Panelists' performances and strategies in paper based and computer based projective mapping

SAVIDAN, Capucine and MORRIS, Cecile <http://orcid.org/0000-0001-6821-1232>

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Title: Panelists' performances and strategies in paper based and computer based projective mapping

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Capucine H. Savidan; Cecile Morris*

Sheffield Hallam University

Food Group

Howard Street, Sheffield

S1 1WB, UK

Tel: +44 (0) 114 2252759

Fax: +44 (0) 114 2254449

Cecile.Morris@shu.ac.uk

Abstract:

Projective Mapping has recently attracted a lot of attention and the main sensory data acquisition software packages have developed interfaces to collect projective mapping data. However, the comparison between paper and computer based projective mapping has never been reported. The objectives of this research were to 1) compare the consensus maps and panelists' performances for paper and computer based projective mapping and 2) analyze the panelists' strategies while performing either tasks. In the first part of the study, 32 panelists were asked to perform both paper and computer based projective mapping on 8 beer samples. In a second part of the study, 10 panelists were asked to repeat the tasks whilst “thinking aloud” their strategy. There was no significant difference in panelists' performance as assessed by the People Performance Index (PPI) between the paper and computer tasks. The consensus maps obtained were similar with respect to sample groupings, RV coefficients and variation explained by the first 2 dimensions. Individual panelists adopted similar strategies on paper and computer but strategies differed greatly between panelists.

Practical applications:

The results reported here will help panel leaders making informed decisions with respect to support choice when designing projective mapping tests. Additionally, an insight into the diversity of panelists' mapping strategies is provided which may inform further research and discussion into the most appropriate instructions given to panelists and/or type of panel used.

Key words: Projective Mapping, Napping, sensory, People Performance Index, Think Aloud, MFA.

1. Introduction:

Projective Mapping is a relatively recent descriptive technique (Risvik *et al*. 1994; Risvik *et al*. 1997) which has attracted a lot of attention due to its relative ease of use and cost effectiveness compared to the more traditional descriptive methods such as Quantitative Descriptive Analysis (QDA). As a result, a number of contributions have focused on evaluating the performance of projective mapping and its limitations against other rapid descriptive methods (Ares *et al*. 2010; Nestrud and Lawless 2010) or traditional descriptive analysis (Kennedy and Heymann 2009; Mielby *et al*. 2014; Moussaoui and Varela 2010). The consensus is that projective mapping is well suited to gathering quick, preliminary descriptive information on samples which present a reasonable degree of dissimilarity and that it compares well with other rapid methods (Mielby *et al*. 2014; Varela and Ares 2012). Identified strengths of projective mapping are its holistic nature and versatility with respect to the type of panel (consumer vs. trained). Since judges are not given any instructions relating to the discrimination criteria to use in order to build their maps, projective mapping has often been described as a holistic method (Dehlholm *et al*. 2012; Varela and Ares 2012). This differs in nature to other descriptive methods, notably QDA, in which panelists analytically assess attributes separately (Lawless and Heymann 2010). This difference between the techniques may be reflected in the type of panel used to carry out projective mapping and a number of studies have focused on whether consumers could be used to generate equivalent data as trained panelists. Some have concluded this was the case (Albert *et al*. 2011), and others have found that trained panelists performed better (Barcenas *et al*. 2004). Despite the assumption that judges approach the task holistically, there is, to date, no real insight into the strategies which panelists adopt to perform projective mapping.

As limitations go, it is accepted that projective mapping does not provide the same richness of descriptive information as QDA and notably, there are not any average scores which can be compared across samples for any attribute (Valentin *et al*. 2012), prompting some to question their "actionability" (Moskowitz 2002) .

Despite these well documented limitations, projective mapping has been applied and validated with an ever growing range of food products such as fresh strawberries (Vicente *et al*. 2014); mortadellas (Santos *et al*. 2013); potato purees (Jimenez *et al*. 2013) and high alcohol beverages (Louw *et al*. 2014) to cite only the most recent examples. In this context of fast growth, it is not surprising that all the major sensory data acquisition software packages have now developed interfaces to collect projective mapping data directly on screen, by-passing thus the elaboration of a map using physical products placed on a large flat surface. However, to date, no study has reported whether the results obtained from the traditional paper based projective mapping agreed with those obtained via computer screens. Comparison between pen-and-paper and online data acquisition methods are well documented in other fields such as social sciences (Campos *et al*. 2011; Díaz de Rada and Domínguez-Álvarez 2014; Gravlee *et al*. 2013). Overall, there appears to be a good agreement between the 2 methods, with subtle differences observed in terms of item response rates and expense of qualitative data generated from open ended questions (Díaz de Rada and Domínguez-Álvarez 2014). However, there are major differences between surveys and sensory analysis, namely the controlled conditions in which the data is acquired (sensory booths) and the fact that panelists are required to taste food products as part of the task and few sensory studies have looked into the comparability of paper and computer acquisition methods. A descriptive sensory study concluded that substituting paper ballots for computer ballots did not significantly alter experimental results (Swaney-Stueve and Heymann 2002). However, the transferability of these findings to projective mapping is yet to be demonstrated.

The objectives of this research were twofold: to compare the consensus maps for paper and computer based projective mapping as well as to analyze the panelists' strategies while performing either task.

2. Materials and Methods:

The aim of the first study was to compare the maps obtained on paper and on computer. Thirty-two consumers were asked to perform both paper and computer based projective mapping on 8 samples of beer (6 different samples and 2 duplicates). The aim of the second study was not to compare the projective mapping results for both tasks (first study) but to investigate the strategies adopted by the panelists. Ten panelists were asked to perform the same tasks once more while describing their strategies. In a food context, asking panelists to "think aloud" as they perform a task to understand their working has been insightfully used elsewhere to investigate emotion reporting (Jaeger *et al*. 2013) but also to obtain an insight into participants' cognitive strategies when presented with different recall aids to estimate portion sizes (Chambers *et al*. 2000). The study set-up was deliberately selected to explore the relative performance of paper and computer based projective mapping in the most challenging and relevant to routine data acquisition conditions: consumers, rather than a trained panel, were used and a complex product (beer) was selected as this has been shown to impact on results (Louw *et al*. 2014).

2.1.Panellists:

Thirty-two regular (at least once every 2 months) beer drinkers (20 males) aged 20 to 60 were recruited via flyers and word of mouth to took part in the first part of the study. They were composed of 19 academic staff, 9 technical/manual workers and 4 students. The number of untrained panelists / consumers used in studies comparing projective mapping to other techniques ranges between 8 and 30 panelists and is typically between 12 to 24 panelists (for a detailed review of number of panelists in projective mapping studies, see Table 1 of Hopfer and Heymann 2013). Ten of those panelists (6 males) aged 20 to 50 agreed to come back for the second part of the study for an in-depth investigation of their strategies.

2.2.Samples:

An initial screening of the samples ensured a reasonable homogeneity of the samples. Three alcohol levels were selected: alcohol free (Beck's blue containing no more than 0.05% ABV by Beck's and Erdinger Alkoholfrei by Erdinger Weiβbräu), light beers (Beck's premium light 2.3% ABV by Beck's and Bière Blonde 2.6% ABV by Brasserie) and regular beers (Beck's 4.8% ABV by Beck's and Foster Gold 4.8% ABV by Foster). Two blind duplicates were included to assess judge's ability to perform the task and discriminate between samples. In order to minimize the amount of alcohol ingested by the panelists, the two alcohol free beers were selected as the duplicate samples. Forty ml of fridge cold (4°) samples were presented in small transparent plastic gallipots simultaneously to the panelist. The order in which the samples were arranged on the trays differed between panelists and was based on William's Latin square design.

2.3.Studies:

2.3.1. First study:

The panelists were randomly allocated to either perform the paper or computer projective mapping task during their first session and came back to perform the other task at a later time, typically one week later. In line with the procedure described in Dehlholm *et al*. (2012), the panelists, who had never performed a projective mapping task before, attended a 10 minutes instruction session prior to both tasks. For the paper task, panelists were shown an example of a paper map acquired with tomato soup samples. For the computer task, panelists were required to build their maps on the computer screen within the space provided to that effect. They were shown, on a large projection screen, how to move the samples within that space and how to record attributes for each sample on electronic sample tags. Panelists attended both sets of instruction sessions regardless of which task they performed first. The instructions provided in the booths were the same for both tasks: “Please evaluate the samples in front of you from left to right and place them on the provided space according to how similar or dissimilar they are for you. The more similar the samples are, the closer they should be positioned to each other, the more dissimilar they are the further apart they should be positioned" (Hopfer and Heymann 2013).

After completing both tasks, panelists were asked which task they had felt most comfortable with and why.

2.3.2. Second study:

Ten panelists aged 20 to 50 (6 males, 6 academic staff, 3 technical staff and 1 student) agreed to come back and take part in the second study which involved performing both the paper and computer projective mapping whilst thinking aloud their strategies. The panelists, who already had experience of both supports, were randomly allocated to start either with the paper or computer task and were reminded of the general instructions for each task. Additionally, they were asked to think aloud their strategies as they carried out the tasks and were recorded using a SONY IC Recorder (ICD-PX312/PX312F).

2.4. Support:

For the paper task, panelists were provided with sheets of paper measuring 60 cm x 40 cm. For the computer task, panelists were not provided with any paper and performed their maps directly on the computer screen available on the booth. The computer screens were 24.6 cm x 18.5 cm and the actual map space dimensions were 16.0 cm x 10.6 cm. While the supports dimensions varied greatly, it was important to compare the methods as they would be applied by panel leaders who would not dispose in their booths of computer screens of equivalent dimensions as the paper maps most commonly used in projective mapping (60 cm x 40 cm).

For the paper maps, each sample coordinate was measured from the bottom left corner of the map and reported in Excel (Microsoft, Seattle, US) along with the attributes generated by the panelists. For the computer maps, the data was acquired using Compusense (Guelph, Canada) and the coordinates of the computer based maps were exported from Compusense into Excel along with the attributes generated by the panelists for each sample.

2.5. Data analysis:

2.5.1. People Performance Index:

The People Performance Index (PPI) which is the ratio between the distance separating 2 duplicates over the greatest distance separating any 2 samples on the map was calculated as reported in Hopfer and Heymann (2013). A factorial repeated measures ANOVA (repeated measure: panelist; factors: duplicate pair and support) was performed using SPSS v21 (IBM Corporation, Armonk, NY) to test for significant differences in PPIs.

Additionally, based on individual map examination, criteria to assess panelists' performance based on their PPIs were introduced as such: $PPI \leq 0.20$ excellent; $0.20 < PPI \leq 0.30$ good; $0.30 < PPI \leq 0.40$ fair; $0.40 < PPI \leq 0.50$ poor; $0.50 < PPI$ inadequate.

2.5.2. Product coordinates and attributes count:

Multiple Factor Analysis (MFA) was introduced to deal with data tables of different natures by, in essence, performing a PCA on each subset of data and superimposing them (Pagès and Husson 2001). In this respect, it has proved highly suitable to analyze projective mapping data where product coordinates and attribute counts can be analyzed simultaneously. The paper and computer based projective mapping data were analyzed by MFA (MFA, Husson et al. 2014) in R (R core team 2013) using FactoMineR (Lê *et al*. 2008). A Hierarchical Cluster Analysis (HPCP, Husson et al. 2014)was performed on the first 5 dimensions of the MFA results. Each individual map was considered as a group and RV coefficients were computed (MFA using FactoMineR) to evaluate the degree of agreement between individual maps as well as individual maps and overall configuration (Robert and Escoufier 1976). Synonyms of attributes used to describe the samples were pooled together (example: "pale" and "light colour") and attributes cited only once were discarded as reported elsewhere (Ares *et al*. 2010; Albert *et al*. 2011). For each modality (paper and computer), the attribute frequency counts across all assessors were collated as a separate group in the same data structure as that described by Nestrud and Lawless (2008); Moussaoui and Varela (2010) and Pagès (2005). Hierarchical Multiple Factor Analysis (HMFA) was introduced to take into account the hierarchical nature of some data sets (Le Dien and Pagès 2003) and has successfully been applied to the comparison of sensory methods (Perrin *et al*. 2008; Ares *et al*. 2010) or replicates (Kennedy 2010). It was therefore used to represent the combined product map from the paper and computer projective mapping (1st level) which were themselves composed of 2 groups: map coordinates and attribute frequency counts.

2.5.3. Think Aloud Task:

The panelists' strategy audio files were analyzed for content and 4 dimensions were derived from the analysis in order to fully characterize the mapping strategies adopted. At the start of the task, panelists were found to differ in their **early attention focus** (building the map or generating attributes); moreover some panelists compared samples for overall similarities/differences while others focused on specific attributes to build their maps. This lead to the generation of a **holistic vs attribute driven approach** dimension. Some panelists attributed meanings to their axis and this was recorded in a 3rd dimension (**axis meaning**) to investigate whether different panelists used different attributes to discriminate between samples. Finally, which criteria were used to place the samples on the map (grouping similar samples or placing different samples apart) was recorded in the **grouping strategy** dimension. Panelist's strategies were assessed against those 4 dimensions for each modality.

3. Results:

3.1. Panelists' performance

The presentation of 2 pairs of duplicate samples for both paper and computer based maps meant that 4 PPIs were generated by panelist. The PPIs ranged from 0.04 to 1.00 and averaged 0.30 and 0.39 on the paper and 0.31 and 0.35 on the computer for duplicate pairs 1 and 2 respectively. For each task, panelists were excluded from the final analysis if both PPIs were greater than 0.40 (poor) or the average of both PPIs was greater than 0.50 (inadequate) as this was taken as an indication that the panelist had difficulties either with the task or the type of sample. Twenty three and 24 panelists were included respectively in the paper and computer analysis.

Twenty panelists out of 32 stated that they were more comfortable with the computer task; overwhelmingly citing being able to move the samples around the screen map on re-taste as the main reason for this (although this flexibility was cited as the reason for preferring the paper support by one panelist who felt it was too easy to change her mind). The judges who were more comfortable performing the task on paper (10 out of 32) often cited the same reason: greater flexibility to move samples around and use the whole space but also cited being able to draw relationships between samples/attributes (using arrows for example). Two panelists out of 32 stated being equally comfortable performing either. Overall, the majority of the panelists was more comfortable using the computer to perform the task however; this did not translate into a significantly better performance as assessed by PPI and there was no significant difference in performance with respect to support type ($p = 0.744$) or duplicate pair ($p = 0.105$).

3.2. Consensus maps

3.2.1. Comparison between paper and computer based projective mapping

A HMFA was performed on the paper and computer dataset. The samples coordinates and attribute frequency count represented one level of hierarchy and acquisition method (paper/computer) represented another. Figure 1 presents the overall product map with the superimposed partial clouds associated with the 2 tasks and Figure 2 presents the relationship of the groups to the first two dimensions.

Figures 1 and 2 thereabout

Both sets of duplicate samples came out grouped together. The space was defined by a triangle which extremities were represented by the Erdinger and Beck's blue samples (clearly opposed on dimension 1) and the Brasserie Blonde and beck's light (opposed to the others on dimension 2). The partial clouds representing both acquisition methods remained close to the samples barycenter indicating a good level of agreement between the methods; this was further supported by the proximity of the groups with respect to their contribution to dimension 1 and 2 (variation 61.4%, Figure 2). However, while this representation pointed to a good agreement between the paper and computer tasks, it did not give any indication of agreement between individual maps and each acquisition method was studied separately to this effect.

Figures 3 and 4 present the consensus maps obtained respectively from the paper and computer based projective mapping exercises.

Figures 3 and 4 thereabout

There was an overall excellent agreement between the paper and computer generated consensus maps. The first 2 dimensions represented respectively 61.7% and 59.5% of the variation for the paper and computer projective mapping tasks. The samples groupings were very similar for both modalities as evidenced by identical clusters (Figures 3 and 4). Duplicate samples were grouped together while the 2 light beers were grouped together and the 2 strong beers formed the last cluster. Dimension 1 opposed the Erdinger samples to the Beck's blue samples while dimension 2 opposed the light beers (Beck's light and Brasserie Blond) to the other samples. Beck's and Foster Gold were found towards the center of the maps.

The average number of attributes generated per panelist and per sample was slightly greater for the computer task (4.2) than for the paper task (3.6). Grouping synonyms and removing the attributes cited only once resulted in the generation of respectively 36 and 31 different attributes for the paper and computer tasks. The attributes significantly correlated to the first two dimensions are presented in Table 1.

Table 1 thereabout

A strong level of agreement in sample description/attribute generation was observed between the paper and computer tasks with 8 common attributes for dimension 1 (5 positively correlated and 3 negatively correlated) and 1 common attribute (bland, negatively correlated) for dimension 2. Anecdotally, panelists did not generate attributes related to alcohol content or strength and informal feedback indicated that they had not guessed that some beers were alcohol free.

3.2.2. Panelists' comparison

Reasonably good agreements were observed between the individual maps and the consensus maps with RV coefficients averaging 0.69 (range 0.45 to 0.93) for the paper MFA and 0.63 (range 0.30 to 0.93) for the computer MFA. RV coefficients between individual maps ranged from 0.06 to 0.92 (average 0.44) and 0.01 and 0.88 (average 0.35) for respectively the paper and computer projective mapping tasks. While these values are in line with those reported elsewhere (Hopfer and Heymann 2013), they are indicative of poor agreements between some of the individual maps. This disagreement is unlikely to stem from poor quality maps as only maps meeting the PPI criteria outlined in section 3.1. and deemed of good quality were included in the final analysis. In order to understand the origin of the poor agreement observed between some individual maps, 10 panelists were asked to come back for a second session in which they were required to “think aloud” their strategies whilst performing the tasks. Content analysis of the recordings identified 4 dimensions to the panelists' mapping strategies. The breakdown of the panelists' strategies into these 4 dimensions is presented in Table 2.

Table 2 thereabout

The strategies adopted by panelists from task to task proved remarkably stable on all 4 strategy dimensions. In this respect, a change of support did not induce a major shift in panelists' strategy but often resulted in an adaptation of the same strategy. For example, on first tasting, panelist 3 wrote the samples attributes in one corner of the paper map or on the electronic tags. But different panelists adopted vastly different strategies ranging from purely holistic with no articulated meaning associated with the axis to attribute-led approaches in which the panelist attributed meanings to the axis. Even within these two approaches (holistic vs. attribute-led), there existed considerable differences in the map construction for the holistic approach with some panelists clustering similar samples together (panelist 1), others focusing on greatest differences (panelist 5) and yet another clustering samples by perceived “class” of samples (panelist 8: traditional beers / low quality). For the attribute-led approach, the choice of attributes around which the map was built differed with criteria based on three different modalities: appearance, taste and texture. It is interesting to notice that while none of the panelists explicitly used smell to label their axis, a number of attributes related to aroma compounds were significantly correlated with the first two dimensions on the maps, such as flowery, fruity, caramel and honey. This is consistent with the approach used by panelist 6 who defined axis meanings (bitterness and thickness) but fine-tuned the map using other attributes (smell). There was no difference between the average PPI values obtained using the holistic approach (average: 0.23) and attribute-led approach (average: 0.23).

4. Discussion:

Overall, despite the fact that a majority of panelists were more comfortable performing projective mapping on the computer, which may be a reflection of the panelists' occupations, the type of support (paper/computer) did not impact on panelists' performance as assessed by the PPI; nor did it impact on the final map results with very similar consensus maps generated in terms of sample grouping and opposition between samples. In this respect, it could be argued that the paper and computer maps generated did not differ more than replicates of the same task, indeed studies specifically investigating projective mapping repeatability showed that overall similarities and dissimilarities were conserved despite somewhat different consensus maps (Hopfer and Heymann 2013) and/or poor agreements between individual panelist's replicates (Kennedy 2010). Whilst there is surprisingly little literature on the subject of paper vs. computer in the field of sensory science, it has often been reported that pen-and-paper and online data acquisition methods yield similar results in other disciplines (Campos *et al*. 2011; Díaz de Rada and Domínguez-Álvarez 2014; Gravlee *et al*. 2013; Swaney-Stueve and Heymann 2002). The subtle differences reported surrounded item response rate and expense of answers on open ended questions, which may be compared to the number of attributes generated in projective mapping. In this respect, the same trend was observed in this study whereby the average number of attributes generated per sample and per panelist was slightly higher on the computer than on paper, however, this did not result in richer sample descriptions as slightly more different attributes were generated on paper. A similar observation was reported when comparing paper and computer based hard laddering techniques (Russell *et al*. 2004): participants, who were able to review previous answers on the paper, generated new links between levels while they re-used more often existing links on the computer. In the computer version of projective mapping, panelists could easily select attributes which they had already typed to describe another sample and this may have facilitated their selection and discouraged the generation of new attributes, resulting in a higher average number of attributes per sample and panelist but an overall lower number of different attributes used to characterize the sample set. However, the differences remained small and the overall trend was that of a good agreement between the techniques.

The fact that a small percentage of panelists struggle with projective mapping is well documented (Pagès 2005; Veinand *et al*. 2011) with panelists rating projective mapping as more difficult than techniques based on the evaluation of sensory characteristics (Ares *et al*. 2011). In line with this, some poor performances on the people performance index were observed and results from panelists who failed to correctly identify duplicates were not included in the final analysis. Despite this, RV coefficients demonstrated a range of agreement levels between individual maps as observed elsewhere (Hopfer and Heymann 2013). This may partly be explained by the vastly different strategies adopted by panelists irrespective of the support used. Although the number of panelists used in the second part of the study is relatively small, the study did not aim to report all possible strategies adopted and there is sufficient evidence that considerable differences in how panelists having received the same instructions approach the task, exist. While self-reported strategies in projective mapping have never been documented before, different cognitive strategies which appeared unrelated to spatial or verbal abilities have been evidenced in conceptual mapping (Hilbert and Renkl 2008), In projective mapping, different separation criteria and map structures were reported elsewhere using a close examination of the maps generated (Hopfer and Heymann 2013). Our findings extend and confirm these observations. This sheds a new light on projective mapping as a task which has up until now frequently been described as a holistic method (Dehlholm *et al*. 2012; Varela and Ares 2012) as opposed to an attribute-driven (or reductionist) one. It is clear from this data that while the holistic dimension of the task is represented in the fact that panelists are free to select the attributes which they use to discriminate between samples; some panelists spontaneously adopt a reductionist approach. This may explain the success of partial napping, in which panelists are required to build different maps for each modality with greater RV coefficients reported for replicates within each modality than for global napping (Louw *et al*. 2013). This could be attributed to a lower number of possible attributes against which operating the discrimination in partial napping. This may be taken as an indication that more prescriptive instructions may improve performance, however, no trend was observed with respect to panelists' strategy and performance on PPI. The range of strategies adopted by consumers may partly explain why a relatively high number of consumers compared to current practices in the field has recently been advocated to ensure map stability; although this was estimated using a conservative RV coefficient criteria and it was noted that the number of consumers required to reach stability decreased with increasing levels of difference between the samples (Vidal *et al*. 2014). Introducing blind duplicates to remove the judges experiencing difficulties with the task or product range may also increase reliability and decrease the number of consumers required.

5. Conclusion:

The majority of panelists reported being more comfortable performing the task on computer; however, this did not impact on panelists' performance which was not significantly different between the paper and computer tasks and there was a high level of agreement between the paper and computer consensus maps. Panelists adopted similar strategies to perform either task, but those differed drastically between panelists. In this respect, the limitations of computer based projective mapping are the same as those documented for paper based projective mapping. It is recommended that blind duplicates are included in the sample set. It is likely that the panelists used in this study were reasonably computer literate and not fully representative of consumers selected from a wider range of occupations. These results should therefore be interpreted with caution and may not be generalized to populations with low degrees of computer literacy.

Further work should investigate strategies adopted by trained panels as they may approach the task in a more analytical way and may display greater consensus around the attributes selected to discriminate between samples.

6. Declaration of interest:

The authors do not have any conflict of interest to declare.

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Table 1: attributes significantly ($p<0.05$) correlated to dimensions 1 and 2 – 1st study

	Paper based projective mapping	**Computer based projective mapping**
Dimension 1	Bitter (-)	Bitter (-)
	Dark (+)	Dark (+)
	Fruity (+)	Fruity (+)
	Golden colour (+)	Golden colour (+)
	Malty (+)	Malty (+)
	Pale (-)	Pale (-)
	Sour (-)	Sour (-)
	Sweet (+)	Sweet (+)
	Caramel (+)	Clean taste (-)
	Cloudy (+)	Creamy (+)
	Corked (-)	Fizzy (-)
	Flowery (+)	Foamy (+)
	Hoppy (-)	Honey (+)
	Sweaty (-)	Lager (-)
	Thin (-)	Smooth (+)
	Urine flavour (-)	
	Watery (-)	
Dimension 2	Bland (-)	Bland (-)
	Mild smell (-)	Bitter after taste (-)
		Not sweet (-)
		Thin (-)
		Watery (-)

Table 2: panellists' strategies for paper and computer PM tasks – 2nd study

Dimension	Panellist	Paper	Computer	Similar
Holistic vs. attribute driven	1	Holistic	Holistic	Yes
	2	Holistic	Holistic	Yes
	3	Attribute driven	Attribute driven	Yes
	4	Attribute driven	Attribute driven	Yes
	5	Holistic	Holistic	Yes
	6	Attribute driven	Attribute driven	Yes
	7	Holistic	Holistic at start - attribute driven towards end	Mostly
	8	Holistic	Holistic	Yes
	9	Attribute driven	Attribute driven	Yes
	10	Holistic	Holistic	Yes
Grouping strategy	1	Placed 1st sample tasted on the map then others in relation to the 1st one.	Looked for similar samples and grouped them together, placed the others in relation to these groups.	No
	2	Placed the 1st sample in the top left hand side of the map, then the other samples in relation to it.	Placed the 1st sample in the top left hand corner then the others in relation to it.	Yes
	3	Wrote attributes for each sample on top right hand side of map. Decided axis meaning. Placed each sample individually based on attributes intensities.	Typed attributes in sample tags during 1st tasting. Decided axis meaning. Prepared map on bench and reproduced on screen. Clustered similar samples based on attributes intensities.	Mostly
	4	Decided axis meaning. Placed each sample individually based on attributes intensities.	Clustered samples by similarity based on specific attributes.	No
	5	Identified the oddest sample on 1st tasting and placed it in one corner of the map; then placed the others (grouped for similarity) in relation to it.	Identified the oddest sample and placed it in one corner of the screen.	Yes
	6	Decided axis meaning: used main differences between 1st and 2nd sample to select axis meaning. Placed each sample individually based on attributes intensities.	Decided axis meaning. Placed each sample based on the intensities of attributes represented by the axis but grouped them for similarity using other attributes too.	Mostly
	7	Compared samples pairwise looking for similarities. Used appearance then aroma, followed by taste to compare the beers.	Compared samples pairwise looking for similarities. Used appearance, then aroma followed by taste to compare the beers.	Yes
	8	Rough map on 1st tasting prepared on the bench, committed to paper on 2nd	Rough map on 1st tasting; fine-tuned on 2nd tasting.	Yes

		tasting.		
	9	Separated the samples by colour then smelled them all writing down attributes along, then tasted all the samples writing down attributes before finishing the map. Used arrows to link descriptors to crosses on the map.	Prepared a rough map on the bench, decided on attributes to discriminate between samples before reproducing the map on the screen.	No
	10	Identified similar samples to group together.	Identified similar samples to group together.	Yes
Axis meaning	1	No articulated meaning for axis.	No articulated meaning for axis.	Yes
	2	No articulated meaning for axis.	No articulated meaning for axis.	Yes
	3	Appearance/colour selected as dimension before starting to taste. Complemented by bitter/sweet after 3 samples.	Appearance/colour selected as dimension before starting to taste. Complemented by bitter/sweet after a few samples.	Yes
	4	After tasting 2 samples, axis meaning selected as flat – frothy (x axis) and sweet – bitter (y axis).	No articulated axis meaning.	No
	5	No articulated meaning for axis.	No articulated meaning for axis.	Yes
	6	Bitterness and thickness established right away as axis meaning.	Bitterness and thickness established as axis meaning after a few samples.	Yes
	7	No articulated meaning for axis.	No articulated meaning for axis but placed last samples in relation to others citing colour and sweetness.	Mostly
	8	Perceived product category used ("traditional beers" at the top).	Perceived product category used ("real ales" or "low quality").	Yes
	9	X axis related to colour, y axis not specified.	Selected attributes for the x and y axis early on "I have now selected the attributes I'll use to build my map" but does not speak them out loud.	Mostly
	10	Not consciously articulated but used "sweetness" and "light" to characterise and separate groups of samples.	Not consciously articulated but used "bitter" and "light straw" to characterise and separate groups of samples.	Yes
Early attention focus	1	Map: built the map then focused on attributes.	Map: built the map then generated attributes.	Yes
	2	Map: built the map then wrote attributes down.	Attributes: typed attributes in sample tags then generated the map.	No
	3	Attributes: wrote attributes down for all samples in the top left corner of the map before generating the map.	Attributes: typed attributes for each sample in the sample tags before generating the map.	Yes

4	Concurrent: wrote the attributes down as the map was generated.	All samples dragged onto the screen to type attributes. Appearance attributes typed first then concurrent, attributes/map.	Mostly
5	Map: generated the map then wrote the attributes on re-tasting/finalising the map.	Map: typed the attributes when happy with the map.	Yes
6	Concurrent: described samples using the axis meaning and sample characteristics to generate the map.	Concurrent: typed the attributes in the sample tags as they were tasted and placed on the map.	Yes
7	Concurrent: wrote the attributes down as the map was generated.	Concurrent: typed the attributes in the sample tags as they were tasted and placed on the map.	Yes
8	Map: rough generated the map then wrote the attributes on re-tasting/finalising the map.	Concurrent: typed the attributes in the sample tags as they were tasted and roughly placed on the map. Map fine-tuned on re-tasting.	Mostly
9	Attributes: all samples assessed for appearance then aroma then taste.	Map: quick taste tour to build map on bench then re-taste to fine-tune and type sample descriptions.	No
10	Attributes: described all the samples before placing them on the map and writing down attributes.	Attributes: described all the samples before placing them on the map and typing in the attributes.	Yes