surfacing people’s perceptions, attitudes or concepts in an uncontaminated way” (Honey, 1979). RepGrids were developed with the inherent interviewer bias that existed in current methodologies in mind. It is this lack of interference that has been described as one of its main advantages (Whyte and Bytheway, 1996) along with the fact that it requires less resource e.g. time than participant observation (Tan and Hunter, 2002) or completing questionnaires (Alexander and van Loggerenberg, 2005).

The “classic” RepGrid as described by Alexander and van Loggerenberg is a matrix consisting of columns comprised of a list of elements and rows for the constructs. The elements are concrete examples that are used to help respondents identify their own constructs or perceptions regarding the particular research topic that is being considered. For example, if the domain being researched was people’s perceptions of medical careers, the elements could be a list of jobs such as “nurse”, “doctor” etc. These elements can be generated by the respondent or the researcher and are assigned arbitrary numbers and these then form the column headings in the matrix. The elements chosen should be precise, homogeneous, representative, meaningful and relevant to the participants (Tan and Hunter, 2002). Respondents are then asked to complete a process called triading where they are asked to pick three of the elements (or are given three of the elements) and identify a characteristic of the three selected examples, such that two of the selected individuals are similar in some way and the third is relatively dissimilar (Alexander and van Loggerenberg, 2005). This can be achieved by asking a question such as “Can you tell me a way in which any two of these people are different from the third, in terms of ......?”. This form of comparison produces a construct with a bipolar scale by describing the way that two things are similar and implies the existence of something else that is different (Upchurch, 1999).

The respondent or interviewer then writes the construct as the row label in the form of two contrasting statements. The first, placed on the leftmost side of the row, highlights what the pair of selected elements have in common and the second, written on the right-hand side, why the single element is different (Alexander and van Loggerenberg, 2005).

The constructs are then turned into bipolar scales by asking the respondent to evaluate each element with respect to the construct and to fill in a score in the appropriate cell of the grid. A high score indicates that the element closely resembles the description on the right, a low score indicates that the element closely resembles the description on the left. This process is repeated as long as the respondent can generate constructs or time allows.

The RepGrids can then be analysed with both quantitative and qualitative methods. The constructs can be categorised into verbatim and super-ordinate constructs to identify similarity between respondents and statistical techniques (Lee and Truex, 2000; Bell, 2006; Harter et al., 2004) can be used to analyse the matrices for similarity of constructs used and the scores given for those constructs. A number of computerised versions of the RepGrid technique have been implemented to support this process (e.g. Boose, Sheema and Bradshaw, 1989).

Although a number of studies have been conducted using RepGrids in Computer Science and Information Science (e.g. Hunter and Beck, 2000; Hunter, 1997; Tan and Hunter, 2002), it has been noted that although people are able to describe their own constructs with reasonable reliability and validity (Rugg and McGeorge, 1997; Tan and Hunter, 2002), people sometimes find it difficult to verbalise their constructs in a way that can be understood by others. There is also the problem that as a construct represents the truth as that person understands it, two people, based on the same set of facts may come to entirely different conclusions based on their own previous experience (Kelly, 1995). There have also been studies that have suggested that RepGrids are not suited for all types of data and have particular problems with nominal values i.e. categories that do not have scalar values (Yorke, 1983; Rugg and Shadbolt, 1991). Sorting techniques however are able to deal with such categories (Rugg and McGeorge, 1997) and have the added benefit of eliciting categories and categorisation as well as an individual’s constructs. There is also the suggestion that sorting has further advantages of being quick, systematic and easy to use for both the respondent and the researcher (Rugg et al., 1992). The following sections explore sorting techniques in more detail.

2.3 Variations of sorting techniques

There are a number of variations on sorting techniques including Q sorts, hierarchical sorts, “all in one” sorts and repeated single-criterion sorts that are used in a variety of domains for a range of purposes. The following section details each variation and gives examples of where each has been previously used.

*Q sorts*

Q sorts were derived from Stephenson’s (1953) Q methodology and have been used in fields such as personality theory in psychology (Block, 1961). Q methodology provides a basis for the systematic study of subjectivity in particular a person’s viewpoint, opinion, beliefs and attitude (Brown, 1993). Q sorts generally involve large sets of cards, which can have a different phrase or statement on them that refer to a particular topic. This is called the Q-set. Respondents, called the P-set, are then asked to rank-order the cards from their own individual point of view, according to some preference, judgement or feeling about them (van Exel and de Graaf, 2005) using a normal distribution pre-determined by the researcher. In doing this, the respondents are providing subjective meaning to the statements, and by doing so reveal their subjective viewpoint (Smith, 2001) or personal profile (Brouwer, 1999). For example, the cards may contain descriptive phrases that relate to a person’s personality and the respondent is asked to place these cards in relation to how important they think those descriptors are on a scale from “strongly agree” to “strongly disagree”. The respondent is encouraged to place the majority of the cards in the centre of the scale with a few cards at either end. These individual sorts are then subject to a statistical technique such as factor analysis (van Exel and de Graaf, 2005). By comparing and analysing Q sorts, details about similarities and differences in viewpoint on a particular subject can be determined. Stephenson (1953) argued that if respondents have their own individual opinions then their profiles (their Q sorts) will not correlate. However, if significant clusters of correlations exist, they could be factorised and described as common viewpoints (or tastes, preferences, dominant accounts, typologies etc.), and individuals could be measured with respect to them (van Exel and de Graaf, 2005).

However, as Rugg and McGeorge point out (1997), imposing a semantic distribution on a respondent’s categorisation i.e. a normal distribution, which might not be appropriate, and could affect the results. Combined with the amount of resources required to prepare the entities for the sort and to statistically analyse the results as well as the time the respondent and researcher require to perform each sort session has led Rugg and McGeorge to suggest that Q sorts are not suitable for routine Knowledge Acquisition (KA) use.

*Hierarchical sorts*

Hierarchical sorts are often used to establish semantic hierarchies within a domain (Rugg and McGeorge, 1997). This can be performed with cards that represent entities at different semantic levels or at the same semantic level. An example task with entities at different semantic levels would be to organise species such as dogs and cats at the same time as others that represented classes, genus, order etc. into a similar hierarchical structure as the Linnaean taxonomy. This method has been previously used in the design of an expert system to develop wood head golf clubs (Chen and Occena, 1999).

Similar to Q sorts, Rugg and McGeorge do not recommend this approach for knowledge acquisition due to the resource involved in preparing the entities (whether at the same or different semantic levels) and the potential to distort the categorisations elicited. The suggestion is that laddering is more suitable for hierarchical elicitation.

*“All in one” sorts*

This category of sort covers a wide range of methodologies with the overlapping feature that the respondent (or groups of respondents) only sorts the set of entities once. One approach to the “all in one sort” is to allow the respondents to sort entities into a matrix layout using one attribute for one axis and another attribute for the other (Rugg and McGeorge, 1997). One potential use of this technique could be to ask respondents to sort cards that have pictures of products for an e-commerce website on them into a matrix with “price of product” along one axis and “rating” along the other.

The more commonly utilised “all in one” sort consists of either open and closed sorting for the purpose of determining the Information Architecture (IA) of a website (Spencer and Wharfel, 2004) (e.g. Frederickson-Mele, 1997; Tullis, 2003; Tullis and Wood, 2004), designing mainframe menu systems (Tullis, 1985), generally improving the findability within a system. The respondent is usually given a set of cards that represent products, pages or functionality within the site or application and then in the case of closed sorting. The number of cards is dependent on the type of entity but around ninety cards has been a suggested limit (Courage and Baxter, 2005). Up to five hundred cards however have been sorted in previous studies (Tullis, 1985). The respondent is asked to sort the entities into a set of pre-defined categories or in the case of open sorting asked to sort the entities into categories of the respondent’s choosing and then name them. In the case of closed sorting the category that each entity has been sorted into is recorded; for open sorting the names of the categories are recorded along with the category position of each entity. Open card sorting “is useful as input to information structures in new or existing sites and products” whereas “closed sorting is useful when adding new content to an existing structure, or for gaining additional feedback after an open card sort” (Spencer and Wharfel, 2004). The reported advantages include similar savings in resources such as time but also cost and in comparison to other approaches used by some web designers and developers it is user-centred and therefore not as susceptible to “gut-feel” biases (Spencer and Wharfel, 2004) and reliance on the designer’s mental model (as opposed to the users’) (Courage and Baxter, 2005). The disadvantages include that the methodology is too content-centric and does not take into account the users’ task i.e. how they would interact with the content on a site and that analysis can be time-consuming, especially with large numbers of cards and/or respondents (Spencer and Wharfel, 2004).

The analysis of results from this “all in one sort” can incorporate both informal and formal methods. Spencer and Wharfel (2004) suggest that with small numbers of respondents and cards the researcher might be able to see broader patterns by simply laying the cards out on a table and looking for patterns through similar groupings and labelling. This approach is also reported in studies by Nielson and Sano (1994) and is termed “eye-balling”. The more formal approach is to use a statistical technique such as cluster analysis with the results often presented in a dendrogram. There have been a number of software tools developed such as EZSort (Dong et al., 2001), which is comprised of a GUI tool to perform sorts (USort) and an analysis tool (EZCalc), which performs cluster analysis and produces tree diagrams for further interpretation. Cluster analysis quantifies card sorting data by calculating similarity scores (Dong et al., 2001). These scores are generated for each pair of cards by counting the number of times a card is sorted into a common group with another card i.e. a co-occurrence matrix. Trees, more formally dendrograms, are then produced to visualise the relationships between the cards and to identify possible navigational structures within a site. Lamantia (2003) has reported limitations with the EZsort software (and a similar tool called WebCAT) in the number of cards and categories that can be analysed. Lamantia has therefore developed a simple Excel spreadsheet in which the results from card sorting sessions can be entered and analysed, using both “eye-balling” and a form of cluster analysis. There is also some overlap in the analysis of “all in one” sorts and the repeated single-criterion sorts, which will be described in the next section.

Rugg and McGeorge however do not recommend “all in one” sorts for knowledge acquisition use due to the fact that this variation is not used to elicit individual constructs and attributes of entities. The respondents are rarely asked to explain their categorisation, only in the case of open sorting to name the category that they have placed the entity within. However, the open and closed variations of this type of sort have been used successfully in the production of large-scale e-commerce websites and are now an integral part of the analysis and design stages of a user-centred design lifecycle (Bevan, 2003; Sherwin, 2018). Due to their prominence, there are now also a number of applications that have been implemented to support this approach.

*Repeated single-criterion sorts*

Sometimes known as open card sorting, repeated single-criterion involves asking the respondent to sort entities into groups of the respondent’s own choosing; after each sort has been performed, the respondent is asked to sort again, using a different criterion of their own choosing, until they run out of criteria. The entities can be picture-based e.g. full- size, full-colour screenshots of Web pages, text-based e.g. descriptions of web pages and physical objects e.g. fruit (called object sorts). Empirical research has so far found no statistical difference between the types of criteria and categories elicited when using different types of entity (Rugg et al., 1992).

This approach works well with nominal categories, and typically elicits group names and criteria consisting of short phrases. This method is described by Gammack (Gammack, 1987) and is described in detail in a tutorial paper by Rugg and McGeorge (Rugg and McGeorge, 1997). The technique has been applied to a wide range of topics, including web page quality metrics (Upchurch et al, 2001); quantification of copyright infringement (Martine and Rugg, 2005), and assessment of differences between expert and student programmers (Sanders et al, 2005). It is supported by a range of statistical analyses, including co-occurrence matrices (Martine and Rugg, 2005) and minimum edit distances (Deibel et al, 2005) which are detailed later in this thesis.

Rugg and McGeorge recommend the use of repeated single-criterion sorting for KA due to its flexibility and a stronger grounding with the relevant theoretical foundation i.e. PCT. Maiden (2009) has also recently highlighted the value of this type of sort for requirements elicitation for similar reasons.

Other sorting methodologies

As well as the four sort types explained in detail in the previous sections, Bernard and Ryan (2000) have described a set of related sorting techniques that are used in sociological research. Although beyond the scope of this review they are summarised below to indicate the level of interest and use of card sorting in other domains. It should be noted that there is also overlap with some of these methodologies and those described previously, with the difference being in name only.

Paired comparisons are where the respondent is asked to compare two objects along a scale, or rank two objects against one another in order to explore the relationships between the two objects.

A triad test is where the respondent is presented with three items and asked to choose the two most similar or the one least like the other two. This is used to explore relationships between three objects.

Frame substitution is where each respondent is asked to link each item in a list of items with a list of attributes. This is performed to define attributes or the context of items.

Pile sorts are where each respondent is asked to sort a set of cards or objects into piles to explore relationships between all objects in the card set. This is similar to the “all in one” sort.

Successive pile sorts are where respondents sub-divide each free pile sort until each item is in an individual pile. This is used to create a folk taxonomy and is similar to hierarchical sorting.

**2.4 Repeated single-criterion/Open sorting process**

The following section focuses on the repeated single-criterion methodology and details some of the issues that are specific to this approach.

*Sort terminology*

An implication of the relationship between PCT and card sorting is that for particular types of sorting, the terminology has been based on that used in PCT (Rugg and McGeorge, 1997) as described below.

A **construct** is defined as an attribute used by an individual to describe an **entity** (Kelly, 1955; Bannister and Fransella, 1980; Rugg and McGeorge, 1997; Rugg and McGeorge, 2002) and falls within a **range of convenience** that the construct can be meaningfully used in. Example constructs of the entities “Windows Vista” and “Snow Leopard” include “ease of use” and “expensive” where “ease of use” would be useful when discussing a computer but not useful in the context of the price of an item. A **criterion** is the attribute used as the basis for a sort when using a sorting technique such as “size of font” or “cost”. A **category** is a group into which an entity can be sorted into using a criterion. For example for the criterion “origin of content”, the categories might be “UK”, “USA” and “France”.

*Analysis of repeated single-criterion/Open sorting*

The usual way of aggregating the output from card sorts, as described in Rugg and McGeorge (1997) involves a three-stage process. The first step is to aggregate those criteria which have identical wording (verbatim agreement). The second stage is then to aggregate criteria which are judged to have identical underlying meaning, but where the meaning is expressed in different words (gist agreement). The third, and most difficult, stage involves aggregating the responses into groups on the basis of underlying similarity. This raises questions about what constitutes “underlying similarity”. It is also a time-consuming process when done manually, and for practical reasons there are advantages in using a single independent judge who is blind to any research hypotheses being tested. One of the few studies which tested inter-judge reliability by Gerrard and Dickinson (2005), found reasonably high reliability between the judges that they used. This, however, is no guarantee that high inter-judge reliability would occur with other judges or in other domains.

One obvious way of assessing similarity is via software, and two main approaches have been developed within the card sort community. One involves co-occurrence matrices, which show how often each card is placed in the same group as each other card in the set (Martine and Rugg, 2005). This method does not require any knowledge either about the domain or about the criteria which were used for the sorting. Another approach (Deibel et al., 2005) focuses on the criteria, rather than the cards, and measures the minimum edit distance between pairs of criteria (i.e. how many of the cards would need to be moved from one group to another in order to produce the identical groupings of cards between the two criteria being compared). This method also does not require any knowledge about the domain or about the semantic meaning of the criteria being compared. Both these methods offer obvious advantages for dealing with very large data sets, such as the set in the multi-institutional study of programming concepts using card sort data (Sanders et al., 2005). They do not, however, answer questions about inter-judge reliability in human ratings of criteria, which appear to be implicitly viewed as the “gold standard” for data analysis.

One source of possible confusion has already received some attention within the card sorts community. Two concepts, such as “readability” and “user-friendliness” may be similar to each other from one viewpoint (Rugg and McGeorge, 1997) or facet (Ranganathan, 1962), but may be very different in terms of another viewpoint or facet. If different viewpoints and/or facets are being used between judges, and/or an individual judge uses more than one different viewpoint or facet, then this could easily lead to apparent inconsistencies in their judging. For example, given the constructs “ease of navigation” and “navigation position”, one judge may group these into the superordinate “navigation” from the viewpoint/facet of “webpage components” whereas another judge may group these into separate superordinates such as “usability” and “layout” from the viewpoints/facets of “web design education”.

A second issue with different implications relates to which higher-level chunking criteria are viewed as important by the human judges. If it turns out to be the case that human judges consistently use a small set of higher-level chunking criteria, then this raises the prospect of using some form of thesaurus-based software to perform semantic aggregation of the data (as opposed to the explicitly non-semantic aggregation performed by co-occurrence matrices and by minimum-edit measures for sorting criteria).

*Respondent Numbers*

It has been suggested that the number of respondents to recruit for a card sort study is as much a factor of time and resource as any published guidelines (Deaton, 2004). The number of respondents in published studies ranges from four (Nielsen and Sano, 1994) to two hundred and forty-three (Sanders. et al., 2005). Informational articles on card sorting generally recommend a minimum of six (Deaton, 2004) whereas Nielsen (2004) suggests fifteen for a correlation point of 0.90, with diminishing returns occurring after this figure. This number is corroborated by research by Tullis and Wood (2004) that indicate that “reasonable structures are obtained from twenty to thirty participants”. However, all of these figures are recommendations for “all in one” sorts used to determine the information architecture of a website. During the research for this thesis, no published guidelines for the number of respondents required for single repeated-criterion sorting were found.

As reported by Deaton (2004), respondents for studies have been recruited from a variety of sources including a campus directory (Faiks and Hyland, 2000), recruiting co-workers (Nielsen and Sano, 1994; Frederickson-Mele, 1997) and recruiting from a corporate database of respondents meeting project requirements (Graf, 2002 cited in Deaton, 2004). The key issue is to ensure that the respondents represent the end-users of the website/application (Deaton, 2004) and to include representatives from all of the major user groups (Spencer and Wharfel, 2004, Robertson, 2001).

*Choice of entities*

Rugg and McGeorge (1997) give detailed advice regarding the choice of appropriate variety of entity when conducting a repeated single-criterion sort. They suggest that object sorts i.e. sorts with a physical object such as fruit, have the advantage that a respondent can use all of their senses when sorting objects e.g. touch, smell etc. and also the entities can be unfamiliar to the elicitor or respondent in the case of a new product. The disadvantages include practical limitations such as size of the object and also the object might have irrelevant or distracting features that the respondent fixates on. Picture sorts have an advantage over object sorts in that they are often more practical, but they are restricted to visual information. Text-based sorts (referred to as “card sorts” by Rugg and McGeorge) have the advantage that they have very little distracting information which inversely can be one of their main disadvantages.

Once an appropriate variety of sorts has been chosen, Rugg and McGeorge stress the importance of the choice of entity and in particular that the entities have appropriate semantic coverage i.e. the cards should represent one entity from each of a set of nodes in a hierarchy, sharing the same parent or all of the children from the same parent i.e. the entities should represent an even spread from the same horizontal level of a hierarchy (if the domain is hierarchical). Spencer and Wharfel (2004) refer to a similar concept when referring to “all in one” sorts but write about the “granularity” of the cards. They suggest that respondents will find it difficult to group entities at different levels of granularity e.g. individual pages, functionality, small groups of pages etc.

*Number of entities*

The reported number of entities that is appropriate for a sort is again dependent on the sort type. For “all in one” sorts, Spencer and Wharfel (2004) recommend that between thirty and a hundred cards “works well” as they suggest that thirty cards does not allow for enough grouping to emerge and anything more than one hundred cards can be too time-consuming for respondents. They report however that they have successfully performed sorts with over two hundred cards. For repeated single-criterion sorts Upchurch et al. (2001) suggested that fewer than eight cards could cause the researcher to overlook important objects, but more than twenty would be too cumbersome for respondents to handle. Rugg and McGeorge (1997) also suggest eight as a lower limit if the results are to be analysed statistically with a maximum of around twenty to thirty being conveniently manageable.

**2.5 Summary of card sorting methods**

This section has presented a review of a number of methodologies and their relationship to the work of George Kelly (1965) and in particular Personal Construct Theory. It is this close relationship between underlying theory and practical application that have increased the interest in techniques such as repertory grids and card sorting in the KA and Requirements Acquisition (RA) communities. A number of studies have indicated however that RepGrids are not suited for all types of data and have particular problems with categories that have scalar values. Sorting on the other hand has been shown to support such categories and has the further advantage of eliciting categories and categorisation, useful for determining information architecture, as well as an individual’s constructs.

Although Q and Hierarchical sorts have been utilised in a range of domains, research by Rugg and McGeorge has indicated that they are not suitable for KA and RA but “all in one” and “repeated single-criterion” sorting are. “All in one” sorting is generally used in IA and uses variations of cluster analysis to determine the navigational structure of a website or application. Repeated single-criterion sorting can also be used for IA and categorisation but is predominantly used to elicit constructs and study people’s perceptions of various media. It also has a greater range of analyses techniques included qualitative techniques such as independent judging (e.g. for superordinate and gist analysis) and quantitative techniques such as minimum-edit distance and co-occurrence matrices. The choice and number of entities is an important consideration when planning a card sort study and there seems to be a range of views as to what constitutes a suitable number of respondents, mainly dependent on the type of sort being utilised.

The continuing use of “All-in-one” Card Sorting in the UX/usability field (Usability.gov, N.D.; Babich, 2019) suggests that user-centred sorting methods are still popular, but there seems little use or knowledge of the “repeated single-criterion” sorting variation and therefore its strengths are currently not being taken advantage of by either researchers or practitioners.

**2.6 Music Categorisation**

The ease of purchasing and streaming music online and the shift towards storing and organising music digitally has shaped music preference behaviour (Greasley & Lamont, 2006). Studies investigating people’s use of music have indicated that people listen to music for specific reasons and that their motivations for listening to music depends on context (DeNora, 2000; North et al., 2000; Sloboda et al. 2001). However, the ubiquitous nature and ease of access to music presents problems: How to organise music so that it is accessible, and convenient? How to discover more songs, similar to those they enjoy?

Musical genre is a widely used standard for categorising music (Aucouturier & Pachet, 2003; Pachet & Cazaly, 2000) and often the preferred technique. However, the definition of a music genre is subjective since it is influenced by extrinsic factors (Lippens, 2004; Aucouturier & Pachet, 2003). This leads to undefined boundaries of genres and as a consequence, there is a lack of a precise method of classifying music to genres. Online stores such as iTunes categorise music by standard music industry decided taxonomies (similar layout of traditional bricks and mortar retail stores) with genre being the primary method for users of the software to find songs that they like. The user has to have a definite idea of what genres they like, what genre a song fits into and for this to match with the categorisation used by the online store.

One of the most commercially popular attempts at improving musical classification with the intention of creating automated playlists for streaming radio is Pandora, based upon the Music Genome Project (Joyce, J., 2006). The Music Genome project attempts to describe music with vectors consisting of hundreds of genes or musical attributes describing each song (McKay, 2010). It is unclear what the complete list of attributes are, but a partial list (that is now not publicly available) suggested that the following are included: Structures; Roots; Tonality; Instrumentation; Feel; Musical qualities; Leanings/styling; Recording techniques; Influence; Instruments; Lyrical content and Vocals.

A song is represented by a vector of these attributes, with up to five hundred genes/attributes forming the vector. Each attribute/gene is assigned a number between 1 and 5 in half integer increments (see Music Genome Project US Patent: No. 7,003,515). Given a single song or a group of songs, a distance measure is then calculated from this vector to produce a list of related songs. Though the retrieval process is automated, the scaling and classification of the songs is an entirely manual, subjective process.

There have been attempts at creating flat taxonomies of music using folksonomies or tagging e.g. Last.fm, which utilise the user generated attributes to categorise songs, increasing the number of attributes that can then be used to describe a song and potentially produce a richer categorisation schema. These rely solely on the individual’s perceptions of a song and depend on users using the same tag or set of tags for the same songs if they can be then used to recommend similar songs.

For the majority of digital music services, there is a reliance on genre-based systems which are reliant on inconsistent, intrinsic features of a song. There is little research into appropriate feature sets for classifying different types of song, and the relationship between objective and subjective attributes that users classify songs by. There is also little exploration into which of these features can be supported by current technologies or by extending pre-existing functionality as opposed to creating entirely new systems. Card sorting offers a potential solution to these problems as it has been previously used to determine user perceptions of a range of media (e.g. Upchurch et al., 2001) and also similarity measures using a range of user identified attributes (Martine & Rugg, 2005).

The following sections describe the use of repeated single-criterion card sorting to identify users’ perceptions of a range of popular songs.

3. Methods

As part of a related study (AUTHOR, 2010), an online card sorting tool has been developed. The application includes functionality to support a range of multimedia such as pictures, music and videos along with analysis techniques such as co-occurrence matrices.



**Figure 1:** Screenshot of online card sorting tool

Figure 1 shows the sorting interface where respondents are presented with the entities on the left-hand side (in this case artist names) and are asked to input the sort criteria (in this case “Gender of Artist”) and sort the entities into groups of their choosing (in this case the user has created 2 groups, “Male” and “Female”). Users can then drag the entity into the appropriate group (see Figure 2). For multimedia entities, users double-click the card to view/hear the video/song.



**Figure 2**: Screenshot showing sorting behaviour

Once the entities are sorted, the user is prompted to either perform another sort using a different criterion or to end the sort. The results are recorded automatically in a database

Respondents were asked to use the card sorting tool to sort, using their own choice of criteria, a number of popular songs. Once respondents had chosen a criterion for a particular sort, they placed each card into a named group and were encouraged to repeat this process until they could think of no more criteria. The researcher used a dyadic elicitation technique which involved playing two random music clips and asking the respondent whether they could think of any differences between the two songs which could form another sort criterion. The sessions were carried out under controlled conditions in the same room, using the same computer to remove unforeseen technical issues that may occur e.g. user not able to hear songs, slow internet connection etc. The sessions were undertaken between 2006 and 2007.

3.1 Respondents

There were a total of 52 respondents, 42 from the School of Psychology student pool and 10 from within the School of Computing and Mathematics. 32 females and 14 males participated (plus 6 participants who did not provide information on their gender). The participants’ age range was 18 years to 37 years.

3.2 Materials

**Table 1.** Songs and artists used as entities for sorting

|  |  |
| --- | --- |
| ID | Artist - Song |
| 1 | Coldplay - Yellow |
| 2 | Eminem – Without Me |
| 3 | Misteeq – Why? |
| 4 | Rage Against the Machine - Wake Up |
| 5 | Maroon 5 - This is Love |
| 6 | UB40 - Red Red Wine |
| 7 | De La Soul - Three |
| 8 | Hard Fi - Living for the Weekend |
| 9 | Madonna – Hung Up |
| 10 | Chemical Brothers - Galvanise |
| 11 | Tracy Chapman – Fast Car |
| 12 | Mary J Blige – Family Affair |

Twelve popular songs were chosen for the entities by researchers in the School of Psychology to complement research that was being undertaken by (Greasley & Lamont, 2006). Songs were from popular artists and represented a range of genre (see Table 1).

Each song was cropped to the first thirty seconds of the song. The screen representation of each song (see Figure 1) that users double click to play was labelled with an arbitrary number between one and twelve. Using the title or artist as the card label was considered but this may have prompted criteria related to the song title or the artist, not the song itself.

4. Results

This section presents the results from the 52 card sorting sessions, outlining the constructs and categories used and their distribution between respondents.

4.1 Number of constructs and categories

A total number of 295 constructs[[1]](#footnote-1) were elicited from 52 respondents. The number of constructs per session ranged from 2 to 11. Respondents used between 2 and 9 categories for each sort with the majority of sorts comprising of dyadic (2 categories used) and triadic (3 categories used) sorts.

4.2 Commonality of constructs

From the 295 constructs, there was direct verbatim agreement i.e. two or more respondents using the exact same phrase, for 28 constructs. The most frequently used verbatim constructs are shown in Table 2.

**Table 2.** *Commonly used verbatim constructs*

|  |  |
| --- | --- |
| Verbatim Construct | Number of Subjects |
| Genre | 23 |
| Tempo | 12 |
| Gender of singer | 10 |
| Gender | 9 |
| Speed | 7 |
| Type of music | 7 |
| Artist(s) | 5 |
| Music type(s) | 5 |
| Style | 5 |
| Audience | 4 |
| Era | 4 |
| Group or solo | 4 |

When scrutinising the verbatim constructs it was apparent that different respondents used different words for similar constructs e.g. “Music Type” and “Type of music”, “Tempo” and “Speed”. In line with previous research (e.g. Gerrard & Dickinson, 2005), an independent judge was used to group the constructs into superordinate constructs, giving an indication of commonality between respondents.

The judge was given a set of standard instructions and a full set of results including the constructs, category names and card groupings. A number of previous studies provided a list of grouped verbatim constructs to the independent judge. As identified in a previous study (AUTHOR, 2010) this should remove constructs that use the same words but are related to different attributes (category names).

**Table 3.** *Commonly used superordinate constructs*

|  |  |  |
| --- | --- | --- |
| Superordinate Construct | No of constructs | % of Respondents |
| Genre of Music | 45 | 88 |
| Gender of Artist | 34 | 67 |
| Speed of song | 27 | 53 |
| Solo or group | 18 | 35 |
| Year music produced/released | 16 | 31 |
| Likeability of song | 13 | 25 |
| Main instrument | 9 | 18 |
| Audience | 8 | 16 |
| Emotion | 7 | 14 |
| Nationality of artist | 7 | 14 |

When grouped into superordinate constructs, the number of constructs was reduced from 289 to 78. Table 3 shows the number of constructs included for each superordinate construct and the percentage of respondents that they were elicited from for the top 10 most used constructs.Following this grouping, agreement was found amongst respondents for 26 superordinates out of the 78 e.g. 88% of respondents used the “Genre of Music” as a construct and 67% of respondents used “Gender of Artist”. This shows a high level of commonality for a small number of the constructs with 52 constructs out of the 78 being generated by single users. Examples of these unique constructs included “Volume of drums”, “Complexity of music”, “Make you sad”, “Is it relaxing” and “Music to work to”.

4.3 Distribution of Items

As described by Martine & Rugg (2005), card sorts data can be used to produce co-occurrence matrices that give an indication of similarity between the entities represented by the cards and the distribution of entities for similar constructs. The matrix is produced by summing the number of times one card appears in the same category as another card for all respondents and criteria.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| **1** |  | 85 | 50 | 119 | 169 | 150 | 110 | 151 | 60 | 92 | 151 | 65 |
| **2** |  |  | 115 | 102 | 104 | 87 | 119 | 118 | 129 | 167 | 63 | 134 |
| **3** |  |  |  | 58 | 80 | 61 | 79 | 97 | 181 | 132 | 61 | 174 |
| **4** |  |  |  |  | 114 | 104 | 121 | 147 | 52 | 116 | 89 | 65 |
| **5** |  |  |  |  |  | 112 | 130 | 176 | 108 | 109 | 94 | 92 |
| **6** |  |  |  |  |  |  | 127 | 95 | 49 | 97 | 155 | 76 |
| **7** |  |  |  |  |  |  |  | 123 | 76 | 136 | 98 | 93 |
| **8** |  |  |  |  |  |  |  |  | 100 | 131 | 81 | 83 |
| **9** |  |  |  |  |  |  |  |  |  | 116 | 75 | 146 |
| **10** |  |  |  |  |  |  |  |  |  |  | 61 | 126 |
| **11** |  |  |  |  |  |  |  |  |  |  |  | 79 |
| **12** |  |  |  |  |  |  |  |  |  |  |  |  |

**Figure 3.** Co-occurrence matrix for the 12 songs

Figure 3 shows the matrix for the twelve songs. With the total number of sorts being 289, the maximum number of times for two cards to be placed in the same category is also 289. The highest amount of co-occurrence was 181 (for songs 9 and 3). The lowest of amount of co-occurrence was 49 (for songs 9 and 6).

To determine levels of agreement within superordinates i.e. whether respondents have placed the same songs in the same groups for similar criteria, co-occurrence matrices were calculated for the sorts where a number of respondents had used similar criteria as determined by the independent judge. The matrices in Figures 4 and 5 show the percentage of times that two songs were placed in the same group to allow for comparison between matrices. For example, in Figure 2, songs 1 and 4 were placed in the same group 94% of the time for sorts related to “Gender”.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| **1** |  | 91 | 0 | 94 | 94 | 94 | 94 | 94 | 0 | 94 | 41 | 0 |
| **2** |  |  | 0 | 88 | 91 | 94 | 94 | 91 | 3 | 94 | 38 | 3 |
| **3** |  |  |  | 0 | 0 | 0 | 0 | 3 | 97 | 0 | 53 | 97 |
| **4** |  |  |  |  | 91 | 88 | 91 | 91 | 0 | 91 | 35 | 0 |
| **5** |  |  |  |  |  | 88 | 94 | 94 | 0 | 94 | 35 | 0 |
| **6** |  |  |  |  |  |  | 94 | 88 | 0 | 94 | 44 | 0 |
| **7** |  |  |  |  |  |  |  | 94 | 0 | 100 | 41 | 0 |
| **8** |  |  |  |  |  |  |  |  | 3 | 94 | 41 | 3 |
| **9** |  |  |  |  |  |  |  |  |  | 0 | 53 | 100 |
| **10** |  |  |  |  |  |  |  |  |  |  | 41 | 0 |
| **11** |  |  |  |  |  |  |  |  |  |  |  | 53 |
| **12** |  |  |  |  |  |  |  |  |  |  |  |  |

**Figure 4.** Co-occurrence matrix for “Gender” (values represented as %)

For these matrices, if respondents agreed on the criterion, the matrix would at best case contain a selection of very high numbers (close to 100%) and very low numbers (close to 0%). This would indicate that certain songs would always be placed in the same group for that criterion and others would never be placed in the same group. Plotting the histogram of this data should demonstrate bimodal distribution. For the superordinate “Gender” as shown in Figure 5, this is mostly the case. For example, songs 1 and 2 are placed in the same group 91% percent of the time when the criterion for the sort is related to “Gender” but songs 1 and 3 are never placed in the same group.

When respondents were sorting based on gender, then male vocalists would always appear in the same group and never appear with songs with female vocalists and vice versa. For the majority of songs this was the case, but song 11 was placed with most of the songs between 35% and 53% of the time. It seems that respondents were unable to consistently group the song into a specific gender. This may be due to the vocalist, Tracy Chapman, having an undeterminable voice.

For the other superordinates levels of agreement are less consistent. “Genre” related constructs were used by 88% of respondents, but the level of agreement between the respondents indicated by the matrix shown below are low. Songs 5 and 8 were sorted into the same group 60% of the time (which was the highest) but the majority of songs had low levels of co-occurrence.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| **1** |  | 0 | 2 | 20 | 44 | 18 | 13 | 53 | 20 | 2 | 40 | 2 |
| **2** |  |  | 16 | 2 | 0 | 2 | 22 | 0 | 2 | 33 | 2 | 38 |
| **3** |  |  |  | 4 | 7 | 7 | 11 | 9 | 31 | 27 | 9 | 53 |
| **4** |  |  |  |  | 7 | 9 | 9 | 24 | 2 | 4 | 16 | 0 |
| **5** |  |  |  |  |  | 11 | 22 | 60 | 42 | 9 | 24 | 7 |
| **6** |  |  |  |  |  |  | 24 | 7 | 11 | 16 | 40 | 2 |
| **7** |  |  |  |  |  |  |  | 20 | 11 | 36 | 29 | 11 |
| **8** |  |  |  |  |  |  |  |  | 11 | 9 | 24 | 4 |
| **9** |  |  |  |  |  |  |  |  |  | 27 | 11 | 13 |
| **10** |  |  |  |  |  |  |  |  |  |  | 16 | 31 |
| **11** |  |  |  |  |  |  |  |  |  |  |  | 0 |
| **12** |  |  |  |  |  |  |  |  |  |  |  |  |

**Figure 5:** Co-occurrence matrix for “Genre” (values represented as %)

The matrix for “Solo or Group” showed higher levels of agreement with a number of songs (5 and 1, 9 and 2, 2 and 11, 8 and 1) co-occurring over 90% of the time. The matrix for “Speed of Song” highlighted some songs that are perceived to be similar (9 and 3, 11 and 1) but the majority show low levels of co-occurrence. For this construct it would be expected that songs would form clear groups based on the time signature that they were written in e.g. 3/4 time compared to 4/4 time but that does not seem to be the case.

Matrices for the constructs “Likeability of Song” and “Year Produced” show similar distributions to “Speed of Song” with some songs with high levels of similarity, but the majority having low levels of co-occurrence.

5. ANALYSIS

5.1 Constructs used

Respondents generated a large range of constructs (2 to 11) and categories (2 to 9). The large number of constructs generated by some respondents suggests that they have expert knowledge in the domain (Rugg & McGeorge, 1997). This might be expected from the student population that the respondents were recruited from as some were studying music or involved with university orchestras etc.

High commonality (>50%) was found for a small number of superordinate constructs such as “genre”, “gender” and “speed of song” but the remaining 75 constructs showed little agreement. This gives an indication that once “genre” and “gender” have been used, further constructs are individual to each respondent. Of these remaining constructs, there is a mixture of objective, such as “age of artist” and subjective criteria such as “would I pay to see them in concert”.

5.2 Sorting behavior

There was little agreement between respondents in how they sorted the songs into categories for all criteria. The maximum number of times that two songs were placed in the same group was 181 (for songs 9 and 3) out of a possible 289 (62% of the time). This may be due to the songs being entirely different, different perceptions of the group a song fits into, or respondents using different criteria. The co-occurrence matrices demonstrate a range in the levels of agreement between respondents when sorting using the same/similar criteria.

*Genre:* Almost all of the respondents used “genre” as a criterion but there was little agreement between which songs fitted into the same genres or what those genres should be called. This indicates that due to “genre” being the default index method in music retail, people use what they are accustomed to despite there being little agreement into which categories particular songs fall into.

*Gender:* When sorting using “Gender” as the criterion, respondents were consistent with the majority of songs, finding it easy to determine the gender of the vocalist in all but one case, but it is sometimes unclear as to what “gender” refers to. For the majority of constructs in this study the gender refers to the gender of the vocalist, but the distribution of songs may become inconsistent if there is more than one vocalist for a song.

*Solo or Group:* Surprisingthe co-occurrence levels for “solo or group” were again low, especially considering that the criterion is highly objective. This could indicate a respondent’s lack of knowledge of the song artists or the inability to determine from a thirty second clip whether it is a solo or group artist.

*Speed of Song:* The co-occurrence levels for “speed of song” were also low indicating that respondents are inconsistent in their perceptions of what constitutes speed, even though the majority used the word “tempo” as the criterion name and “fast”, “slow” and “medium” as categories. This echoes research by Scheirer (1998).

5.3 Summary

Some agreement was found in the criteria used for sorting but there were many constructs that were unique. Within the categories, agreement was only found for the “gender” construct, with some agreement for certain songs when using certain criteria. The differing levels of agreement regarding song categorisation have implications for digital music services that are described in the following section.

6. Discussion

6.1 Implications for Digital Music Services

Having identified that there is some level of agreement between respondents for the criteria used to sort music, one possible use of these constructs would be to then integrate them into music library/streaming software such as iTunes, to improve the ability of users to organise and navigate music libraries. The following table (Table 4) details constructs that could potentially be used as attributes for categorising music that are already utilised by iTunes, Spotify or the ID3 specification. ID3 frames are a popular “audio file data tagging format” that are used by a number of popular music players (O’Neill, 2013). An ID3 tag is a data container within an MP3 file that is stored in a predefined format allowing users and artists/vendors to encode additional information into an MP3 file such as text or pictures. Currently iTunes, and similar software, do not use all of the frames that are defined within the standard and therefore specialised ID3 tag editors have to be used to edit the majority of the ID3 frames (although iTunes does allow the user to edit certain fields and automatically populates them via the iTunes store or via the Internet).

**Table 4.** *Constructs used in Digital Music Services*

|  |  |  |  |
| --- | --- | --- | --- |
| Construct | iTunes | Spotify | ID3 |
| Genre of Music | Yes | Yes | Yes |
| Speed of song | Yes "BPM " | No | Yes: “Exact tempo codes” |
| Year music produced/ released | Yes | Partial: "Decades" | Yes “Date/Year of recording” |
| Likeability of song | Yes"iTunes Rating" | Partial: "Add to My Music" | Yes “Pupularimeter” |
| Emotion | No | Yes: "Moods" | No |
| Place to listen to music | No | Yes: "Focus", "Travel", "Dinner", "Sleep", "Workout" | No |
| Chart position | Yes"iTunes Chart" | Yes"Charts" | No |
| Familiarity with song | Yes"Play Count" | Partial"Your Music" | Yes: “Play counter” |
| Mainstream or alternative | No | Partial"Genres" | No |
| Popularity of music | Yes"iTunes Chart" | Yes"Charts", "Plays" and "Trending" | Yes “Pupularimeter” |

This table illustrates that of the 78 constructs, only 14 are utilised for organising or finding music. Spotify, has recently started to support more subjective ways of browsing music such as “Emotion” and “Place to listen to music” via their own curated playlists in the “Genres & Moods” area of their desktop application.

From the commonly used constructs shown in Table 3, “Gender of Artist”, “Solo or group”, “Main instrument”, “Audience” and “Nationality of artist” are not currently supported by either iTunes, Spotify or ID3 tags.

The majority of the remaining unsupported constructs are highly subjective e.g. “Music to work to”, “Times to listen to” suggests that automation of these parameters may be unrealistic and it would therefore be more practical to include functionality within the software that allowed users the freedom to sort and define songs with relevant constructs and attributes. Playlists provide this functionality to a certain extent but specific ID3 tags for certain attributes that could be saved within the file (as opposed to within the software such as Playlists) would be preferred due to the potential for standardising and sharing this information, particularly for objective attributes such as “Gender of Artist” and “Main instrument”.

6.2 Automation of constructs/categorization

With large collections of music, manual curation of songs and playlists is non-trivial and automated methods of categorisation are appealing.

Over 50% of the respondents from this study used “Speed of song” as a criterion, suggesting that tempo is a widespread construct in perception of music and would be a suitable attribute to include in automated music retrieval and classification systems. Tempo is one of the basic attributes of music and has been used previously as a parameter for automatic information retrieval (Scheirer, 1998). The current support in music players relies on the artist/user manually including/editing the relevant “BPM (beats per minute)” ID3 frame or using software such as Media Center 9 to try and automatically detect the BPM (anecdotal evidence however suggests that this method is inaccurate). Automated rhythm and frequency methods have been previously used to identify the tempo and beat of a song and these methods have also been compared to people’s perceptions of tempo (e.g. Lippens et al., 2004).

Respondents from this experiment used the following criteria related to “speed of song”: Song speed, Speed, Slow and fast, BPS, Pace, Type of dance, Tempo, Music speed, Fast paced and Beat speed. The co-occurrence matrix for sorts related to “speed of song” indicated that there was a high level of disagreement between respondents even though they used similar category names e.g. “slow”, "fast”, “quick” etc. This indicates that even if an automated method for determining tempo is used, users themselves are using different attributes or measures for what constitutes the speed of a song.

6.3 Folksonomies and tagging systems

There has been increased interest in the idea of using folksonomies and tagging as a way of categorising and exploring music. A number of studies into the use of tagging and the related field of social bookmarking (Kipp, 2007; Kipp & Campbell, 2006; Golder & Huberman, 2005) suggest that tagging and bookmarking share similar features to more traditional indexing systems (Kipp & Campbell, 2006) but also contain extra dimensions such as tags related to time e.g. “toread” and task or users’ emotional responses to a document e.g. “cool”, which conventional indexing systems and approaches do not support (Kipp & Campbell, 2006).

Last.fm is a website that builds profiles of musical listening habits and also allows users to tag songs and artists with descriptive words or phrases. Comparing the constructs used by the respondents in this study with the tags generated by the users of last.fm highlights some interesting similarities and differences.

The majority of tags used currently on last.fm (see Figure 19 in (AUTHOR, 2010)) are genre based and are similar to the most common criteria used by respondents in this study e.g. “alternative”, “classis rock”, “electronic” etc.. There are also tags such as “female vocalists” and “male vocalists” that refer to the “gender of artist”, temporal tags e.g. “00s”, “80s” etc. that are similar to the “year music produced/released” and “favorites” “favourite”, “favourites” are similar to the “likeability of songs” construct.

It is interesting that “seen live” and “albums I own” are popular tags on last.fm but were not commonly used by respondents in this study (no respondents used “seen live” as a criterion and only one used a criterion related to “ownership”). Another point of interest is that the constructs “speed of song” and “solo or group” do not have equivalent last.fm tags.

6.4 Implications for Faceted Navigation

Amazon and Google make use of faceted navigation structures to allow users to further filter search results. The use of these structures can be linked to Facet Theory, originally devised as an improved way for categorising and indexing books by Ranganathan (Ranganathan, 1962). Generally, in these systems, once a user has performed a standard keyword search, as well as seeing the list of returned results, they are also given the option of searching/filtering within those results by various facets. This approach is often called “guided navigation” and although the term facet is not explicitly used, it is clear that providing users with options to search by format e.g. video, academic resources, images etc. or by geographical location or by time e.g. latest, past 24 hours, past year etc. the resources or products are being categorised by various facets.

Ranganathan’s approach to facets, deriving them systematically using Canons, Postulates, and Principles, meant that several high-level attributes or facets could be used to describe any entity (in his work, the entities were books). Ranganathan’s five initial facets were “Personality”, “Matter”, “Energy”, “Space” and “Time” but it is apparent that now, these terms, although appropriate for Ranganathan and librarians of the time, are not useful for all users of books. Automated methods for identifying facets are now being investigated (Ben-Yitzhak et al., 2008).

When comparing the results of this study with the faceted navigation structure utilised by Amazon for the “Music” section of its website, it can be seen that there are some similarities and significant differences.

The number of similarities demonstrates that Repeated single-criterion sorts are a potential method for eliciting these types of navigation structure. The search filters that cannot be mapped onto a specific construct can be explained by the choice of entities used in this study. The card sorting tool only provided respondents with the mp3 of the song itself. No information was given regarding the artist, edition, or format, so it is unlikely that these could have been used as criteria. Therefore, choice of the representation for a song needs further consideration and a mix of media may be more appropriate e.g. having the album cover representing the song instead of a number or a screenshot of the product description webpage (which could then also incorporate price and delivery options).

More noteworthy is that there are a number of constructs elicited during this study that are not part of the search filters on the Amazon website, specifically “Gender of Artist”, “Speed of song”, “Solo or group”, “Main instrument”, “Audience”, “Emotion” and “Nationality of artist”. These are all potential methods of guiding a user through a set of search results and apart from “Emotion” are all objective characteristics of the entity. This is similar to the findings of Cassidy (Cassidy et al., 2013) who used “All-in-one” sorting to determine how children categorise games. When compared with existing categories in the Google Play Store, they found that “children used categorization criteria much more aligned to the goals of the game rather than more abstract categories currently found in mobile phone application stores” (Cassidy et al., 2013).

6.5 Implications for the UCD process

“All-in-one” card sorting is already used in the UCD process to determine the IA of websites. However, this is commonly used to determine single level hierarchies where an entity fits into one specific top-level category e.g. Books, Music, Games, Films.

Repeated single-criterion sorting is a complimentary method for eliciting faceted navigation structures for when a user has chosen a top-level category, such as Books, and is now looking for a particular item using relevant criteria such as Author, Publication Date, Genre etc. From this study it is clear that this method can elicit traditional criteria which are akin to those originally proposed by Ranganathan but can also provide additional, user-centred dimensions such as those seen in user-generated tagging systems.

A combination of the two sorting variations would provide a methodology for developing IA’s that avoid the limitations of hierarchical structures where products/pages may fit into multiple sub-categories. Closed sorting could also be used with both sorting variants to evaluate how well the category and criteria labels work.

Repeated single-criterion sorting could also be used in the initial stages of user experience design to analyse the target users’ perceptions of websites in the particular field. For example, if a developer was creating a site for a theatre company, the tool could be populated with images of the homepages of other theatre company websites and a study into users’ perceptions of those sites could be undertaken. The results from this study could then be fed directly into the development process, with attention then being directed at the attributes of the pages that were elicited.

6.6 Challenges and Limitations

The main challenge with repeated single-criterion sorting is the same as with any other user-centred activity; recruiting respondents. For this study, a pool of willing participants was fortunately available, but this in itself causes potential issues with bias and representativeness. It should also be noted that there is limited published evidence on how many respondents are needed for this type of sorting to create effective IA’s and this is where future work is needed i.e. to take the results from a study such as this, build a website with faceted navigation and then evaluate it with users.

7. Conclusions

The results of this study have demonstrated that card sorts are an effective method for investigating people’s perceptions of music. Repeated single-criterion music sorts have elicited criteria which have previously eluded music psychologists and digital music service designers, while providing explanations to inconsistent musical genre classifications seen in previous studies.

Current support for digital media organisation and discovery relies heavily on genre across a range of different product types e.g. Music, Books and Films. Although genre was used by the majority of respondents, there was little agreement between respondents in which songs should appear in the same genre. This study has shown that perception of music is highly subjective, and genre, although considered to be objective by music retailers, is no longer adequate. The results indicate that as the volume, and variety of music increases, categorising music becomes more difficult. Repeated single-criterion sorting provides a method to support the systematic elicitation of additional objective and subjective features for use in the design of digital music services. This variation of card sorting has previously been reliant on a number of time-consuming processes (recruiting respondents, conducting synchronous sessions etc.) and although low cost and high yield, has not been frequently used as a standard part of design and development methodologies. The key contribution of this work therefore is a demonstration that this card sorting variation and tool described can support developers and designers at various stages in the development life cycle to determine IA’s for websites and applications that go beyond traditional objective features. This study has also shown how this method could be used as part of the UCD process in parallel with the more common “All-in-one” version to create faceted navigation structures. The close link of sorting methods to PCT provides theory behind the practice, which should give users of sorting methods confidence in their results, due to the presence of reasoning behind those results. It is now the role of card sorting researchers and practitioners to popularise the full suite of sorting methods and highlight their uses and advantages to professionals within the UX/UXD/Interface Design field. This will ultimately lead to better IA in apps, website etc. and improvements in the experience of their users.

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1. Criteria elicited during card sorting sessions of this type are normally known as constructs due to the link with PCT. [↑](#footnote-ref-1)