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Developing sensory evaluation methods for consumers with low-literacy levels applicable in developing countries

by

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In the

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University of Pretoria

South Africa

DECLARATION

I declare that the dissertation here with submitted for the degree MSc Food Science at the University of Pretoria, has not previously been submitted by me for a degree at any other university or institution of higher education.

Joseph D Kamdem Mademgne

Date: 26/04/2016

DEDICATION

This dissertation is dedicated to God for the gift of life and making this possible. It is also dedicated to my family for their unfailing love, support and encouragements.

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Above all, to God who made all possible.

ABSTRACT
DEVELOPING SENSORY EVALUATION METHODS FOR CONSUMERS WITH LOW LITERACY LEVELS APPLICABLE IN A DEVELOPING COUNTRIES

Joseph D Kamdem Mademgne

Supervisor: Prof Henriëtta. L. de Kock

Co-supervisor: Prof Shakila Dada

Conventional consumer sensory methods take literacy and language capabilities for granted. Consumers with low-literacy levels are considered as people lacking reading proficiency to fill out basic forms or read simple instructions. The conventional format of the paired preference test requires participants to read instructions and indicate which one of two samples is preferred.

The first objective of the project was to develop formulations for two ginger biscuits that differed perceptibly but subtly in salt content only to use as test materials for paired preference test trials using consumers with low-literacy levels. The signal biscuit contained 0.65% salt on a flour basis and the high salt biscuit contained 4.54%.

Physicochemical analysis showed that the two biscuits were significantly different in total carbohydrate, moisture, ash, protein, fat and Na^+ contents as well as texture by instrumental analysis. However, biscuits weren't different in terms of their colour values. Sensory analysis revealed that the high salt biscuit was perceptibly more salty compared to the signal biscuit, but not different in hardness in contrast to the instrumental analysis. An untrained panel of literate student participants preferred the signal biscuit over the high salt biscuit.

The second objective was to develop variations of the conventional paired preference method and to determine the effects of variations of the basic elements of the method on task performance by low-literate consumers. Seven individual paired preference tests were carried out at seven different test stations using 50 participants per method.

The conventional method was less efficient and time-consuming with a mean time of 5.6 min taken per participant. The efficiency of the paired preference method was improved to an extent that almost no assistance was needed and the mean time to complete the test was 4.2 min with the modify methods.

Participants performing the test claimed that, combination of audio and picture instructions positively influence their performance and improved understanding of test instructions. For the conventional paired preference test, 34% of participants struggled to follow the test instructions and only 52% of participants appeared confident with the procedure. For the method with limited reading and writing requirements, only 16% of participants struggled to follow the instructions and 84% appeared confident with the procedure.

Basic elements developed associated to instruction to pull the coding sticker from the sample chosen to stick it on a positive smiling face was identified as the best paired preference method for independent completion by low-literate consumers.

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1 INTRODUCTION

Literacy is defined as the "ability to read and write" and the inability to do so is called illiteracy (Stevenson, 2010). According to the UNESCO Institute of Statistics (USI) September 2014 review, there are still 781 million adults and 126 million youths in the world that cannot read or write a short simple sentence about their everyday life, despite significant improvements in literacy rates globally (UNESCO, 2014). Twenty four per cent of illiterate consumers live in sub-Saharan Africa. In South Africa it is estimated that between 7.4 and 8.5 million adults are functionally illiterate and that between 2.9 and 4.2 million people have never attended school (International literacy day, 2015). This represents a substantial percentage of the population in the region and also an important group of food consumers.

Literacy seems to be a term that everyone understands but as a concept it has proved to be both complex and dynamic. It is difficult to arrive at a concise definition of literacy because the concept changes with societal demands (Mhlanga, 2011). According to Adkins and Ozanne (2005a), low-literate people lack reading proficiency to fill out basic forms or read simple instructions.

Food choice and acceptability are primarily based on whether the sensory properties of food products are liked or disliked. Nutritional or health benefits come as an aftermath, thus researchers should pay special attention when measuring food products' acceptance (Sosa et al., 2008). Sensory evaluation with consumers is easy in its principle but its implementation in the field is often complicated especially in rural areas where consumers are generally characterised with low levels of education or low income (Muhimbula et al., 2011).

Food industries all over the world have the challenge of supplying food products to a diverse group of people from the most affluent to the poorest consumers (Coetzee, 2001). Conventional consumer sensory methods take literacy and language capabilities for granted (Coetzee and Taylor, 1996). One of the reasons why food products often fail might be because consumers' preferences regarding the food products are not clearly understood (Coetzee and Taylor, 1996). Illiterate consumers are often unable to read instructions and complete evaluation sheets, or make a choice on a scale to indicate their preference (Coetzee and Taylor, 1996). Consumers with low-literacy levels represent a marginalised or worse ignored group, and are underrepresented in market research (Viswanathan, Gajendiran and Venkatesan, 2008). Development of suitable sensory test methods (e.g. paired preference or hedonic tests), modified from conventional methods for consumers with low-literacy levels,

might contribute to ameliorate consumers' performance during such tests and could improve understanding of consumers' attitudes when it comes to making choices during sensory research. More intuitive methods that limit reading and writing tasks may also be useful to allow independent completion of the task by illiterate or low-literate consumers. The structure of the dissertation is as follows: a review of literature is presented in chapter 2. From the literature review, hypotheses were formulated leading to objectives to be tested in an experiment. The methodology for the experiment and results are presented in two research chapters (chapter 4 and 5) that form the basis for two researcher publications. A general discussion to critically review the experimental design and methodologies is presented in chapter 6. This chapter concludes with a guideline for using the new method developed through this research. Chapter 7 presents conclusions from the researcher and recommendations for future studies.

2 LITERATURE REVIEW

2.1 Introduction

This review presents the attributes of consumers with low levels of literacy when it comes to making a choice of one product among others in the market place and during sensory food research. It reviews quantitative and qualitative sensory methods using low-literate consumers. An overview of one-on-one qualitative data collection with consumers with low literacy levels is given. Studies of various adapted sensory paired preference, preference ranking and hedonic rating test are also reviewed. Researchers' difficulties when carrying out sensory testing using consumers with low-literacy levels are reviewed and presented.

2.2 Literacy

The way literacy has been defined has changed over the last few decades; it is therefore a dynamic concept. It is changing to embrace multiple approaches to societal demands (Mhlanga, 2011). The Oxford English dictionary defines literacy as "the ability to read and write" and the inability to do so is called illiteracy (Stevenson, 2010). However, this definition is simplistic and fails to include the process of understanding and applying information that was read. Literacy is an important concept in many areas of social life, it refers not merely to the act of reading and writing printed language, but also to the ability to extract and process complex meanings in a socio cultural context (Bengtsson and Firat, 2006). Viswanathan et al., (2009), affirmed that literacy is the ability to respond properly to all possible reading tasks. De Bruin and Minnaar (1994), viewed literacy as the ability to think and reason like a literate person. A person identified as functionally literate can engage effectively in all those activities in which literacy is required; read, write and do calculations on his own (Keefe and Copeland, 2011). Literacy is a key ability that should influence whether a consumer is persuaded by peripheral cues (external aspects of a product or packaging e.g. colour, shape, size, images), in a market place rather than written message claims. Thus the choice process for consumers with low-literacy level focuses on peripheral cues rather than attribute claims (written messages). Literate consumers will focus more on the strength of message claims (Jae and Delvecchio, 2004).

2.2.1 Definition and description of literate consumers

Literacy involves a set of decoding and encoding skills (Adkins and Ozanne, 2005a). A literate person has a set of skills that work in any context, whether it is reading a financial or scientific statement or the ability to complete a specific task (Adkins and Ozanne, 2005a). A literate person can fill out any form, and filling out a form at the doctor's office is the same as filling out a form at home (Adkins and Ozanne, 2005b). Thus a literate person is able to act as other literate people would act in the same situation, which requires more than decoding skills and the ability to complete reading tasks, but also entails social and cultural practices (Adkins and Ozanne, 2005b). According to Carstens (2004), literate consumers possessed skills that help them to understand written instructions: perception skills (ability to discriminate between letters, words, number, pictures or whatever is on a page), decoding skills (ability to recognise words), encoding skills (ability to comprehend information), feedback skills (ability to think about information) and memory skills. Thus, consumers with excellent literacy levels have the ability to find and manipulate text and numbers to accomplish complicated related tasks e.g. associate price, weight, description of the product etc. within a specific market context in which other skills and knowledge are also employed (Adkins and Ozanne, 2005a). Literate consumers usually experience satisfaction by selecting the right product at the right time because they combine all peripheral cues of products including written information when making purchasing decisions (Fingeret and Drennon, 1997).

2.2.2 Definition and description of consumers with low-literacy levels

Adkins and Ozanne (2005a), defined consumers with low-literacy levels, as people that lack reading proficiency to fill out basic forms or read simple instructions. People who can read enough to enter background information on a simple form, that can locate identifiable information in text, but otherwise possess only marginal literacy skills. Carstens (2004), presented consumers with low-literacy levels as persons that lacked strategies to recognise words and decode them. Adkins and Ozanne, (2005a), affirmed that consumers with low-literacy levels may for example choose a wrong product in a store due to misunderstanding of the written price information. They also experience substandard product choices because of overdependence on peripheral cues (e.g. image on a packaging of the product, price, weight), in product advertising and packaging (Jae and Delvecchio, 2004). Viswanathan, et al., (2009), used the term pictographic thinking to express the idea developed by Jae and Delvecchio (2004), concerning low-literate consumers ways of thinking, and said they depended on perceptual, rather than conceptual processes, in acquiring, retaining and using information

(they enjoyed physical representation of any object rather than written representation). For example, consumers with low-literacy levels have a tendency to visualize quantity of products to buy by picturing them, rather than using available symbolic information, such as weight or volume or units of measurement (Adkins and Ozanne, 2005a). According to Carstens (2004), people with low-literacy levels are able to process visual information despite some limitations such as quality of the object representation (unrealistic reproduction of the colour, dimensional objects representation etc.). Pictures are attracting, it increases speed of message transfer, stimulate, motivate and enhance the memories of consumers with low-literacy levels and is an important vehicle of information in the health sector.

Malhotra (1988), stated that visual processing particularly, mental imagery, is a strong facilitator of learning that characterises consumers with low-literacy levels. Information acquisition and unique sensory features of pictures allow them to be encoded more distinctively. Viswanathan, et al., (2009), characterised consumers with low-literacy levels as persons with a lack of or limited ability to think abstractly. They explained that when adults with low-literacy levels were shown sets of objects (e.g. hammer, saw, log, and hatchet), and were asked to select the three that were most similar, they could not identify hammer, saw and hatchet as tools and derived ad-hoc categories even when prompted that hammer-saw-hatchet were tools "Yes, but even if we have tools, we still need wood-otherwise, we can't build anything". In this regard, Villanueva and Da Silva (2009) affirmed that consumers with low-literacy levels primarily function in the visual (pictorial thinking), concrete realm, rather than the symbolic abstract realm. Similarly, children with disabilities and low-literacy levels also have difficulties understanding what pictures mean. This has been attributed to the iconicity of the picture which is a perceive relationship between a symbol and its referent (Mizuko, 1987; Fristoe and Lloyd, 1980; Lloyd and Fuller, 1990; Blischack, Lloyd and Fuller, 1997; Schlosser and Sigafoos, 2002).

2.3 Overviews of consumer sensory test methods

Two general classes of consumer testing methods exist. Acceptance testing presents consumers with products individually, for which a hedonic response is elicited without direct comparison to other products, typically using a type of scale to quantify overall acceptability (Hein et al., 2008). Preference test methods require the selection of one product that is preferred over another (Lawless and Heymann, 1999). Acceptance methods measure the degree to which a product is liked or disliked and give interval or ratio data (Courcoux and Semenou, 1997). Preference methods produce ordinal data that permits identification of sample preference within the test set (Lawless and Heymann, 1999).

2.3.1 Preference test

Preference test methods involve comparisons between two products or among several products. If two products are compared it is called a paired preference test and if more than two, it is called preference ranking test. In the latter case the consumer orders the product from best liked to least liked (Lawless and Heymann, 1999). It is the simplest type of sensory test method.

2.3.2 Paired preference

The paired preference test can be considered as the first sensory test method developed to assess preferences (Stone, Bleibaum and Thomas, 2012). Thus it should not be surprising that there is extensive literature about the method and especially on the topics of test design, statistical analysis, and mathematical methods to help explain choice behaviour in a pair comparison situation (Stone et al., 2012). The method requires the subject to indicate which one of two coded products, is preferred (Figure 2.1). Sometimes the inclusion of “no preference” as a third choice is included (Figure 2.2). The orders of presentation are A-B and B-A, the test usually evaluates only one pair of products in a test with no replication. It is usually a two-tailed test because we do not have any knowledge regarding which product is preferred (Stone et al., 2012). The appeal of the test method is quite strong because of the unambiguous design. However, it is not very informative because the responses provide no direct measure of magnitude of acceptability of the products, both products may be disliked. The method is less efficient compared to some other methods because there is only one response for each pair of products. However, it typically mimics what consumers do when purchasing products (choosing among alternatives) (Stone et al., 2012). Conventional wisdom is that consumers make choices by implicitly comparing products to each other.

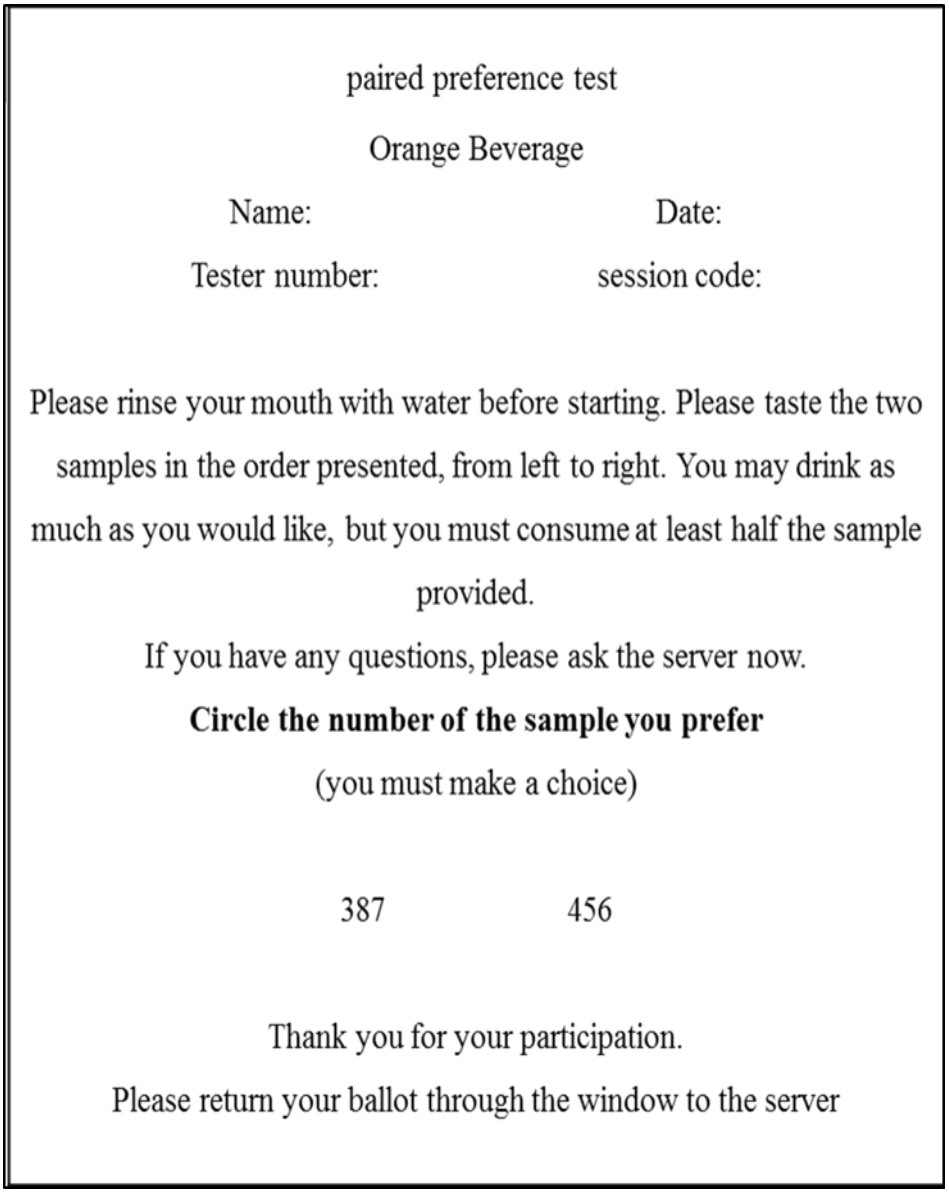
Depending on the groups of participants (children or adults) and demand of some food companies, conventional sensory paired preference test methods underwent some modification. Coetzee and Taylor (1996), develop a paired comparison method for illiterate and semi-literate consumers where the usual three digit code numbers were replaced with graphic symbols (outlined and solids) (Figures 2.3, 2.4, 2.5). They concluded that many of the consumers who could not read or write could reliably perform this type of paired comparison test when verbal instructions were given. They observed that consumers were able to perform or complete the test without any assistance when using the adapted score sheets. Only occasional direction was needed to explain to participants how to perform the test. Paired comparison symbols proved to be successful because no time wasting was noted and efficiency of the test improved compared to the conventional method with usual code number system which proved to be ineffective (Coetzee and Taylor, 1996).

Coetzee (2001), proposed an adapted paired preference test method (Figure 2.6) for illiterate and semi-literate consumers. The method was designed to clearly understand the opinions of illiterate consumers. Consumers were given two food samples and asked to make a choice based on some specified criteria or characteristic; consumers were given a blank score sheet and two stickers (different colours). After tasting the products they were asked to stick the corresponding sticker of the sample they preferred on a blank score sheet to indicate their preference. The conventional 3-digit number code to mark was also removed and the usual pen for filling forms avoided. She mentioned some observations relevant to the illiterate consumers' behaviour during the test. Illiterate consumers often were not able to interpret three-digit numbers on the score sheet; participants were not able to evaluate more than two samples at the same time. She concluded that illiterate and semi-literate consumers performed better with the adapted method compared to the conventional method.

2.3.3 Paired preference test sensitivity

Generally for the paired preference test the approach to the statistical analysis requires the use of a two-tailed test over a one-tailed test. A good argument can sometimes be made for applying a one-tailed test, for example, consider paired comparisons between samples of a food with and without an extra ingredient, say sugar. When asked to identify the preferred sample, it is reasonable to expect that if the judges could distinguish between the samples, then participants would choose the sample with added sugar. Since we can predict the direction of the outcome: it is a one-tailed test (O'Mahony, 1985). According to the ASTM E2263 (2013), the paired preference test is a test in which the researcher might have an a

priori assumption concerning the direction of the preference. In this case the alternative hypothesis will express that a specific product is preferred over the other product (that is only A > B or A < B) depending on the a priori belief. If the researcher does not have any a priori assumption concerning direction of the preference, the test is a two-tailed or two sided test. In this case the alternatives hypothesis is that the products are not equally preferred (that is A≠B). The test sensitivity of the paired preference depends on important statistical concepts i.e. α-risk, the probability of concluding that a preference exists when, in reality, one does not, and β- risk, the probability of concluding that no preference exists when, in reality, one does as well as P*max* the proportion of common responses that the researcher wants the test to be able to detect with a probability of 1-β. For example, if a researcher wants to have a 90 % confidence level of detecting a 60:40 split in preference, then Pmax = 60 % and β = 0.10. Smaller values of α, β and Pmax indicate a more sensitive test. The test sensitivity parameters are established prior to testing and are used to determine the number of participants needed in a study (ASTM E2263, 2013).



paired preference test

Orange Beverage

Name: Date:

Tester number: session code:

Please rinse your mouth with water before starting. Please taste the two samples in the order presented, from left to right. You may drink as much as you would like, but you must consume at least half the sample provided.

If you have any questions, please ask the server now.

Circle the number of the sample you prefer

(you must make a choice)

387 456

Thank you for your participation.

Please return your ballot through the window to the server

Figure 2.1: Example of a scorecard for the paired-preference test, showing option A, which limits the subjects to two choices (Lawless and Heymann, 2010).

Paired preference test

Orange Beverage

Name: Date:

Tester number: session code:

Please rinse your mouth with water before starting. Please taste the two samples in the order presented, from left to right. You may drink as much as you would like, but you must consume at least half the sample provided.

If you have any questions, please ask the server now.

Please indicate your preference by circling one of the following three answers.

387 456

No preference

Thank you for your participation.

Please return your ballot through the

Window to the server

Figure 2.2: Example of scorecard for the paired-preference test, showing option B, which includes a No preference choice to the subject (Lawless and Heymann, 2010).

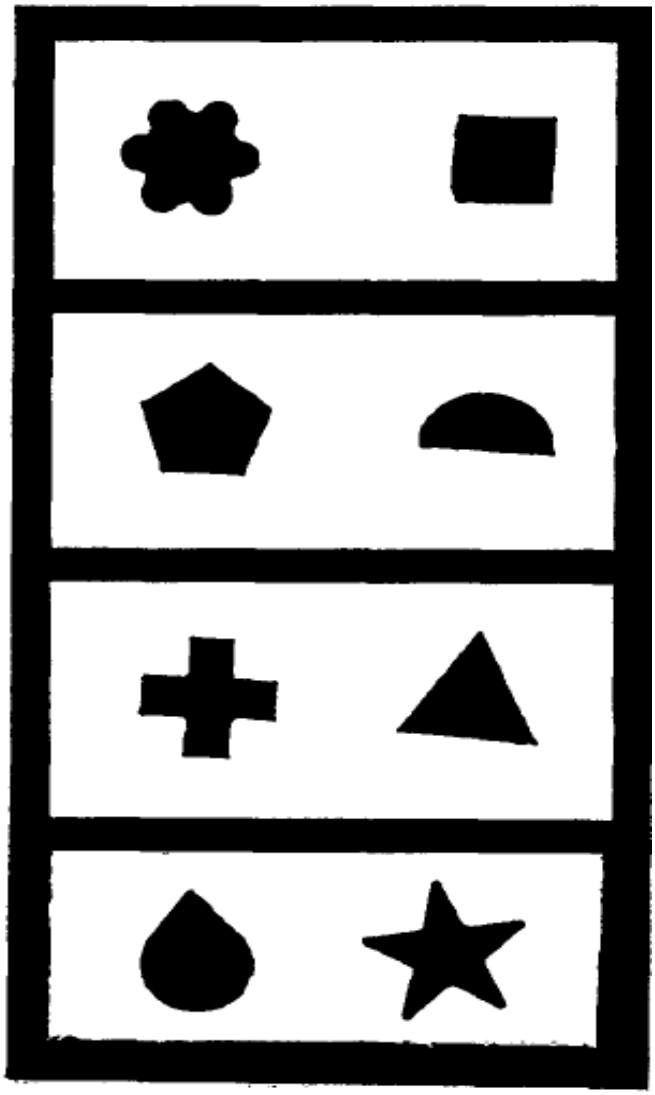


Figure 2.3: Set of first solid paired symbols test developed and adapted for paired comparison test with illiterate and semi-literate consumers (Coetzee and Taylor, 1996)

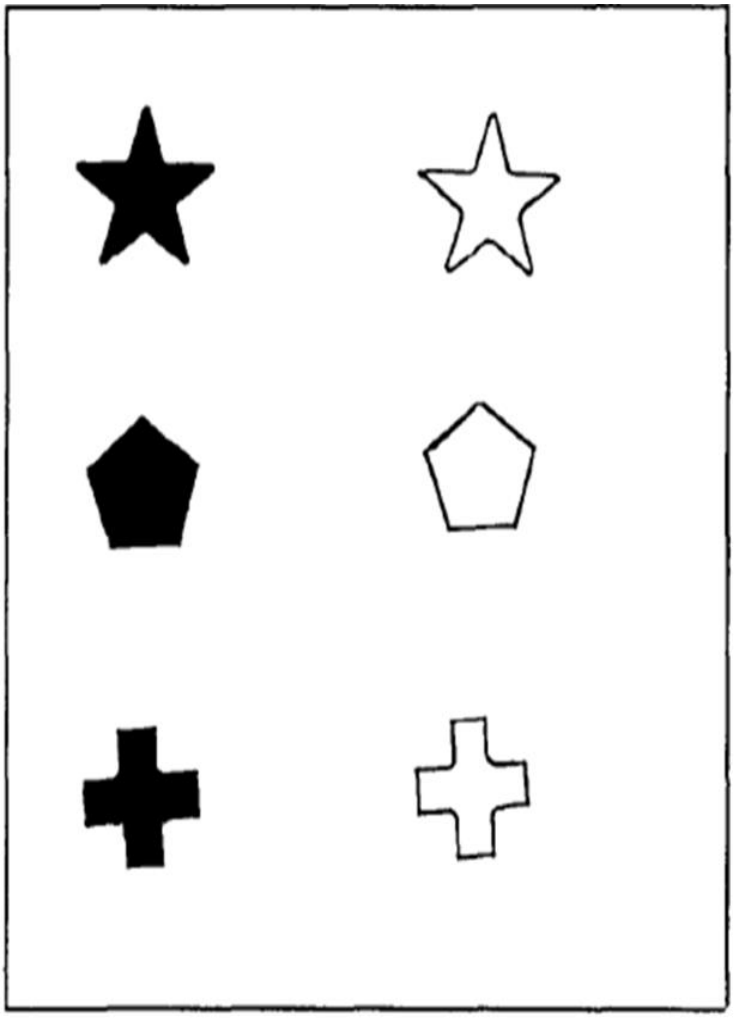


Figure 2.4: Set of second developed paired symbols (outline and solid symbols) adapted for paired comparison test with illiterate and semi-literate consumers (Coetzee and Taylor, 1996).

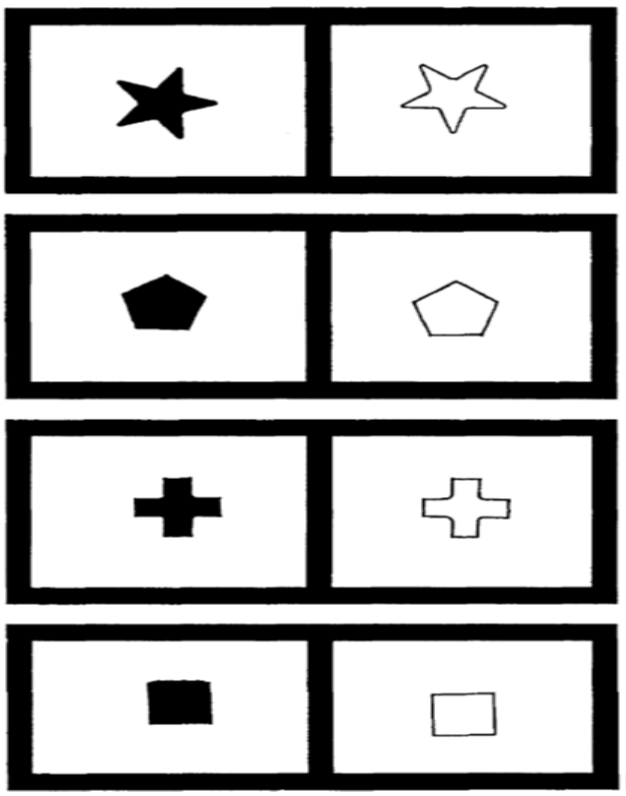
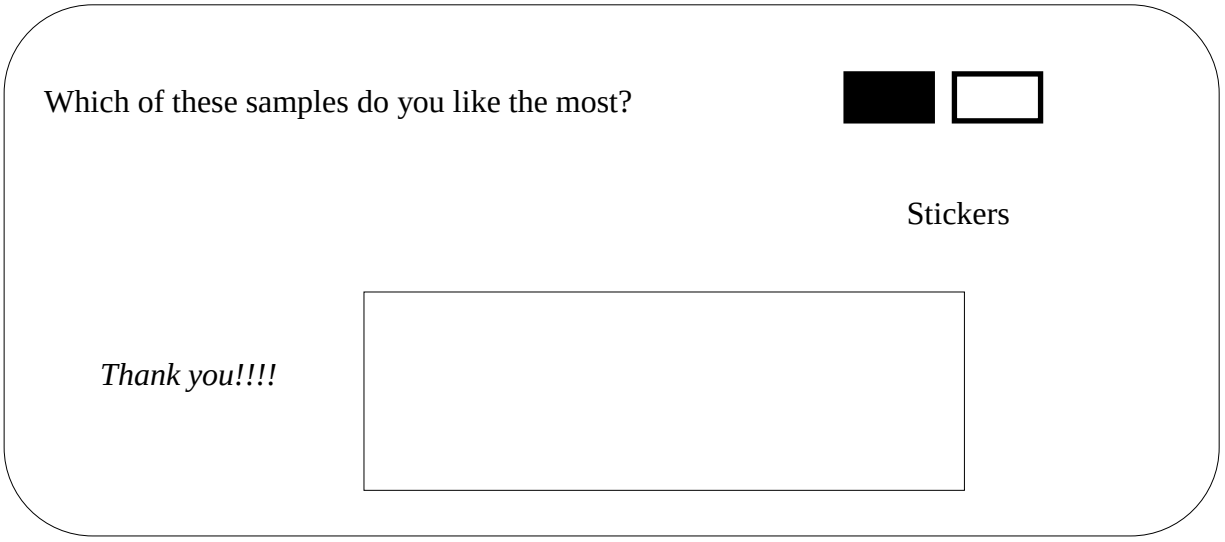


Figure 2.5: Set of third developed separated paired symbols (outline and solid symbols) adapted for paired comparison test with illiterate and semi-literate consumers (Coetzee and Taylor, 1996).



In this adapted method consumers were given a blank button and two stickers corresponding to the sticker codes for the samples to indicate preference. Instruction was orally given.

Figure 2.6: Adapted paired preference method proposed by Coetzee (2001)

2.3.4 Preference Ranking

The objective of most quantitative consumer research conducted in support of product development is to determine consumers' affective reactions to new or revised products (Popper et al., 2004). For preference ranking, consumers are presented with more than two samples and instructed to order them from least preferred to most preferred (Figure 2.7) (Kempt et al., 2009). Preference ranking is an excellent sensory technique to apply when participants have to make decisions about different product samples that are all fairly well liked (Stone et al., 2012). The participants are usually not allowed to have ties in the ranking. Ranking do not give a direct estimate of the size of any difference in preference. The method is generally considered intuitively simple and can be done quickly with relatively little bias. It is considered as a force choice method (Lawless and Heymann, 2010).

Few studies applying the sensory ranking method using illiterate consumers was found. A method was developed by Brich in 1979 named ranking by elimination and applied by Leon, Couronne, Marcuz and Köster, (1999) using young children as participants. They found good repeatability for children above 5 years. The test method was quite easy thus during the test verbal instructions were given. Children tasted five types of biscuits following this instruction: I want you to taste the five biscuits in front of you and to show me the one you like the most". The child was invited to finish the favourite biscuit. After that, they tasted again the four remaining biscuits and showed the one they preferred. This favourite biscuit was then also eaten or if the child did not want to eat it, eliminated from the choice set. The process was repeated until all biscuits were ranked. The method was found to be successful and good repeatability was observed. The method could potentially be applied with low-literate and semi-literate adult consumers.

Preference test - Ranking

Fruit Yogurt

Name:---------- Date:----------

Tester Number:---------- Session code:---------

Please rinse your mouth with water before starting.

You may rinse again at any time during the test if you need to.

Please taste the five samples in the order presented, from left to right.

You may re-taste the samples once you have tried all of them.

Rank the samples from most preferred to least preferred

Using the following numbers:

1 = most preferred, 5 = least preferred

(if you have any questions, please ask the server now)

Sample	Rank (1 to 5) (ties are NOT allowed)
387	---
589	---
233	---
694	---
521	---

Thank you for your participation,

Please return your ballot through the window to the server.

Figure 2.7: Example of preference ranking score sheet proposed by Lawless and Heymann, (2010).

2.4 Hedonic rating

The hedonic rating task represents one of the most important sensory methods used in the food industry during product development and launching of new products in the market due to the fact that it informs some measure of whether products are liked or not (Nicolas et al., 2010). Over time, various measures of liking have been developed and reviewed. However, one of the best-known measures of liking is the 9-point hedonic scale developed by Peryam and Girardot in 1952 and introduced as an aid to menu planning for US soldiers in their canteens (Figure 2.8) (Villanueva and Da Silva, 2009). The scale comprises a series of nine verbal categories ranging from 'dislike extremely' to 'like extremely'. The method permits consumers to categorize foods according to how much they liked it or not (Nicolas et al., 2010). The 9-point hedonic scale has been modified over time. Yeu et al., (2008), developed a 9-point category scale labelled with numbers ranging from 1 to 9 and anchored only at the left and right ends with "extremely dislike" and "extremely like," respectively. The ends were anchored with words to provide the direction of overall liking (Figure 2.9). Chung (2010), presented a 9-point scale with nine empty category boxes (no numbers) labeled at appropriate ends with 'dislike extremely' and 'like extremely' (Figure 2.10). The labeled affective magnitude scale (LAM) (Figure 2.11) was developed to measure absolute liking. It is reliably sensitive to difference and is as easy to use as the 9-point hedonic scale. The scale range from "greatest imaginable dislike" to "greatest imaginable like" (Hein, et al., 2008).

Curia et al., (2001), found that the 9-point hedonic scale anchored with Spanish phrases translated from English were not appropriate for consumers from rural areas with low income in Argentina. The research demonstrated that 30% of the subjects ranked the translated phrases differently in relation to the English version. They recommended the use of numbered or unstructured scales for low income consumers in Argentina and warned that use of the 9-point hedonic scale in languages different to English should be done with caution, and researchers had to make sure that the general population understood the phrases in a similar manner.

Abede, Stoecker, Hinds, and Gates, (2006), working with mothers from Southern Ethiopia, used a five point hedonic scales from "5"= like very much, to "1" = dislike very much. To facilitate data collection, the sensory evaluation instruments were translated from English to Amharic, which was commonly understood by the technical team and the participants. They also emphasized that during sensory research caution needs to be taken with language when using adults from rural areas where literacy may be limited. The researchers recommended

the use of focus group discussion during data collection as very useful and important in rural areas.

Sosa et al., (2008), presented a 10-point scale from 1 = 'I dislike' to 10 =' I like' which they compared with a 9-point semi-structured hedonic scale using low income, low educated participants in Buenos Ares (Figure 2.12a). The tests were done in two different test locations with home usage tests (HUT) and central location tests (CLT). They found that results with the two scales were not statistically different, nevertheless some difficulties of understanding of the box scale (Figure 2.12b) were noted. A general survey showed that the consumers preferred the number scale (Figure 2.12b). The researchers recommended that when choosing the most adequate scale it is important to consider not only the statistical outcome, but also consumers' comments and expressed choice of scale.

Another modification of the original 9-point hedonic scale used successfully with children and illiterate consumers is facial hedonic scales (Figure 2.14), where conventional words are replaced with faces (Lawless and Heymann, 1999). Hedonic facial scales are simple smiley faces, but they may also be more representational involving animal cartoons or more realistic pictures of adults (Lawless and Heymann, 1999). According to Lawless, Popper and Kroll, (2010), hedonic facial scales may introduce unintended bias or confusion especially in younger children. This is because a face which is intended to represent a level of dislike can also be interpreted as conveying anger. Other difficulties with children are their shorter attention span and their cognitive capacities which are potentially not fully developed, consequently leading to extreme answers or random answers with low reliability (Zeinstra et al., 2009). The same observations could possibly be observed with low -literate adults.

Coetzee (2001), proposed an adapted five faces hedonic test where the conventional verbal scale was removed and replaced by a five point facial scale corresponding to how much the product is liked or disliked (Figure 2.13). Consumers used stickers to stick on the corresponding image with no assistance given. After trying several adapted methods, she concluded that low-literate consumers reacted positively to the adapted method. However, she emphasized that not more than two samples were evaluated by consumers during a session. De Bruin and Minnaar, (1994), proposed a combination of a five-point facial hedonic scale with five digital numbers 1-5. With this test method, low-literate participants received coded samples, tasted them and then pointed to or selected on the scale the image that best represented how much each sample was liked or disliked. They concluded that the specific

test method used, together with the assistance given to assessors during evaluation, lead to a successful completion of evaluation forms and credible results.

Bwambale et al., (2013), working with illiterate women in a rural area of Uganda (Karamoja), implemented a novel survey technique using 10 local beads as tools of measurement. The surveys required participants to estimate their households' expenditures on foods, health, education and other items using the beads. The objects of measurement could be bean seeds, stones or beads used by local artisans, but the team used only one form of beads throughout the survey. The field teams asked participants to think about their annual household income and how that income was spent. Then interviewers asked participants to use the beads to create piles that represented expenditure on different items. They found that women could readily create piles of beads to indicate quantification of expenditure behaviour. In this case, the field researcher can then easily convert the pile of beads into the equivalent of a 5-point Likert scale or other scale range. For example, on a 5-point Likert scale, two beads would equal a score of 1 while an odd number of beads would be treated as a half step between the standard scores. They concluded that used of local beads was a feasible approach. The technique provides an example of how locally-adapted social research methods might be useful when illiterate participants are asked to quantify responses and the researchers believe it can be useful in community or household surveys with illiterate or low-literate participants.

2.4.1 Facial reading techniques

If a consumer with low-literacy levels does not understand the instructions and what is expected of them in a sensory evaluation test, how would they be able to give responses that would accurately rate a product? Such considerations explain why the use of implicit measures such as facial reading or instrumental facial reading could be regarded as beneficial for understanding illiterate consumer or consumers with a low-literacy level.

Steiner (1973), studying gusto facial responses (indirect sensory test method) of infants demonstrated that facial expressions of infants during preference tests expressed their choices. For sour and bitter tastes, infants rejected the product by grimacing but for sweet taste elicited positive facial responses. The method found a great interest when developing babies' medicine, because reading the babies facial expressions when tasting a particular product explained the choice made by them. The same facial expression technique can also possibly be applied with adults with low-literacy levels. Erickson et al., (2003), underlined that facial expression is a fundamental example of illiterate behaviour, and is important to

understand their emotion and social interaction. However, no research on facial expression of adult consumers with low-literacy levels could be found.

Danner et al., (2013), presented an approach of facial reading using an instrument, FaceReader4 (Noldus Information Technology, Wageningen, The Netherlands) which was capable of analysing facial expression patterns from video data online and offline. The instrument was used to test whether facial reactions measured with FaceReader4 was a sufficiently accurate measure for differentiating between six different orange juice samples in the Austrian market. Participants were asked to taste an orange juice sample (30 ml), take twenty seconds to reflect on the taste impression, then give a signal with their right hand and visualize the taste experience of the sample with a facial expression best representing their liking of the sample. No timer was used to allow natural facial expressions and to keep the experiment as unobtrusive as possible. Afterwards, they rated their liking or disliking of the orange juice on a 9-point hedonic scale, ranging from 1 (like extremely) to 9 (dislike extremely). The whole procedure was filmed with a Logitech C600 webcam, mounted on a laptop facing the participants, using Media Recorder software (Noldus Information Technology, Wageningen, Netherlands). They concluded that the technology is sufficiently accurate to detect significant differences in facial expressions elicited by different orange juice samples and can deliver additional information to conventional acceptance tests. However, the method also presented some limitations e.g., it is difficult to use with very young children (below the age of three years). Participants have to face the camera and the face must not be obscured by hair. The methods will also not be appropriate with participants that have natural “poker faces” i.e. they do not show much emotion on their faces. The test can also be not appropriate when the tasting conditions are more complex like evaluating a full meal.

Figure 2.8: Examples of the 9-point hedonic scale designed by Peryam and Girardot, 1952, for studying US soldier's preferences in the field (Lim, 2011).

Figure 2-9: The 9-point category scale used by Yeu et al., (2008).

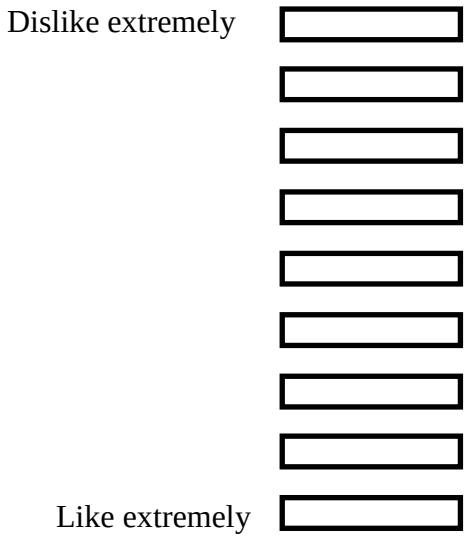
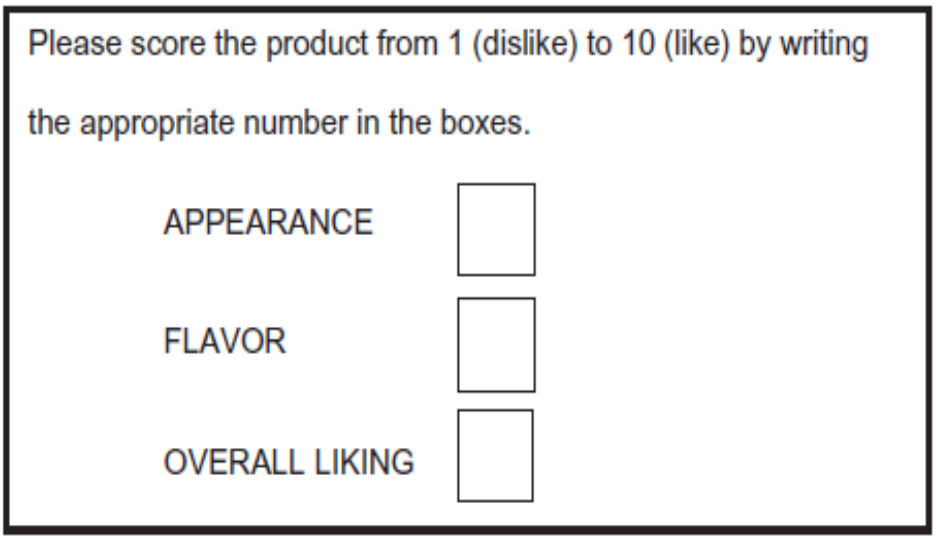


Figure 2.10: The 9.point empty boxes scale used by Chung, (2010).

Figure 2.11: The label affective magnitude scale (LAM) (Hein, et al., 2008)

a



b

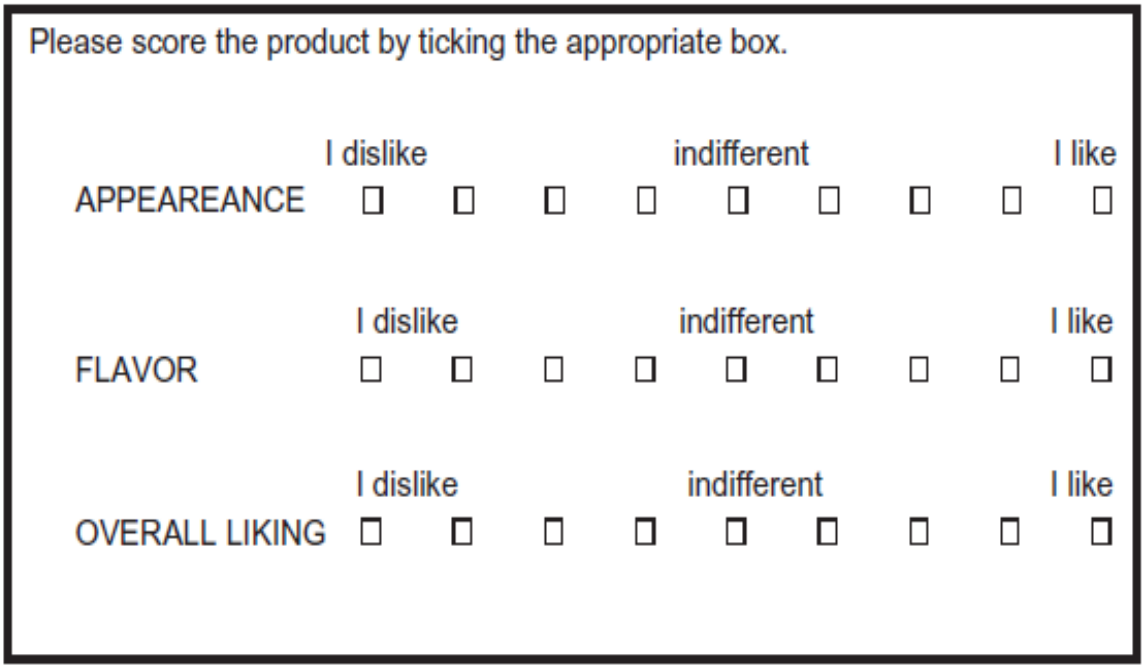


Figure 2.12: Acceptability scales (a) number scale (b) box scale used by Sosa et al., (2008)

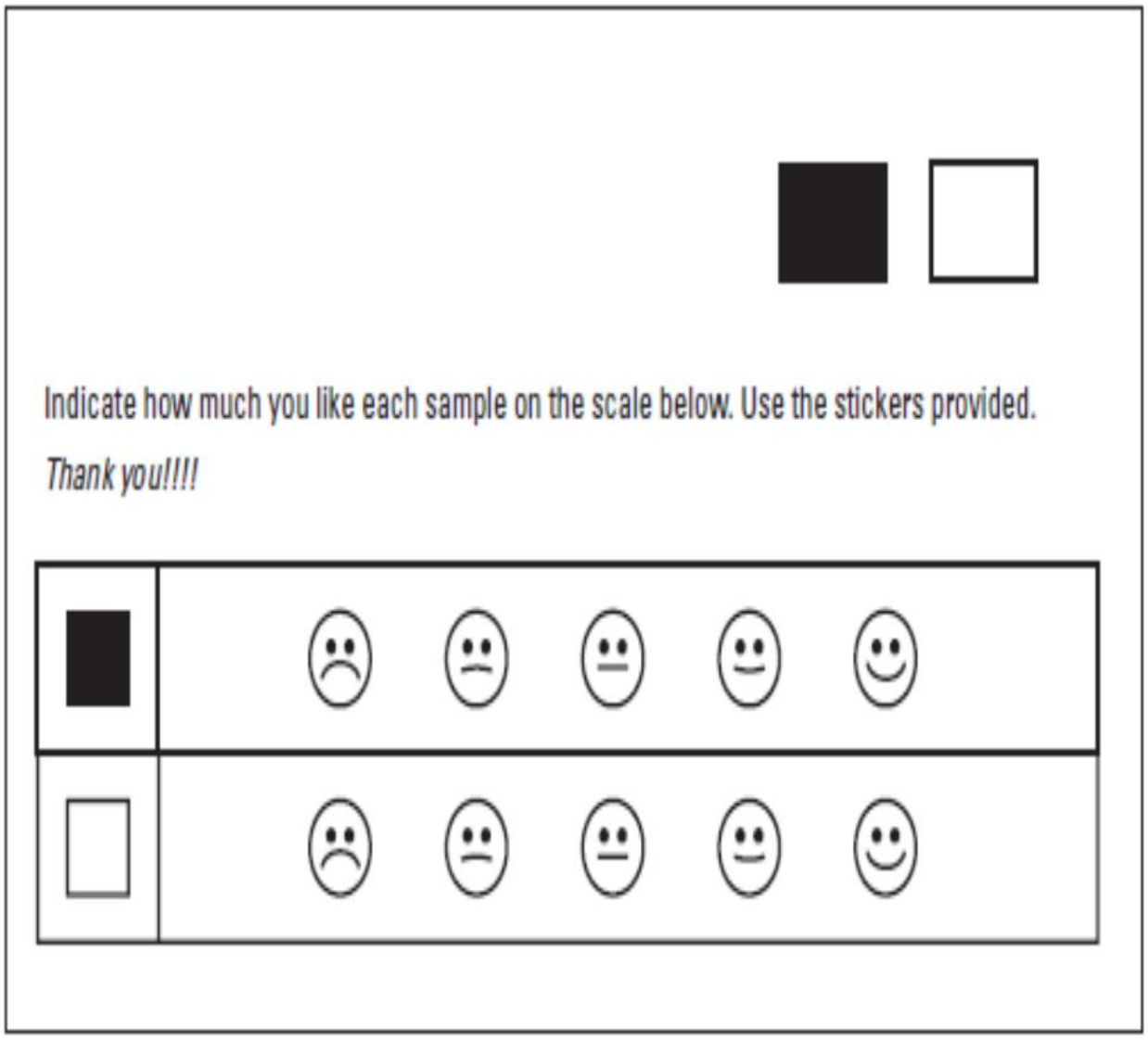


Figure 2.13: Hedonic score sheet adapted for illiterate consumers by Coetzee (2001).

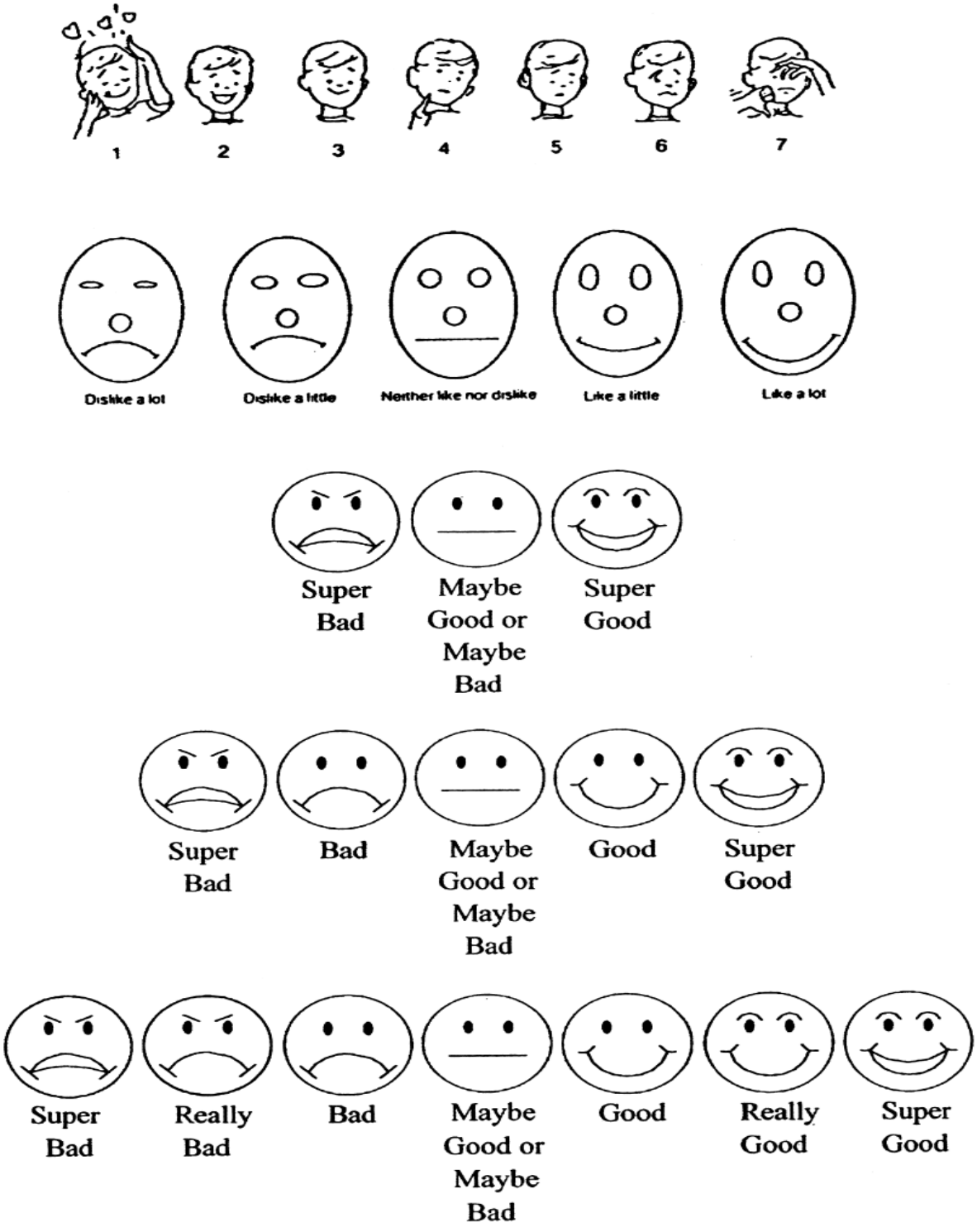


Figure 2.14: Example of Facial Hedonic scales used for hedonic rating by children (Guinard, 2001)

2.5 Qualitative analysis research using consumers with low literacy levels

While most consumer sensory test methods traditionally focus on gathering quantitative data it may be important to also gather qualitative information when working with illiterate or low-literate adult consumers.

Qualitative research is an umbrella concept encompassing several forms of inquiry that facilitate understanding and explanation of the meaning of phenomena with as little disruption as possible (Merriam, 1998). It is an investigative process where the researcher gradually makes sense of social phenomena by entering the participants' words through ongoing interaction to seek the participants' perspectives and meanings (Creswell, 2003). Compared to quantitative research, qualitative does not depend on numerical data. Quantitative research attempts precise measurement of something by answering questions related to how much, how often, how many, when and who in numeric terms (Cooper and Schindler, 2006). Qualitative research techniques seek to describe and come to terms with the meaning and not the frequency of certain phenomena. It is typically used to answer questions about the complex nature of a phenomenon, often focussing on describing and understanding the phenomenon from the point of view of participants (Leedy and Ormrod, 2005).

According to Rubin and Rubin (1995), collecting data is only the beginning of the research process. Once collected, the information has to be organised and interpreted. Qualitative analysis of consumers' comments can provide answers which can be numerically summarized. The process involves coding techniques for finding and marking the underlying ideas in the data, e.g. consumers comments, by grouping similar kinds of information together in categories; relating different ideas and themes to one another; organising the data; finding ideas and concepts; build overarching themes from the data; ensuring reliability and validity in the data analysis and in the findings; and finally find possible and plausible explanations for findings. According to Saunder et al., (2007), collecting data in qualitative research involved two types of in-depth questions, namely unstructured and semi-structured.

With semi-structured interviews, the researcher has a list of themes and questions to be covered. The data is recorded by either note taking of the conversation or perhaps audio-recording or both. The order of questions may vary from one interview to the next depending on the flow of the conversation, the interviewer or researcher guides the conversation (Mhlanga, 2011).

However, in unstructured interviews, questions are asked informally. There is no predetermined list of questions. The participant is allowed to talk freely in relation to the topic being explored. The conversation is guided by the interviewee (Mhlanga, 2011).

According to Ritchie (2003), a semi-structured interview provides undiluted focus on the individual and also provides the opportunity for detailed investigation, in-depth understanding of the personal context within which the research phenomena are located providing the necessary personal privacy during discussion. In food sensory research, a semi-structured interview also called one-to-one interview, is suitable for clarification of research problems and consumers' perspectives, identifying opportunities and generating ideal hypotheses (Lawless and Heymann, 2010). The main interest is that the activity generate the most variable and possible ideas and reaction about a given food prototype or variable. Participants verbalise their opinions and expectations about the task they performed (Lawless and Heymann, 2010).

Creswell (2003) and Kumar (2005), revealed some limitations of semi-structured interviews such as difficulty of standardising qualitative data as it depends on the quality of interaction between the interviewer and the interviewee. People are not equally articulated, the interviewer might introduce bias when forming questions and interpretation of responses. It is possible that the presence of an interviewer may affect the participant's perceptions of the test and interviews might provide "indirect" information through the views of the interviewees.

Practical difficulties of doing sensory testing with illiterate or consumers with low-literacy levels

Consumers with low-literacy levels have developed some special techniques to face their challenges such as the ability to cope (asking for immediate assistance), to cheat (trying to get any answer from a neighbours work) thereby avoiding exposing in public their lack of literacy. These consumers relied more on concrete thinking than abstract thinking. These aspects might explain difficulties that researchers encounter when performing sensory analysis tasks with this particular group of participants. In Table 2.1, we presented some important practical difficulties that researchers might face.

Table 2-1: Summary of some important practical difficulties of doing sensory testing with illiterate or semi-literate consumers.

Difficulties	Reasons or importance
Need for numerous helpers or assistants	To describe, translate and explain correctly different tasks to participants to ensure reliability and validity of responses from each participant e.g. consumers cannot read instructions on how to perform the task (Gau, et al., 2012). Instructions need to be verbally explained.
Limitation on the number of questions per task	Consumers struggle to read multiple questions and need to focus on a simple task. The reading tasks have to be limited (Gau, et al., 2012). Consumers may take a long time to perform tasks. The time and effort for tasks may lead to fatigue. Low-literate consumers have a short attention span (Stone et al., 2012).
Simplification of terminology and instructions.	The vocabulary used needs to be at the level of literacy of participants, the questions chosen have to be clear and simple (Gau et al., 2012).
Need for appropriate test environment.	The environment where the consumer test is conducted could easily influence the level of anxiety related to the performance of the task, e.g. if the participants feel that they are judged during the test they will feel uncomfortable. This may affect their ability to focus on the task. Home or an open familiar venue with less entertainment and distractions will be favorable for them.
Grouping of participants during test session.	To avoid anxiety during the consumer method, it is best to group consumers of the same educational level or literacy level together. Individual consumers may feel very anxious if they notice that others are coping well while they are struggling to comprehend what is required.

2.6 Conclusions

Literacy was presented as the ability to use reading, writing and numeracy skills in order to successfully complete any specific life task. Consumers with low-literacy levels do not make decisions in the same way as their literate counterparts, and usually face a number of challenges when making decisions in the marketplace or during sensory research. For example, the individuals may be less able or unable to combine different external descriptive cues of a particular product (pictures, symbols with written instruction) to motivate their choices or decisions and unable to understand written messages or instructions. There is therefore a need to develop appropriate sensory methods including a combination of non-verbal (use of pictures, symbols) and oral modes of communication where low-literate adult consumers will clearly understand the test instructions, and be able to perform a task without any external assistance while giving accurate and honest responses.

3 HYPOTHESES AND OBJECTIVES

3.1 Hypotheses

Adult consumers with a low level of literacy will struggle to independently complete the conventional paired preference test (ASTM E2263, 2013) involving two food samples. This is because such consumers do not possess the necessary reading and writing skills required. The ability of the consumers to independently complete the test will be improved if the requirements to read test instructions and to write responses were eliminated. Participants' ability to correctly choose a signal sample as the preferred choice will depend on the format by which instructions are provided.

- The use of oral instructions will eliminate the requirement to read.
- The use of paired symbols as sample identifiers requiring only visual interpretation rather than three digit codes, as conventionally used in sensory studies, will eliminate the requirement to read numbers.
- The printing of the sample identifiers (symbols) on stickers that can be removed from the food sample selected and pasted on a score sheet, will eliminate the need for any writing involving a writing instrument.
- The use of both oral and pictorial instructions will improve understanding of instructions even more.
- The addition of a positive facial image ("happy face") on the score sheet will improve the understanding of the requirement to make a choice based on preference.
- In addition, the introduction of the proposed test elements will shorten the time taken to complete a paired preference test, will reduce the level of anxiety of the participants and will improve participants' perceptions of their abilities to handle and understand the task.

Adults with low-literacy levels possess pictorial thinking skills. For this reason instructions in the form of pictures or photographs is a better way to give information to low-literate consumers (Goetze and Strothotte, 2001; Sieber, 2001; Viswanathan et al., 2009). Pictorial instructions will provide important information (e.g. it first draw low-literate participants' attention, accentuate, reinforce, demonstrate and complement a verbal or written message), that written instructions and even oral instructions cannot give. Adults with low-literacy levels showed skills to listen and capture verbal data or instructions and for decision making

relied strictly on verbal information e.g. radio advertising or advice or recommendations from a friend (Riecks et al., 2003; Jae and Delvecchio, 2004).

Additionally adults with a low-literacy level interpreted with more difficulty conventional three-digit number codes in sensory evaluation studies compared to paired symbols (Coetzee and Taylor, 1996). The use of number codes lead to more time consumption when performing a consumer sensory test. Participants with a low-literacy level experienced difficulty when reading and understanding written instructions, and took more time to follow instructions, and required more assistance from helpers (Bloomfield, 1927, Coetzee and Taylor, 1996 Goetze and Strothotte, 2001). Association of audio with pictorial instructions will provide a better guideline and explanation of test instructions. The procedure will avoid the need to read written instructions which is a difficult task for consumers with low literacy (Adkins and Ozanne 2005a). Generally, written instructions enhance feelings of anxiety in low-literate consumers. Additionally, use of sticker code symbols to indicate their choice instead of using a pen will also reduce their level of anxiety. This is because when seeing the pen, they will probably think of writing, which is a difficult or impossible task for these consumers. According to Gau et al., (2012), low-literate consumers encountered this challenge when they are forced into situations where they are expected to write.

3.2 General objective (AIM)

To develop sensory methods adequate for low-literate consumers and applicable in developing countries.

Phase one: development of test materials

3.2.1 Objective 1

To develop formulations for two ginger biscuits that differ perceptibly but subtly in salt content. The purpose of the biscuits was to use as test material for the paired preference test trials with low-literate consumers.

Phase two: development of paired preference test methods

3.2.2 Objective 1

To developed variations of the conventional paired preference method (ASTM E2263, 2013) to systematically limit reading and writing requirements.

3.2.3 Objective 2

To determine the effects of variations of the basic elements to limit reading and writing and used of a pen to indicate choice when conducting a paired preference test on task performance by low-literate consumers.

4 FORMULATION OF GINGER BISCUITS TO USE AS TEST MATERIAL FOR SENSORY METHOD DEVELOPMENT

ABSTRACT

The aim of this part of the research was to develop formulations for two ginger biscuits that differed perceptibly, but subtly in salt content to use as test materials for the paired preference test trials using consumers with low-literacy levels. The two types of biscuits were made with wheat flour. The proportions of different ingredients used were similar in both biscuit formulations, except for salt content. The signal biscuit, which was expected to be the more preferred option, contained 0.65% salt on a flour basic and high salt (HS) biscuit contained 4.54%. Proximate analysis, texture analysis, Na^+ content and colour analysis on the biscuits were carried out to verify similarities and dissimilarities. A statistically significant difference ($p < 0.05$) was observed in moisture content, ash content, protein content, fat content, total carbohydrate, Na^+ content and texture (by instrument) of the two biscuits. However, the biscuit did not differ significantly ($p < 0.05$) in terms of L^*, a^*, b^* colour values. A panel of university students ($n = 50$) significantly preferred ($p = 0.001$) the signal biscuit over the HS biscuit. They observed no difference in hardness between the two biscuits ($p>0.05$) in contrast to the instrumental analysis. The HS biscuit was perceptibly more salty compared to the signal biscuit.

***Key words**: biscuit, low-literacy, paired preference, proximate analysis, salt*

4.1 Introduction

The purpose of this part of the study was to develop test materials suitable for the sensory method development phase. The research focused on the paired preference method (ASTM E2263, 2013) and the aim was to adapt the method in such a way that low-literate or illiterate consumers would be able to complete the required task independently. For the paired preference method only two food samples are compared. Biscuits were selected as test material because it has a long shelf life, is a relatively low cost food product and it is generally and widely accepted by all age groups and socio economic consumer groups (Hossain et al., 2013). Ginger biscuits is a popular type of biscuit in South Africa (F2M Food Multimedias, 2007).

The requirements for the test material were decided a priory. The main requirements for such test materials is that the products should only differ in one attribute, in this case salty taste. The different units (biscuits) should be homogenous and prepared in a standardised way with no visual or texture differences. The development of test materials such as biscuits that differ perceptibly but subtly in salt content was selected as test material to create a signal (preferred) sample and a distractor or noise sample. The ease of varying the salt content of biscuits, and a generally expected dislike of a noticeable ‘salty’ taste in a sweet ginger biscuit, motivated the decision.

4.2 Objectives

The objective of this part of the project was to develop formulations for two ginger biscuits that differed perceptibly but subtly in salt content to use as test materials for paired preference test trials with consumers with low-literacy levels.

4.3 Material and methods

4.3.1 Biscuit formulations

Two ginger biscuit formulations (Table 4-1) were developed according to a recipe described on a web page (http://www.hulettssugar.co.za) of Huletts sugar® (Tongaat Huletts sugar Durban South Africa).

Table 4-1: Different expressions of the formulations for ginger biscuits that differ in salty taste used as test material during this study.

	Mass (g)		Baker's %	
Ingredients (brand)	Signal biscuit	High salt biscuit (HS)	Signal biscuit	High salt biscuit (HS)
Cake wheat flour (snowflake)	770	770	100	100
Cream of tarter (Robertsons)	12.5	12.5	1.62	1.62
Ground ginger (Pick n Pay)	25	25	3.24	3.24
Salt (Cerebros iodate table salt)	5	35	0.65	4.54
Sweet brown sugar Pick n Pay)	500	500	64.93	64.93
Eggs (without shell)	154	154	20	20
Full cream UHT milk (SPAR)	20	20	2.59	2.59
Bicarbonate of soda (Robertsons)	10	10	1.29	1.29
Golden syrup Pick n Pay)	225	225	29.22	29.22
margarine (Rama original margarine)	250	250	32.46	32.46
Total	1971.5	2001.5	-	-

Baker's percentage= (mass ingredient (g) /mass flour (g))*100 (Marcotte and Ramaswamy, 2005); (-) not applicable

4.3.2 Biscuit preparation

Dry ingredients (cake flour, cream of tartar, ground ginger, salt, sweet brown sugar) were weighed, mixed together in a bowl with a Kenwood Chef Excel mixer (Kenwood, Maraisburg, South Africa) starting at the minimum speed and gradually increasing the speed to speed two for three minutes. Margarine was added to the dry ingredients then rubbed with hand, until the mixture resembled fine breadcrumbs. The mixture of beaten eggs, golden syrup and bicarbonate of soda dissolved in milk, was added to the dry ingredients and mixed starting at the minimum speed and gradually increasing to speed two for four minutes. After the dough was chilled for 1h at 6 ^{0}C, it was sheeted on a rectangular baking tray (295 x 197mm) to 5mm thickness, using a plastic dough rolling pin. The rolling action was stopped when the dough was well flat and with a cylinder steel cutter (diameter 4cm), the dough was cut to approximately 9 g biscuits. The biscuits were put on a greased oven tray. The biscuits

were baked using a pre-heated convection oven (Unox model XV30G oven Padova, Italy,) at 180 ^{0}C for 11min at 75% dryness until cooked and brown. Then biscuits were cooled for 30 min at room temperature (27 ^{0}C) and finally transferred to a dry clean plastic container for storage. Approximately 800 biscuits were baked for the two treatments.

4.3.3 Proximate analysis

4.3.3.1 Moisture content

Moisture content of the biscuits was determined by the AACC International (2000) method 44-15A. In triplicate, ground biscuit samples of 2 g was dried at 105 ^{0}C for 4 h. Moisture content was obtained by calculating loss in moisture as percentage of the original wet weight of the sample.

4.3.3.2 Ash content

Ash content was determined using the AACC International (2000) method 08-01. A 2 g sample of ground biscuits was heated in a silica crucible at 550 ^{0}C for 5 h using a muffle furnace oven. Ash content was obtained by calculating the weight of the residue as a percentage of the original sample weight. The analysis was done in triplicate.

4.3.3.3 Fat content

Fat content was determined by the Soxhlet extraction method 30-25 (AACC International, 2000). Biscuit samples of 3 g were weighed into an extraction thimble and fat extracted for 1 h using petroleum ether (40- 60 ^{0}C). The petroleum ether extract was dried in an oven at 103 ^{0}C for 30 min. Total fat content was obtained by calculating weight of extract as a percentage of original sample weight. The analysis was done in triplicate.

4.3.3.4 Protein content

Protein content was determined by Dumas combustion method 46-30 (AACC International, 2000). It is based on combustion of the whole sample in an oxygen-enriched atmosphere at a high temperature (950 ^{0}C) in order to ensure complete combustion. The gases are then passed over special columns (such as potassium hydroxide aqueous solution) that absorb the carbon dioxide and water. A column containing a thermal conductivity detector at the end is then used to separate the nitrogen from any residual carbon dioxide and water and the remaining nitrogen content is then measured. The nitrogen content measured was then multiplied with a factor 5.70 (protein = N x 5.70) to convert nitrogen content into protein content. The analysis was done in triplicate.

4.3.3.5 Carbohydrate content

Carbohydrate content of the biscuits was calculated by difference. Percentage Carbohydrate = [100 - (moisture%+ protein%+ fat% +ash %)] (Food and Agriculture Organisation, 2003).

4.3.4 Sodium content

Sodium content of the two biscuit formulations was determined using AOAC method 935.13 (AOAC, 2000). The analysis was done at Nutrilab University of Pretoria. The analysis was done in triplicate.

4.3.5 Texture analysis of biscuits

For texture analysis of the biscuits the EZ-Test analyser (Model EZ-L, Shimadzu Tokyo Japan) was used for analysing the breaking force. The test speed was 30 mm/min, and the grip was a 3-point bend rig. The distance between the two steel bars supporting a biscuit was 30mm. The data were recorded as breaking force in Newton. The analysis was performed in triplicate.

4.3.6 Colour analysis

The colour values L^*, a^*, b^* of the top of each biscuit type was determined using a Chroma meter (CR-400/410 from Konica Minolta, Okasa, Japan). The measurement was done in triplicate and three biscuits were randomly chosen in each batch of biscuits. The L^* value gives a measure of lightness of the product from 100 for perfect white and zero for black. The a^* value accounted for redness (+) and greenness (-) while b^* value accounted for yellowness (-), and blueness (+) respectively. A white tile (L^*= 96.76, a^*= 0.12 and b^*= 1.80) was used to calibrate the Chroma meter before used. The measurement was taken at the middle upper side of selected biscuits.

4.3.7 Paired comparison tests for the saltiness, hardness and preference of biscuits

Three different sets of paired comparison tests were conducted respectively to confirm that the HS biscuit was noticeably more salty (n = 49), to compare the hardness (n = 51) of the two biscuits and measure the preference for the biscuits. Two blind coded ginger biscuits were served to consumers (university students) who participated in the different tests. The test conditions were select based on the paired comparison method (ASTM E2263, 2013). The test was conducted in the sensory laboratory of University of Pretoria. During the test, participants tasted two blind coded biscuits (signal and HS biscuit). They had to take a sip of water to rinse out their palate before and in between samples and were asked to select the more salty/harder/more preferred biscuit depending on the objective of the test. The test

instruction was displayed on computer screen and data collected using Compusense Five ® release 5.4 (Compusense Inc, Guelp Canada).

4.3.8 Statistical analysis

Paired sample t-tests were conducted to determine whether there were significant differences ($p < 0.05$) in the chemical analyses, texture and colour measurements between the two types of biscuit using Statistica Version 11 (Statsoft, Tulsa, OK, USA). All the paired comparison results were analysed using the Binomial distribution test (Excel Microsoft Office version 2010, Microsoft Corporation Santa Rosa California USA).

4.4 Results

Table 4.2 compares results of proximate analysis, sodium content, texture analysis, colour analysis and sensory evaluation of the two biscuits. It revealed that there were significant difference between the two biscuits in their proximate analysis, sodium content, and texture analysis at ($p < 0.05$). No significant difference was observed between the two biscuits on colour analysis. Paired preference analysis results revealed that no significant difference in hardness was observed between the two biscuits). The HS biscuit was perceived as more salty than the signal biscuit ($p < 0.05$) and the signal biscuit was preferred by more participants ($p < 0.05$).

Table 4-2: Physicochemical analyses and sensory evaluation of the biscuits

		Signal biscuit as is basis	High salty biscuit as is basis	P-values
Proximate analysis	Moisture content %	6.36±0.05^{b}	4.20± 0.75^{b}	0.04
	Ash content (%)	1.67±0.57^{a}	3.42±0.07^{b}	0.03
	Fat content	12.50±0.7^{b}	11.00±0.05^{a}	0.01
	Protein content	7.65±0.02^{b}	6.93±0.53^{a}	0.02
	Carbohydrate (difference)	71.82±0.17^{a}	73.97±0.53^{b}	0.02
Na^{+} analysis	Na^{+} content (mg/100g)	640±0.02^{a}	1200±0.01^{b}	0.001
Texture analysis	Breaking force (N)	30.20±2.58^{a}	72.38±0.01^{b}	0.01
Colour analysis				
	L^{*}	45.07±0.64^{a}	44.88±1.41^{a}	0.14
	a^{*}	10.04±0.07^{a}	10.48±0.60^{a}	0.11
	B^{*}	17.52±0.62^{a}	16.52±0.65^{a}	0.12
Paired comparison analysis	Number of participants selecting a biscuits as more salty (n=49)	2	47	0.001
	Number of participants selecting a biscuits as preferred	45	6	0.001
	Number of panellist selecting a biscuits as harder	32	19	0.092

Except for the paired comparison analyses, values are expressed as Mean ± SD (Mean ± standard deviation); Values in the same row followed by a different superscript letter differ significantly at ($p < 0.05$).

4.5 Discussion

During dough formation and baking of the biscuits very complex reactions occurs such as ionic and disulfide bonds formation, protein hydration, water evaporation and browning of the biscuits (Wieser, 2007). The result showed that the amount of salt used as an ingredient (0.64% or 4.48%) in the biscuits affected the final moisture content of the biscuits. The same quantity of milk (source of moisture) was used for the two types of biscuits. When more salt was added, the moisture content was significantly lower. This could be linked to the capacity of salt to bind water molecules from the surrounding environment (e.g. from milk), during dough formation and thus reduce the free moisture content of biscuit (Fu, Sapirstein and Bushuk, 1996). Indrani and Rao (2007) reported similar results in a study to determine the effect of salt on rheological characteristics of wheat flour dough. They concluded that when salt concentration in the dough increased the toughness of the dough increased and the moisture content of the final product was reduced. The values for moisture content of the two

biscuits were acceptable considering the recommended value for ginger biscuit which is below 7% as proposed by Filipcev et al., (2011).

Measurement of ash content determines the inorganic matter in the biscuit. The higher ash content of the HS biscuit confirmed the higher salt proportion initially added as an ingredient. In this study, both biscuits types (signal and HS) had higher ash content compared to the general biscuit ash content of 1.0% (Hossain et al., 2013).

The fat and protein content of the two types of biscuits were significantly different ($p = 0.01$). These differences are related to the initial proportion of fat or protein contributing sources in the two biscuits as a result of the difference in salt content. The fat content of the two biscuits were less than what is generally reported for biscuits (18.5%), while protein content of the two biscuits were similar to values reported for biscuits (7.1%) by Hossain et al., (2013).

The carbohydrate content differed significant ($p = 0.02$) between the two biscuits. The difference could be related to the different proportions of dry ingredients per biscuit initially used. The value of total carbohydrate content for the two biscuit were slightly lower than the values reported for wheat biscuit (78.23%) by Hossain et al., (2013).

The breaking force of the two biscuits was significantly different ($p = 0.01$). The salty biscuit (HS) required more force to break. Indrani and Rao (2007), found when studying the rheological characteristics of wheat flour dough, that as the concentration of salt increased the toughness of the wheat dough (tightness of the gluten network) increased (measured as resistance to extension). They related this to the action of bonds formed during biscuit making such as hydrogen bonds, disulfide bonds and ionic bonds established between protein-protein and protein-salt molecules. In addition, the capability of salt to cause electrostatic shielding of charged amino acids on the surface of gluten proteins resulted in increased inter-protein hydrophobic and hydrophilic interactions (Indrani and Rao, 2007).

The result for the paired comparison test for salty taste between the two biscuits revealed that the HS biscuit was clearly perceived as more salty compared to the signal biscuit ($p = 0.001$). They was no difference in the hardness of the two biscuits by the sensory panel result ($p = 0.168$) which was contrary to the difference in breaking force differed detected using instrumental analysis. According to Hegenbart, (1998), it is difficult to compare human perception of bite or mouth feel to the values obtained from an instrumental texture analysis. The instrumental measurement measured the equivalent of only one bite, while the human panel bite and chew, and combine with saliva interaction. It is limitation to describe and

compare texture or mouthfeel by a single value obtained from an instrument. Furthermore, perceived texture involves a food's entire physical and chemical interaction in the mouth from initial perception on the palate, to first bite, through mastication. The result for comparison test for biscuit preference revealed that the signal biscuit was more preferred than the salty biscuit (HS).

4.6 Conclusions

The purpose of this phase of the research was to develop test materials to use for the next phase of comparing different methods of presenting the paired preference test method to low-literate consumers. It can be concluded that the high salt biscuit was perceptibly more salty compared to the signal biscuit. Slight differences in moisture, protein, fat, total carbohydrate and ash content were observed. It took greater force to break the high salt biscuit using the instrumental method; however, consumers did not perceive a significant difference in hardness between the signal and salty biscuit. The signal biscuit was more preferred than the HS biscuit. The test material was therefore considered appropriate for the next phase.

5 THE EFFECTS OF VARIATION OF THE BASIC ELEMENTS OF THE PAIRED PREFERENCE SENSORY TEST METHOD ON TASK PERFORMANCE BY CONSUMERS WITH LOW-LEVELS OF LITERACY.

ABSTRACT

Consumers with low-literacy levels represent a substantial percentage of consumers in emerging markets. Sensory science has not focussed much on developing test methods for this consumer segment. Incorrect decisions about products may be made because conventional consumer sensory methods take literacy and language capabilities of participants for granted. Preference tests are widely applied in consumer sensory research. Consumers with low-literacy levels are often unable to read instructions and complete evaluation sheets. The aim of this research was to develop variations of the conventional paired preference method (to limit reading and writing requirements) and to determine the effects of variations of the basic elements of the method (instructions, sample coding, and method of indicating choice) on task performance by low-literate consumers. Participants (n = 350) were randomly assigned to seven groups of 50 each. For consumers with low-literacy levels the conventional method was inefficient (48% of participants were unable to perform the task independently) and time-consuming with a mean time of 5.6 min taken per participant. The efficiency of the paired preference method was improved (only 18% of participants were unable to perform the task independently) and the time to complete the test was reduced to 4.2 min per participant. The use of a combination of picture and audio instructions, the use of symbols rather than 3-digit number codes for sample identification and the instruction to pull the coding sticker from the sample chosen and to stick it on a positive smiling face (rather than any writing task) was identified as the most promising paired preference method for independent completion by low-literate consumers.

Key words: *low-literate, paired preference, symbols codes, coding sticker, 3-digit number, positive smiling face, picture instructions, audio instructions.*

5.1 Introduction

The UNESCO Institute of Statistics (USI), in their September 2014 review on literacy revealed that 24% of all illiterate adults live in sub-Saharan Africa (USI, 2014). In South Africa it is estimated that between 7.4 and 8.5 million adults are functionally illiterate and that between 2.9 and 4.2 million people have never attended school (International literacy day, 2015).This represents a substantial percentage of the population and an important group of food consumers in that region.

Literacy is a dynamic concept and is changing to embrace multiple approaches. Fingeret (1994) defined literacy as "the ability to respond appropriately to written language". The Oxford English Dictionary defines it as "the ability to read and write" and the inability to do so is called illiteracy. Adkins and Ozanne (2005a), defined consumers with low-literacy levels, as people that lack reading proficiency to fill out basic forms or read simple instructions. These consumers rely heavily on nonverbal communication (gestures, facial expression, and tone of voice).

In sensory research, conventional consumer test methods take literacy and language capabilities of consumers mostly for granted (Coetzee and Taylor, 1996). The conventional paired preference test (ASTM E2263, 2013) requires participants to read instructions and then indicate which one of two samples is preferred. The choice is usually indicated by marking (with a writing instrument e.g. pen), the code, a randomly selected three digit code number, of the sample chosen. The tests may also be administered on a computer or mobile device screen which would require reading and basic computer operation skills. The test may also be administered by a trained interviewer on a one-to-one basis, a strategy often also used with young children. One of the reasons why some food products fail in the market might be because consumers do not clearly understand instructions during product acceptance or preference tests, which may lead to wrong conclusions and product decisions by researchers (Coetzee and Taylor, 1996). Consumers with a low-literacy level are often unable to read instructions and complete evaluation sheets, or make a choice on a scale to indicate their preference (Coetzee and Taylor, 1996).

Consumers with low-literacy levels represent a marginalized or worse, ignored group in sensory testing, and are under-represented in market research (Curia et al., 2001). Administering a consumer sensory test on an interview basis is time consuming and labour intensive. There is also a risk that the interviewer / test administrator may consciously or

unconsciously influence the choices of participants. Development of suitable modified sensory test strategies to determine preference or hedonic ratings from consumers with a low level of literacy might contribute to ameliorate consumers' performance during such tests and increase the reliability and validity of responses. It could improve understanding of consumers' attitudes when it comes to making choices during sensory research. More intuitive methods that limit reading and writing tasks may also be useful to allow independent completion of the task by consumers with low-literacy levels.

5.2 Objectives

The objective of this research was to develop variations of the conventional paired preference method to limit reading and writing requirements and to determine the effects of variations of the basic elements of the paired preference sensory test method on task performance by consumers with low-literacy levels.

5.3 Materials and Methods

Figure 5.1 shows the experiment design of this study. The graphic symbols used were obtained using commercially available online software BoardMaker (Pittsburgh, PA. USA)

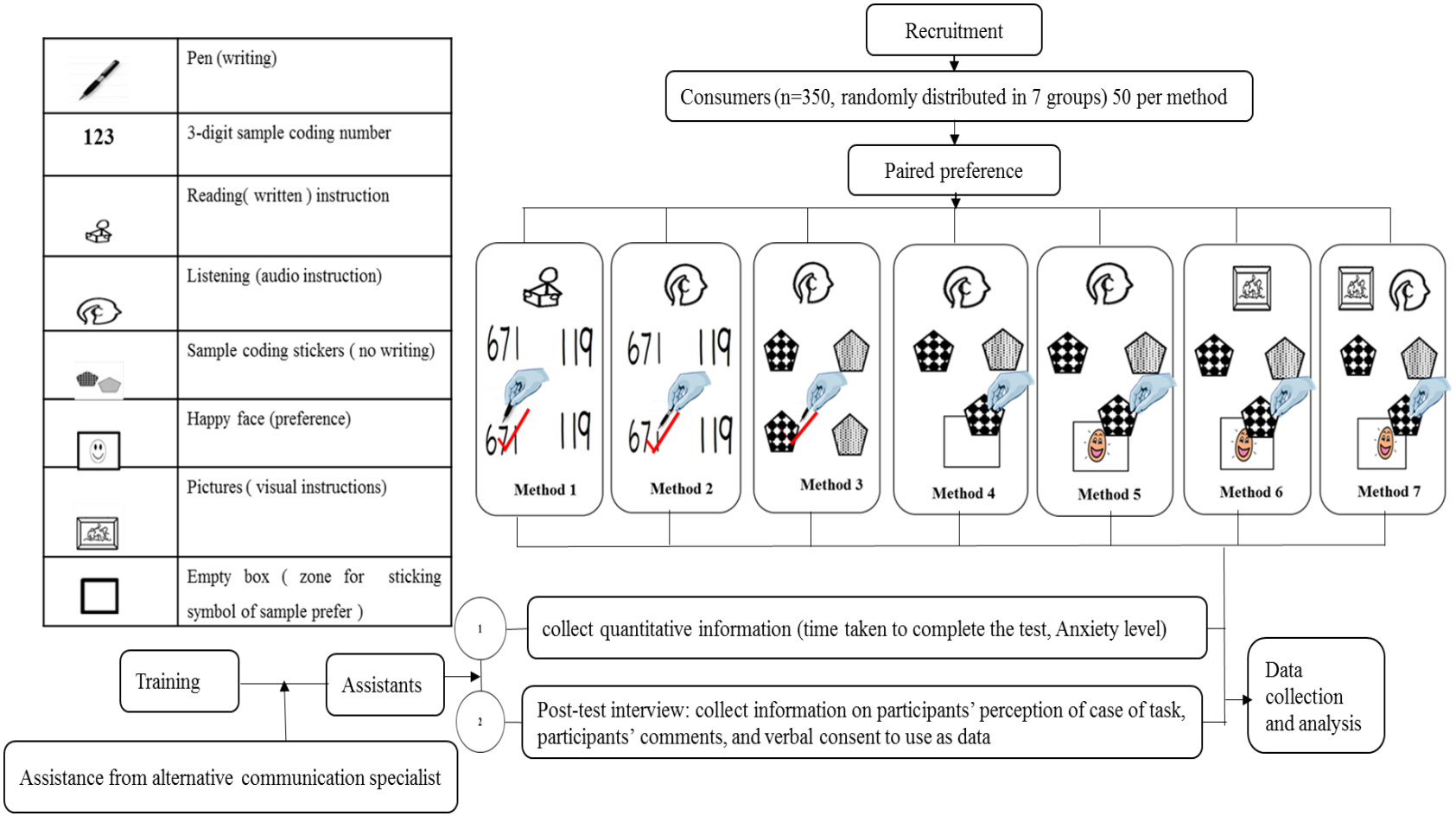


Figure 5.1: Design of experiment to measure the effects of variations of the basic elements of the paired preference sensory test method on the task performance by consumers with low-literacy levels. Pictures of audio, listening, reading instructions were accessed from Mayer-Johnson, (1985).

5.4 Test materials

Two biscuits (described in Chapter 4), a signal (higher probability of being preferred) and a high salt variant were used as test materials for the study. Each consumer received, in random order, one biscuit of each type packed in a zip lock plastic bag (30mm x 25mm).

5.4.1.1 Participants and test location

A recruitment agent familiar with the literacy level of the target community surrounding the test location on the University of Pretoria Mamelodi campus (located northeast of Pretoria, South Africa), was hired to recruit 350 participants from the area according to a recruitment screener questionnaire.

5.4.1.2 Audio instructions, picture instructions and coding

Sound recordings of a female voice reading instructions in English for the various paired preference test variations were recorded using a *Blackberry 9300* cell phone. For picture instructions, a series of 8 photos were taken using a *Canon* E50 camera demonstrating the different steps of the paired preference test. The photographs were printed on a poster (1088 mm X 840 mm) in order of the test evolution from top to bottom (Figure 2). Five series of paired symbols were developed for non-numeric sample coding purposes (Figure 3) and printed on white stickers. A series of randomly selected three digits number codes was generated using Compusense Five ® release 5.4 software (Compusense Inc, Guelph, Ontario, Canada) and printed on white stickers.

5.5 Methods

5.5.1.1 Method 1: Conventional paired preference test (ASTM E2263, 2013).

Each participant received the two biscuits coded with randomly selected three digit numbers, a pen, a score sheet, serviette and a glass of water on a white tray. Participants were asked to perform the test following the written instructions on the score sheet (Appendix A1). No further assistance was given.

5.5.1.2 Method 2: Paired preference test with audio instructions

Each participant received the two biscuits coded with randomly selected three digit numbers, a pen, and a score sheet with no written instructions, a serviette and a glass of water on a white tray. The participants were asked to listen to audio instructions (Audio 1) for the test, which were played using a computer (Appendix A2). No further assistance was given.

5.5.1.3 Method 3: Paired preference test with audio instructions and non-numeric symbol codes

Each participant received the two biscuits coded with paired symbols (Figure 5.3), a pen to indicate which symbol was chosen, a score sheet with no written instructions, a serviette and a glass of water on a white tray. The participants were asked to listen to the audio instructions (Audio 2) for the test which were played using a computer. (Appendix A3). No further assistance was given.

5.5.1.4 Method 4: Paired preference test with audio instructions, non-numeric symbol codes and no writing task

Each participant received the two biscuits coded with paired symbols (Figure 5.3), a score sheet with no written instructions, but an open box for sticking the selected symbol sticker, a serviette and a glass of water on a white tray. The participants were asked to listen to audio instructions (Audio 3) for the test, which were played using a computer (Appendix A4). No further assistance was given.

5.5.1.5 Method 5: Paired preference test with audio instructions, non-numeric symbol codes, no writing task, positive hedonic face as motivation

Each participant received the two biscuits coded with paired symbols (Figure 5.3), a score sheet with no written instructions, only a box with a happy face in the middle for sticking the selected symbol sticker, a serviette and a glass of water on a white tray. The participants were asked to listen to audio instructions (Audio 4) for the test, which were played using a computer (Appendix A5). No further assistance was given.

5.5.1.6 Method 6: Paired preference test with photograph instructions, non-numeric symbol codes, no writing task, positive hedonic face as motivation

Each participant received the two biscuits coded with paired symbols (Figure 5.3), a score sheet with no written instructions, only a box with the happy face in the middle for sticking the selected symbol sticker, a serviette and a glass of water on a white tray. A poster with a series of pictorial instructions (Figure 2), were available on the wall. Participants were asked to perform the test following the pictorial instructions (Appendix A6). No further assistance was given.

5.5.1.7 Method 7: Paired preference test with audio and photograph instructions, non-numeric symbol codes, no writing task, positive hedonic face as motivation

Each participant received the two biscuits coded with paired symbols (Figure 5.3), a score sheet with no written instructions, only a box with a happy face in the middle for sticking the selected symbol sticker, a serviette and a glass of water on a white tray. A poster with a series

of pictorial instructions (Figure 5.2), were available on the wall. The participants were asked to listen to audio instructions (Audio 5) for the test played using a computer. The audio also instructed the participants to follow the pictorial instructions. (Appendix A7). No further assistance was given.

5.6 Test procedure

The consumer testing was done during two days. Participants were allocated with an individual identification number (UpX_i) where X represents the test method number 1 – 7 and *i* the number of the participant per test method (1-50). Nine student assistants from University of Pretoria were trained (using role playing exercises) to administer the tests and collect the data, this with the aid of a specialist from the Center for Augmentative and Alternative Communication (CAAC). The assistants were aware of the overall purpose and specific objective of the study. All the participants were trained to handle correctly all the seven methods. Seven participants, one per method participated simultaneously at a time. Participants were greeted and directed to one of the seven test stations, where the assistant in charge of the station presented himself and briefly directed the participants to proceed with the test. During the test, the participants were individually seated at tables. Assistants completed the first part of the qualitative interview {observation of participant's gender, rating of anxiety level of different participants while performing the test using a facial affective scale (FAS) [1= no anxiety to 6= very anxious] (Goodenough et al., 1999) and recorded the time taken to complete the task (the starting time was taken immediately after the participant received the tray and the end time after he/she confirmed to the assistant that he/she was done)}. Assistants also observed and wrote comments about the attitude and actions of participants from receiving the tray with samples until the end of the task. Only when a participant confirmed that they completed the test, assistants carried on with the second part of the questionnaire to obtain information through a semi structured face to face interview. Assistants asked the home language of each of the participants, highest school level, participants' age and the general perceptions and opinion about the test they performed. At the end of the interview assistants asked participants whether or not the responses that they gave could be included in the data set for analysis and reporting thus obtaining verbal consent to use the data. During the interview, a person was available to assist with translation of English to the home language of participants, when necessary. After the interview, assistants directed participants to the exit to receive a store voucher (R50) to thank them for

participating. The study was approved by the Ethics committee of the Faculty of Natural Sciences, University of Pretoria (EC141125-095).

5.7 Statistical analysis of qualitative and quantitative data

The numbers of consumers speaking specific languages as home language were analysed using descriptive statistics. One-way analysis of variance (ANOVA) using SPSS version 22.00, IBM New York, United States was used to determine whether there were significant differences ($p < 0.05$) among the test methods for age of participants, anxiety level and time taken to complete the test. If significant differences were found, then means were separated using Fisher's Least Significant Difference (LSD) test at $p < 0.05$. Paired preference test result were analysed according to the ASTM E2263, (2013) applying a one sided test. When n=50 participants, significant preference for one of the biscuits was observed with a minimum of n=28 participants selecting one of the biscuits. Participants' comments regarding the ease of completing the task and assistants comments were first coded (using appropriated words, which expressed their comments e.g. a sentence from participant *"I didn't know what to do with all this"* was coded as "instruction difficulty"), then analyse using Atlas.ti version 6.1.1 software (ATLAS.ti, GmbH, Berlin). Coded concepts were expressed as percentages of the total number of participants per method. The Chi-square test using XLSTAT Software version 8.0 (Addinsoft, New York City, USA) was used to compare, gender groupings per method, percentage of participants that did not struggle to follow the test instruction per method, percentage of participants that regarded the task as difficult to understand. Chi-square test using XLSTAT software 8.0 (Addinsoft, New York City, USA) was used to look at the association between participants' perception of different task performed and the specific method.

Figure 5.2: Pictorial instructions used to describe different steps for completing the paired preference test. Pictures were presented vertically on a poster in order of test evolution from 1 to 8 (Methods 6 and 7).

*Note that the symbols used for the instructions were different from those used by participants

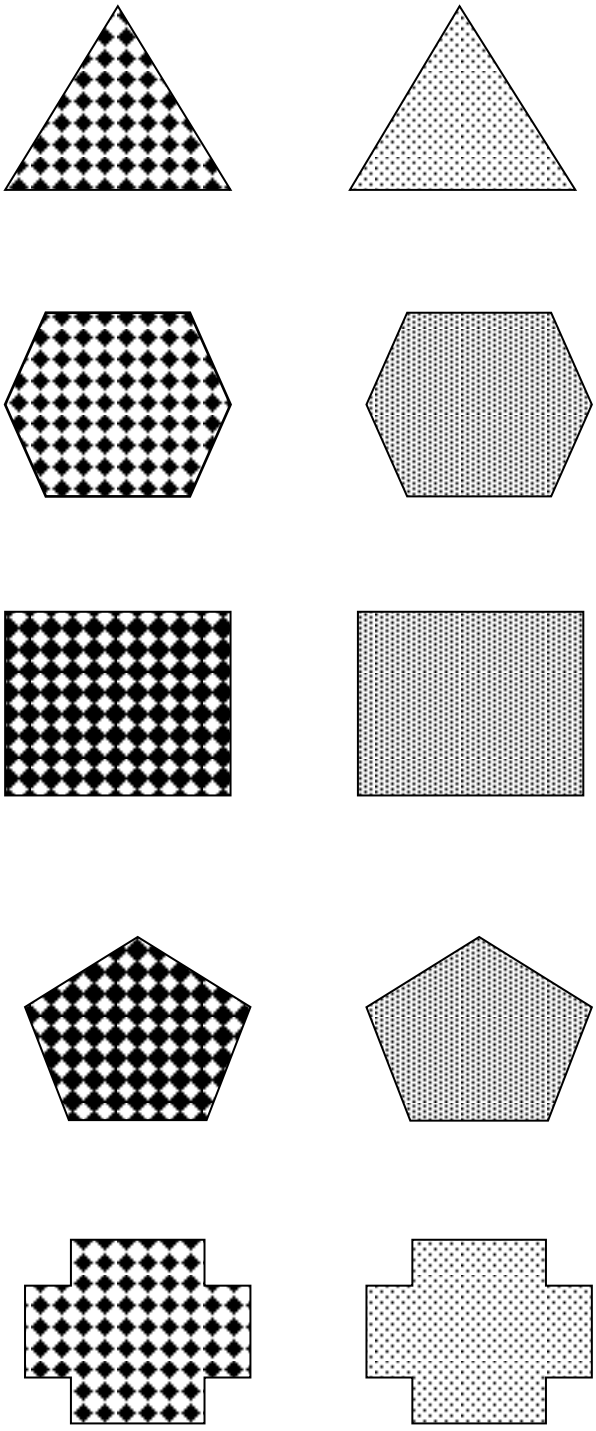


Figure 5.3**:** Pairs of geometrical symbols used as coding symbols for methods 3, 4, 5, 6, 7.

5.8 Results

5.8.1 Demographic results

Figure 5.4 shows the general percentage distribution of participants indicating one of the SA (South Africa) official languages as home language. Sepedi was the home language of at least 38% of participants, followed by Sesotho (17 %) and Isizulu (17 %). Less than 1 % of the participants indicated English as home language. Figure 5.5 presents the distribution of participants by method that speaks a specific home language.

Results in Table 5-1 provide information on gender and age distribution of participants per method. There was a significant difference in gender distribution of participants over the methods. Method 3 was the only test method where males were more represented compared to other methods where more females participated. A total of 62% participants were females and 38% males. The group of participants consisted of 89% participants who indicated that they attended grade 7 or higher education level and 11% indicated that they never attended school or attended school up to grade 6. They were all South African, 99% indicated speaking one of the eleven South African official languages as mother tongue and 1% indicated speaking another language. Participants' ages ranged between 18 and 55 years. The average age of participants for test method 6 was significantly lower than those completing test methods 2 and 4.

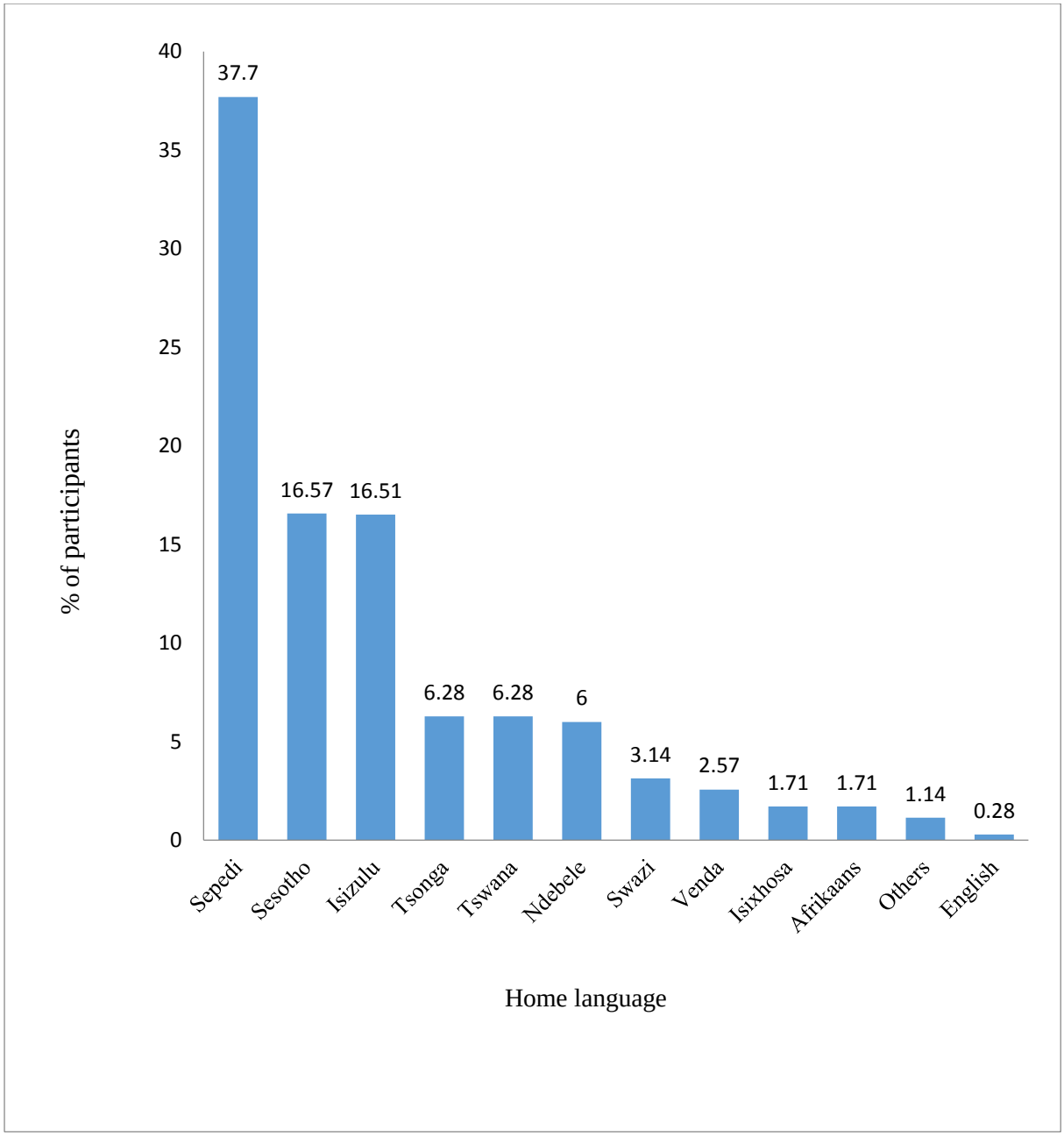


Figure 5.4: Distribution of % participants that speak a specific home language (n=350).

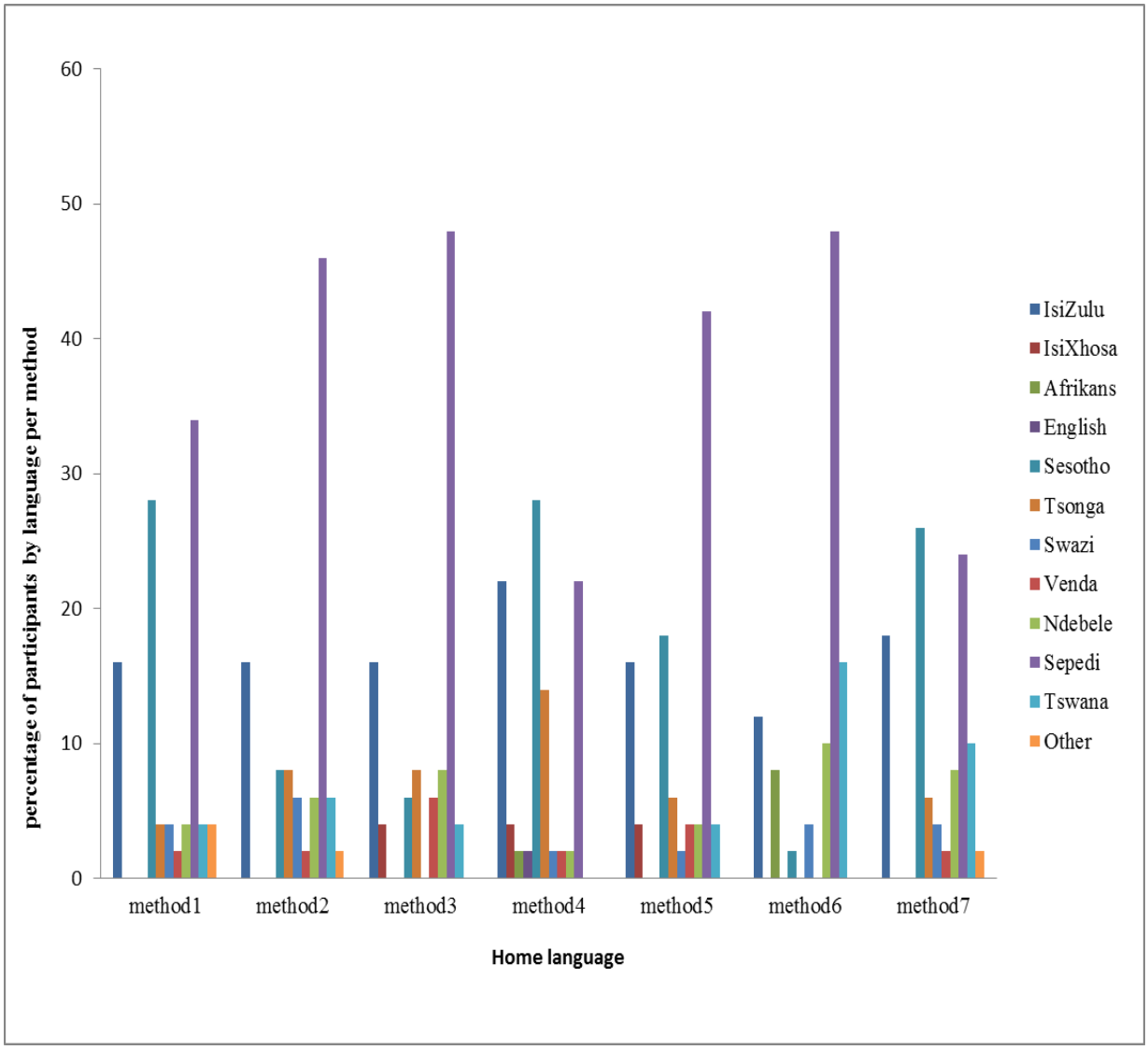


Figure 5.5: Distribution of home languages spoken by participants of the different methods

Table 5-1: Gender distribution and average age of participants per test method (n=50 per test method)

		Method 1	Method 2	Method 3	Method 4	Method 5	Method 6	Method 7
Gender %	M (male)	30	24	76	44	30	34	31
	F (female)	70	76	24	56	70	66	69
		X^2= 78.936, df=6, N=350, p=0.01						
Age (years) Mean (±SD)		44 (±14)^{ab}	45 (±14)^{a}	43 (±13)^{ab}	48 (±14)^{ab}	44 (±14)^{ab}	40 (±15)^{b}	42 (±14)^{ab}

Age values in a row with different superscript letters (a, b, c, d) are significantly different at ($p<0.05$).

5.8.2 Quantitative analyses results

5.8.2.1 Paired preference analyses

Table 5-2 provides a summary of participants' results for the different variations of the paired preference method analysed separately for participants that completed the test method independently (not assisted) and those that completed the task with some assistance, average time taken for the task and indication of anxiety level of participants per method. Results indicated method 6 as the test method where no significant preference was found between the two biscuits. Methods 1, 2, 3, 4, 5 and 7 concluded a significant preference ($p < 0.05$) for the signal biscuit. Test method 5 was the test where a large number of participants (n = 12) selected both biscuits. However, test method 7 was the test where a large number of participants were able to perform the test independently.

A significant difference ($p < 0.05$) was observed in the time taken to complete the test methods. The time taken to complete the test increased significantly in the following order: Method 5 took the least time, and then methods 3 and 4 followed by methods 2 and 7, and methods 1 and 6 required the most time. The anxiety levels of participants' participating in the different method where significant different ($p < 0.05$). Participants in test method 1 appeared less anxious compared to those completing methods 2, 3, 4, 5, 6 and 7.

Table 5-2: Paired preference test results analysed separately for participants that completed the test independently (not assisted) and those that completed the task with some assistance, anxieties level of participants and time taken to complete the test.

	Method 1		Method 2		Method 3		Method 4		Method 5		Method 6		Method 7	
	A	NA	A	NA	A	NA	A	NA	A	NA	A	NA	A	NA
Number selecting signal biscuit	32	23	43	37	28	21	33	28	30	22	0*	15	36	33
Number selecting high salt biscuit	11	3	7	2	7	4	15	9	7	5	0*	7	13	8
Number of participants unable to perform the test independently	24		11		50		13		23		28		9	
Number selecting both biscuits	2	0	0	0	2	0	0	0	12	0	0*	2	0	0
Number selecting none of the biscuits	5		0		13		2		1		26		0	
Percentage of participants performances	86	52	100	78	70	50	96	74	74	54	0*	44	98	82
P-Value	0.002	0.004	0.002	0.002	0.002	0.002	0.002	0.004	0.002	0.002	0*	0.134	0.002	0.002
Biscuit Preference	S	S	S	S	S	S	S	S	S	S	0*	NP	S	S
Time to complete the test (min) Mean (±SD)	$5.6(1.6)^{d}$		$3.8(1.3)^{c}$		$3.0(2.0)^{b}$		$2.6(1.5)^{b}$		$1.4(0.7)^{a}$		$5.5(2.7)^{d}$		$4.2(3.2)^{c}$	
Anxiety level Mean (±SD)	$2.2(0.7)^{a}$		$3.7(0.9)^{c}$		$2.6(1.3)^{ab}$		$3.5(1.3)^{bc}$		$2.5(1.3)^{ab}$		$3.1(0.7)^{b}$		$3.5(0.9)^{bc}$	

A: Assisted; NA: Not assisted; S: signal biscuit; NP: no preference; (0^{*}): no assistance given. For time and anxiety level, values in a row with different superscript (a, b, c, d) letter significantly differ at ($p<0.05$).

5.8.3 Qualitative analyses

Table 5-3 presents the analyses of the assistants' observations, comments on participants' attitudes and generals' skills (capability of understanding the test instruction and participants' ability to us the test tools) while performing the different test methods. The results revealed that more participants had difficulties to follow the test instructions of test method 6. While a significantly higher number of participants were able to easily follow the instruction for test method 7. Significantly, more participants did not appear confident while performing test method 6 compared to test method 7. Some difficulties of using test material such as opening a zip log bag with methods 1 and 3, difficulties of writing (use of pen) and reading, as well as medical reasons (e.g. visual impaired), were noted. However, the frequencies of these observations were quite low.

Analyses of participants' perception of the tasks (Table 5-4) revealed that participants' perception of the different test methods was significantly different and depending on the task they performed. Significantly more participants rated test method 6 as difficult, while very few consumers rated methods 3 and 7 as difficult. Significantly, fewer participants commented that methods 4 and 6 were easy compared to the other methods.

Participants' responses to the question about how they perceived the task (Table 5-5) revealed that a larger number of participants (90%) indicated that instructions for test method 7 compared to the other methods positively reinforced their performance. Comparatively more participants perceived the test instructions of test method 6 as difficult to understand e.g. 38% compare to 8% for method 7. For test method 1 comparatively more participants (28%) claimed that the taste of the biscuits positively contributed to their perception of the ease of performing the task compared to 2% for test method 7. Cases of failure to perform the task by some participants after they received assistance was recorded for test method 1 and 5, respectively 2% and 6% of participants; also inconsistent verbal response (incoherence between what participants said about the test they performed compared to what was observed in terms of their performance) was noted for methods 1, 3, 5, and 6, with an exceptionally high percentage (30%) for test method 3.

Table 5-6 is a summary of observations of action of participants as reported by assistants while performing the different test methods and assistants' comments on observation of participants during each test method.

Table 5-3: Grouping (expressed as percentage of participants per test method) of observations, from assistants regarding the reasons why participants struggled with a test method.

	Method 1	Method 2	Method 3	Method 4	Method 5	Method 6	Method 7
% participant that struggled (did not struggled) to follow the test instruction	38 (62)	30 (70)	38 (62)	28 (72)	31 (69)	64 (36)	18 (82)
			$X^2 = 25.869$; df = 6; N = 350; P = 0.0002				
% of participants that regarded the task as difficult to understand (easy to understand)- ask for assistance	36 (66)	22 (78)	20 (80)	22 (78)	20 (80)		16 (84)
			$X^2 = 10$; df = 5; N = 300; P = 0.0752				
% participants that appeared confident about their ability to perform the task (did not appear confident about their ability to perform the task)	52 (48)	68 (32)	64 (36)	78 (22)	62(38)	42 (58)	84 (16)
			X^2= 39.72; df = 6; N = 350; P < 0.0001				
% participant that struggle to write (given excuse e.g. " I am too old, I can read"	4	-	-	-	-	-	-
% participant that struggle to write (difficulty to used pen)	-	-	2	-	-	-	-
% participant that cited medical reason (e.g. visual impaired)	4	-	2	-	-	-	-
% participant showing technical difficulties (e.g. difficulty to open the zip lock bags with biscuits)"	2	-	-	-	-	-	-

(-) Not cited as a reason by assistants; 0^*: no assistance given

Description coded words:

Difficulty to follow the instructions:

Method1: represented difficulty with reading and understanding of test instruction

Methods 2, 3, 4, and 5: represented difficulty to understand audio instruction combined with assistance (e.g. requested that audio instructions be replayed),

Method 6: (-) no assistance given

Method 7: represented difficulty of understanding pictorial instructions and/or audio instructions

Table 5-4: Cross tabulation table (Task * methods) of participants' perceptions of the ease of performing the different test methods in response to the question "How did you perceive the task?" (n=50 participants per test method)

		Method 1	Method 2	Method 3	Method 4	Method 5	Method 6	Method 7
Task	Difficult	7	5	1	7	13	22	3
	Okay	9	12	14	25	2	9	16
	Easy	34	33	35	18	35	19	31
$X^2=72.982$; df= 12; N=350; p =0.001								

Table 5-5: Grouping of comments mentioned by participants' (expressed as a percentage of total number of participants per method) after rating the ease of performing a test method and responding to the question "You said it was (easy, okay or difficult), why?"

	Method 1	Method 2	Method 3	Method 4	Method 5	Method 6	Method 7
Instruction (comments that showed that test instructions positively reinforced participants' performance)	60	56	84	79	68	62	90
Product (comments that showed that the taste of the biscuits positively contributed to participants' decision making)	28	22	10	7	8	0	2
Instruction difficulty (comments that showed difficulty of understanding test instructions reading, listening, picture instruction)	12	22	6	14	24	38	8
% participants assisted but unable to make a choice	2	-	-	-	6	-	-
% of participants where inconsistency between what was reported and action was noted	12	-	30	-	2	18	-

(-): Not noted

Instruction difficulty:

Method 1: described the difficulty of reading.

Methods 3, 4, 5: described the difficulty of understanding audio instructions (language, sound, speed of instructions)

Method 6: described the difficulty of understanding picture instructions

Method 7: described the difficulty of both picture and audio instructions

Table 5-6: Qualitative information related to task performance by participants completing the different test methods based on comments of respondents and observations by assistants

Methods	**Observations of actions of participants as reported by assistants**
Method 1: Reading, writing, 3-digit number codes	- -Some participants: used a finger to assist them with the reading of instructions, read the instructions loudly and more than once before starting the test. - -Some participants: Looked around while performing the test as if trying to look for assistance. - Some participants did not drink water in between tasting the different biscuits. - Some participants compared the task to a test that they had to pass *"I manage to perform the test."* - Some participants asked for assistance *"Please can you explain to me what I have to do".*
Method 2: Audio instruction, writing, 3-digit number codes	- Some participants had difficulty to hear or understand clearly the audio instructions on the first play. - Some participants had difficulty understanding the English instructions and indicated that they needed translation of test instruction in a language that they are more familiar with. *"The test was difficult at the beginning but after translate in my language it was easy".* - Participants mentioned that the oral instructions was beneficial *"I just do what the voice said."*
Method 3: Audio instruction, writing, symbols codes.	-Some participant tried to look around as if they needed assistance to perform the test. -Some participants mentioned that oral instruction was beneficial *"I just do what I hear".* -Some participants had difficulty to use the pen. -Some participants asked for assistance *"Please can you explain to me what I have to do".*
Method 4: Stickers symbols codes, audio instruction, and empty box.	- Some participants presented good use of sticker symbols. - Some participants developed concrete thinking by focussing on immediate facts, literal definition or physical word (e.g. *please can you showed me where the empty box is; they asked for presentation of an empty box from the assistant*). - Some participants had difficulty understanding the English instructions and indicated that they needed translation of test instructions in a language that they are more familiar with *"she made the test easy by translating the instruction".*
Method 5: Stickers symbols codes, Audio instruction, and happy face in a box.	- Some participants compared the task to a test that they had to pass*" I manage to perform the test".* - Some participants did not drink water in between tasting the different biscuits. - Some participants mention the audio instruction was beneficial or was not clear "the *voice facilitate the test"; "translation of the voice in my home language makes it easy"; "The last part of the oral instruction was too fast".*
Method 6: Stickers symbols codes, pictorial instructions and happy face in a box.	- Some participants developed concrete thinking by focussing on immediate facts, literal definition or physical words. *"Why are sticker symbols on the zip bag different from the symbols on the picture instructions?"* - Some participants mentioned that pictorial instructions was beneficial *"I just follow the instruction looking at the pictures, the task was not demanding".* -Some participants complained about pictures: "*The last pictures were too dark, I try to understand but I can't follow the last part.\."*
Method 7: Stickers symbols codes, pictorial instructions, happy face in box, audio Instruction.	-Some participants had difficulty to follow the oral instructions *"last part of audio instruction was too fast".* -Some participants mentioned that the instruction was beneficial *"combination of the audio instruction and pictures instruction made it easy for the understanding"; "oral instruction made me understand pictures instruction"; "I could not follow the pictures instructions but oral instructions make it easier, I found the test instructions easy."* -Assistant mentioned some participants became more anxious during the test, but they performed the test well "*Participant gets more anxious when the oral instruction was played and replayed, get relaxed when he/she receive assistance".*

*Sentences in italics are participants' comments during performing each test method.

5.9 Discussion

5.9.1 Language of communication

English was used as the primary language of communication for this experiment. It should be noted that only one person (1/350) indicated English as his/her home language. Although no clear assessment was made of the English literacy level of the participants, it can be safely assumed that a relatively large percentage of consumers may have had a low to very low level of English literacy. Lombard et al., (2012) reported that a very large group of the Mamelodi population is low educated, and struggled more with English than their home language. A relatively large proportion of the population in the area dropped out of school before matric (Grade 12), they are often unemployed and many rely on social grants. Mamelodi residents considered English as the second spoken language in the area. Van der Berg et al., (2011), reported that adult readers who speak English as a second language would perform worse when performing the same test in English compared to in their native language.

5.9.2 Which biscuit was preferred, and why?

The results of the paired preference tests revealed that all methods where oral instructions (method 2, 3, 5, 7) were applied gave the same result (participants significantly preferred the ‘signal biscuit' over the salty biscuit) at the same statistical significance ($p < 0.05$) as the control test method (Method 1). However, method 6 where only picture instructions were applied, a different result was obtained ($p > 0.05$), no preference between the two biscuits). This difference was probably due to the complexity of understanding the test instructions for test method 6. The highest number of participants rated method 6 as difficult, with many commenting on the difficulty to understand the test instructions. The assistant observed that 64% of the participants struggled to perform the test while 38% of participants, reported that the instructions were difficult for them to follow. This finding might suggest a lack or limitation of visual literacy by the participants. Hattwig et al., (2013), defined visual literacy as the ability to interpret, evaluate, negotiate, and make meaning from information presented in the form of images or the ability to find meaning in imagery. Jae and Viswanathan (2012), stated that participants with low-literacy levels might display lower comprehension levels and may make more errors when they view pictures that they do not perceive as congruent. Some participants in this study were perhaps less familiar with following a sequence of picture instructions and this might explain their attitudes when they were faced with the pictures; they did not really know what to do with the tools that they received for the test. Beukelman and Mirenda, (2005) mentioned that photographs are highly iconic, they usually described

exactly the specific activities or routines presented. However, Linney (1995), speaking about visual literacy and people that are illiterate, specified that for illiterate adults who are not regularly in contact with pictures or not involved in any picture training, it would be difficult to understand and interpret pictures and they do not easily developed visual literacy. Dada et al., (2013), working with disabled participants, related this difficulty to understand pictorial instructions to a lack of apprehending picture iconicity. This reasoning might also be used to justify illiterate consumers' difficulties to comprehend the instructions.

The quality and small size of the pictures used might have also been one of the reasons why participants had difficulties to understand the picture instructions. Comments such as "*The last three pictures were too dark, I try to understand but I can't follow"* mentioned during the post-test interview with participants' supports this conclusion. This participants' responses or performances to picture instructions (effect of picture understanding) were contrary to initial expectation because Jae and Delvecchio (2004), stated that when people with low levels of literacy had to make decisions in a marketplace, they depended more on perceptual rather than conceptual processes in acquiring, retaining and using information. Viswanathan et al., (2005), characterised consumers with low-literacy levels as individuals that possessed good pictorial thinking. However, Knickman and Gaus, (1999), discussing the understanding of pictures by consumers with low-literacy levels, stated that pictures had to be made simple with good image quality. The authors explained that to understand any picture such consumers begin with a visual interpretation, discerning light and dark contrast of the picture quality, shapes perception and finally decoding the picture instruction. This might also reinforce the thought that the picture quality presented to participants would have affected participants understanding (decoding) of the picture instructions and time taken for the task.

Results showed that the percentage of participants that required assistance for the different methods was associated with the level of understanding of the test instructions. Test method 1, compared to the other methods, was the method where most participants required assistance (34%) while for method 7 the lowest number of participants needed assistance (16%). Even though the results reflect that no assistance was given to participants for method 6, this does not necessarily mean that participants did not require assistance. Note that no assistance was given to participants by the assistant tasked with test method 6. For test method 6, the assistant assigned followed the procedure exactly and did not offer assistance or indicated (verbally or with body language) that such option was possible. Difficulties in decoding and understanding written instructions by participants in method 1 probably

justified the level of assistance given. Coetzee and Taylor (1996), experienced similar participant difficulties when illiterate consumers were asked to read and understand written instructions. These researchers indicated that for people with low-literacy levels to be able to perform a conventional paired preference test, they had to be assisted to understand the test instructions. Hoover and Gough (1990), characterised the writing task as a complex organization of patterns of high mental processing that can embrace all types of thinking (word decoding and reading comprehension), judging, imagining, reasoning and problem solving for people that are illiterate or low-literate. Rue (1990), said to be able to understand written instructions, a reader has to be able to read the written instruction first. Therefore, to be able to fully decode written instructions, a proper reading level from participants is required.

For the modified test methods 2, 3, 4, 5 and 7 the most common type of assistance given to participants were either translation of audio instructions from English to the home language, replaying of the audio instructions and explanation of what or where is the empty box. Language understanding (level of English terminology used), the speed at which the audio instructions were spoken, the tendency for concrete thinking i.e. literal thinking, relying almost exclusively on images, and the low-literacy levels explain the main reasons for needing assistance with the test methods. The type of assistance given to the participants was based on the comments and inquiries of participants such as *"the last part of the oral instruction was fast";* "*where is the empty box?*"; *"I don't understand English, please explain to me*". This justified the need for a repetition of audio instructions, assistance to explain the terminology, showing the empty box to participants (method 4 "empty box") and translation of English audio instruction to their home language (methods 2, 3, 5, 7). Viswanathan and Da Silva (2009), identified the behaviour observed in test method 4 as being due to the tendency for concrete thinking because consumers with low-literacy levels primarily function in the visual, concrete realm, rather than the symbolic, abstract. The test method 4 instruction stated that the participants had to remove the sticker for the code-selected sample and paste it on the empty box (a geometrical figure represented on the score sheet ☐). Participants who asked the assistant to identify the empty box expected / visualised an empty carton box in the room where they had to paste the sticker selected, which emphasizes concrete thinking attitude from some participants.

Of interest is the evaluation of participants' ability to select one of the biscuits as the preferred one (performance) separately for those participants that completed the test

independently and those that completed with some assistance. The difference in performance assisted and independent completion were for methods 1 (86 % versus 52 %), 2 (100 % versus 78 %), 3 (70 % versus 50 %), 4 (96 % versus 74 %), 5 (74 % versus 54 %) and 7 (98 % versus 82 %). This explains the role and influence that assistants had on the ability of the participants to complete the task independently and on the sensory results. It revealed also that if no assistances were given, method 7 was the method with the best potential for independent completion by consumers with low-literacy levels. Important observations were made with methods 1 and 5 where 2% and 6% of participants, respectively were unable to perform the test correctly although they received assistance. A similar observation was noted by Coetzee and Taylor (1996), who found that even after given a clear explanation to consumers with low-literacy levels, they were still subjected to make errors. Some participants claimed that the test they did was easy but when observing how they performed the paired preference test method, their comments and actions were inconsistent, (most said that the test was easy however, they found it difficult or needed assistance). Knickman and Gaus (1999), revealed that when it came to ask an adult with low-literacy level if the survey item he performed was understood he/she will always answer "yes" or give positive feedback even if she found it difficult.

5.9.3 Time to complete the test

Comparing the average time taken to complete the task, test method 1 where participants had to read and write took a lot longer than the rest of the methods involving listening to audio instructions, decoding picture instructions only or a combination of picture and audio instructions. Participants' reading and writing difficulties associated with a lack of clear understanding of language instruction might explain the longer time compared to the methods involving the action of listening to audio instruction in association with the new elements such as use of sticker symbols, pictures instructions and sticking symbols rather than writing and use of numbers as codes. Participants took more time to read and interpret test instructions before starting to perform the test. Goetze and Strothotte (2001) and Bloomfield (1927), during their research on literacy, made similar observations and said that consumers with low-literacy levels take more time to read when trying to understand a simple sentence. They experienced less interest during reading, (are susceptible to interference) and they read a sentence more than once to get the real meaning. Thompkins and Binder (2003), explained the use of time by illiterates during reading by the fact that they applied a phonological strategy to decode words and try to understand the meaning (e.g. to pronounce the word

biscuits they would start by pronouncing bis and then cuits, followed by the reading of the complete word). Jae and Viswanathan (2012), said poor readers are deficient in selective attention, they are therefore more susceptible to disturbances, then might read a text more than once to get the meaning. Asking for assistance during the test can also explain why the time taken for method 1 was longer. Coetzee and Taylor (1996), noted a similar observation. The need for providing assistance is time consuming during performing sensory tests with consumers with low-literacy levels. Mhlanga (2011) identified the spontaneous need for assistance by consumers with low literacy levels while performing a task as a confrontative mechanism. A technique used by with low-literate consumers to quickly cope with complicated tasks are to ask for help e.g. from family and friends, even a stranger. However, the lesser time taken for methods where audio instructions were played can be explained by the impact that audio instructions have on participants' ability to understand the test instruction. Jae and Delvecchio (2004), revealed that consumers with low-literacy levels relied strictly on verbal information, radio advertising, advice or recommendation from a friend when they have to make a decision, and concluded that audio instructions are a necessary strategy to provide information to adults with low-literacy level. Goetze and Strothotte (2001), added that illiterate adults feel comfortable when they are listening to somebody reading their letters. Rue (1990), said adult illiterates never like reading and do not think they are missing anything they want to know because they can get it from radio, television or friends by listening and watching.

When comparing the time taken for method 1 (reading written instructions) and method 6 (pictorial instructions), no significant difference was observed. Participants took more time to perform both methods compared to the others. As discussed earlier participants' difficulty to decode written instructions and picture instructions might justify the longer time taken. This statements from some participants: "*The last three pictures are too dark, I try to understand but I can't follow" or "Please can you explain to me what I have to do"*, might explain why some participants took a longer time in those two specific test methods (1 and 6). The fact that they were unfamiliar with sensory testing, led them to take more time to decode picture instructions (iconicity). According to Rue (1990) and Mhlanga (2011), consumers with low-literacy levels believe that as long as they can use their hands they can perform every task proposed to them. When the task seemed to be complicated they avoided to ask for assistance or help, then struggled to understand and finally abandon which generally coupled with inefficient used of time. When comparing time taken for test method 7 (combination of

pictorial instruction with audio instruction) with test method 6 (only pictorial instructions), participants took more time in method 6 than method 7 and the difference on average was 1.3 min. The gain in time presents the impact of the audio instructions on participants' ability to perform the task. Audio instructions clearly enhanced the participants' abilities to understand the pictorial instructions. Drager et al., (2006), characterise this dual action as aided augmented input. Aided augmented input requires using ongoing natural speech while pointing to and labelling key graphic symbols. These comments support the impact of audio instruction on participants: *"I could not follow the picture instructions but oral instructions make it easier, I found the test instructions easy"; "combination of the audio instruction and picture instructions made it easy for the understanding"*. When comparing method 7 with the control method (Method 1), participants took a longer period of time to perform test method 1 and the difference on average was 1.4 min. As explained earlier, difficulties to understand written instructions and spontaneous requirement of assistance may explain why more time was needed for method 1 compared to the association of audio instructions with pictorial instructions in combination with new basic elements, which contributed to the better understanding of the test instruction (method 7). Benitez et al., (2002), concluded about understanding of written instruction by consumers with low-literacy levels that reading of written instructions is an inappropriate task for them based on their education background which limited their capabilities to read and understand any written instruction quickly. Sieber (2001), in her book “Teaching with objects and photographs” revealed that photographs aid human memory by creating a direct sensory connection between learners and the subjects that succeed interest and attention. Photographs can be used to reinforce material covered in other media, which is a benefit to a learner who do not always respond to written material. She concluded that using objects and photographs are excellent means to enhance learning. This observation may also explain the reason why participants took shorter time to complete test method 7.

Completion of test method 5 was faster compared to other test methods with an average time 1.4 min. This made it the fastest test method. However, when comparing test method 5 results with other test methods, based on difference in performance, assistants' comments, participants' perception of the ease of performing the task and participants comments, test method 5 was not the perfect test method. The assistants identified that at least 31% of participants had difficulties to follow the test instructions compared to other methods (methods 7 and 4 respectively 18% and 28%); 20% of participants required assistance to

complete method 5 compare to method 7 where only 16% needed assistance. Faster execution of the test method after receiving assistance with language translation and very good understanding of the test instruction by some participants might justify the shorter time taken for test method 5.

5.9.4 Anxiety

The anxiety measurement method used revealed that for methods where audio instructions were applied (methods 2, 3, 4, 5, 7) and only picture instructions provided (method 6), anxiety rates were greater than for the control method (method 1). This conveys that participants appeared less anxious while performing test method 1 than methods where the basic conventional elements were changed. This was contrary to expectation. It was expected that participants would be more anxious when they were exposed to reading and writing tasks. Gau et al., (2012), demonstrated that consumers with low-literacy levels experience a challenge when they are forced to read and write and they become more anxious. While Jae and Delvecchio (2004), explained that consumers with low-literacy levels feel more comfortable with oral instructions because they rely strictly on verbally conveyed information, when they have to make a decision at the marketplace. The observations about anxiety rates might possibly be related to misinterpretation of participants' facial expressions by assistants. Tourangeau and Ellsworth (1979), mentioned that understanding facial expressions need more attention from researchers when collecting data and observers needed intensive training. In this study, the assistants were not trained extensively to read facial expressions and body language. Facial expressions are linked to participants' ' emotions or feelings. It is also difficult to rate facial expressions of someone who externally show little emotion (Tourangeau and Ellsworth, 1979). Participants' behaviour, body language and facial expressions, while reading written instructions and listening to audio instructions (non-verbal communication), might also justify why assistants had difficulties on rating facial expressions. When reading, participants looked down at the paper with instructions, this may have made it difficult for an assistant to easily "read/rate" his/her facial expressions (eyes, frown etc.). However, while listening to the audio instructions participants probably did not look down, they probably faced assistants and concentrated to pay attention to the sound. In fact by paying attention (listening) and concentrating on the audio instruction playing via a speaker, they use facial expressions that demonstrate listening skills (e.g. frown or pucker their face which may result in contraction of their facial muscles). Thus, it was not easy to read and compare facial expressions of participants performing the test and to rate whether

they were anxious or not. Wendin, Allesens-Holm and Bredie (2011), revealed that some men and woman have naturally a "pucker face" while other have a “poker face” (showing very little emotion) appearance, which makes rating of their facial expression difficult. The fact that the audio instructions were played via an instrument (speakers) would have affected their facial expression as well. They probably had to give more attention to the instruction played compared to those that were required to read written instructions where they can directly ask for assistance or explanation. The speed with which the information was provided and also the quality of the voice as recorded and played also might have had an influence on the participants' level of anxiety. Coping with following test instructions, the speed of the information and at the same time the quality of the voice (pitch, tone, accent, pronunciation etc.) potentially made participants to pucker their faces. Listening to the instructions with attention seem to have increased the perception of anxiety. However, participants and assistants comments, for method 6, show that participants struggled with the method. In this case, the anxiety levels of participants as rated by the assistant in method 6 reflected the facial expressions of participants while struggling to understand picture instructions.

5.9.5 Effect of the combination of the different basic elements

Audio instructions in association with picture instructions only did not contribute positively or influenced participants’ performance. Basic elements such as use of symbols as codes, symbols to stick rather than writing, a positive smile face to motivate and indicate preference, have also influenced participants' behaviours and performance while performing the test. Differences in participants' comments on methods; level of confidence; need for assistance might support the idea that the new basic elements really influenced participants behaviours and performance. Finding of other authors may reinforce this conclusion. Coetzee and Taylor (1996), reported that used of traditional number codes proved to be ineffective and time consuming with consumers with low-literacy levels, but use of paired symbols was shown to be more successful. Consumers with low-literacy levels feel more comfortable to use symbol stickers to show their choice than to use a pencil to write or make a choice (Coetzee, 2001). Illiterate consumers relied more on verbal instructions than written instructions (Reicks et al., 2003). Photographs can be used to reinforce understanding (Sieber, 2001).

The test venue (university campus), may also have affected participants’ ability to master the test. For some it was their first time to walk on university soil and perform such experiment. That may be why certain participants compared the task to a test that they had to pass because they perceive a university as a centre of higher learning. They might have assumed that the

researcher or interviewer might expect them to perform the task easily and therefor they said the task was “easy or okay” not difficult. That might be why some hide their difficulties by giving answer that they thought will please the assistants.

5.10 Conclusions

This study shows that the mode by which instructions are given has to be taken into consideration when asking consumers with a low-literacy level to take part in a sensory test. Consumers with low-literacy levels, generally have difficulties to understand written instructions. Using interviewers to eliminate reading and writing by consumers requires effort, resources and is time consuming. New basic elements (pictorial and audio instructions, sticker symbols, positive smile face) improved individual consumers' performance in such a way that the efficiency of the paired preference method was much improved, to an extent that almost no assistance was given to consumers and the time taken to complete the task independently was optimised.

From this study, it is concluded that the test method with dual action of audio and pictorial instructions in combination with sticker code symbols to stick rather than write and a positive smile face to indicate preference (i.e. method 7) is the most effective paired preference method for independent completion by consumers with low-literacy levels: This method is now called the Kamdem paired preference method. However, further research is needed to establish whether any further improvements can be made to the test and to evaluate the suitability of the new method in practical product test situations as well as with other groups of consumers. In addition, it is important that this study should be replicated among low-literate individuals whose literacy status has been verified.

6 General Discussion

This chapter is divided into two sections, the first section will critically review the experimental design and methodologies used and suggest ways for future research. The second section presents a sensory paired preference guide line when using the Kamdem paired preference method. This guideline was based on the ASTM standard test method for paired preference tests (ASTM E2263, 2013).

6.1 Critical review of the experimental design and methodologies

Developing suitable test material (formulation of two ginger biscuits) for the paired preference test was the initial important step of this work. Using human judges, the two biscuits were verified as different in salty taste. Instrumental analysis of the breaking force of the two biscuits revealed that they were different in hardness, while the human panel did not noticed a difference. Possible reasons for this difference might be related to the number of biscuits used for texture analyses. For each batch of approximately 80 biscuits baked from different treatments, three biscuits were randomly selected per treatment, i.e. a total of 12 biscuits per treatment were analysed. This was probably too few biscuits to represent a batch. The test method used and measurement parameters also was not necessarily reliable to measure human perception of the hardness of biscuits. However, the difference noted by texture analysis did not influence the outcome of the work. For future research, it will be beneficial to improve the production of the test biscuits by using industrial equipment. This would result in production of biscuit pieces with exactly the same weight, size and shape resulting in a generally improved biscuit quality.

Consumer sensory evaluation of the seven variations of the paired preference task was carried out at the Mamelodi Campus, University of Pretoria. The venue was chosen based on the representation of residents of Mamelodi as discussed by Lombard et al., (2012). The authors mentioned that Mamelodi was characterised by a large group of adults with low-literacy levels. The location of the venue provided practical proximity to potential low-literate consumers. Participants' age range was between 18 and 55 years with a proportionally larger representation of females in the group. This age group was chosen because it represents the socio-economic group of participants that are usually used in sensory research. Adults do not require parental consent, such as required for children. The drawback with the group was that participants recruited were not all identified as having low-literacy levels even if they were from the same location (living area). This problem probably did not affect the overall finding because of the relatively large number of participants included. However, for future analyses

with the same target group of participants' attention has to be put on verifying the literacy level of different participant during recruitment. Selected candidates might go through a series of tests before being selected as qualified for the test e.g. pictogram question (picture identification), demographic question (gender, age, educational levels), reading of time, and reading a short sentence, a method usually practised in medical fields (Hoogwegt, 2007; Dowse, and Ehlers,. 2008).

The number of participants per method was determined based on test sensitivity parameters initially fixed by the researcher [probability of concluding that no preference exists when, in reality, one does (β- risk= 0.05%), probability of concluding that a preference exists when, in reality, one does not (α- risk = 0.05%), proportion of common responses that researcher wants the test to be able to detect with a probability of 1-β (Pmax=75%)]. ASTM E2263 (2013), recommends a minimum number of n=42 participants for this condition and a significant difference was observed between the two biscuits if the total proportion of common responses from participants per method was equal to or superior to 28. The number n=50 participants was selected to maximise the chance to have enough participants, at least, 42 per method.

The sensory tests were carried out in an open space either outside on the lawn or under roof on the Mamelodi campus. The tests were carried out at seven different stations. The close distance between the different stations was a drawback of the test venue. The stations were not separated far enough; some participants were able to look at the next station trying to find any element or clue that might help them to perform the task. The movement of assistants between stations to collect or deposit trays at the samples preparation area, and noise produced while assistance was given (translation of audio instruction or reading of the written instruction) could have affected participant's attention during the test. According to Jae and Viswanathan (2012), consumers with low-literacy levels are more susceptible to interference. These might have affected the final results. However, the fact that attitudes were recorded by assistants were useful. This, helped with understanding of the coping mechanisms developed by the participants as was previously described by Mhlanga (2011). Coping attitude was noted for participants in a few test methods. To avoid such problems in future research, distances between stations have to be considerable in such a way that no possible nuisance factors (e.g. noise), might captivate participants' attention or give them a simple chance to look around. It is recommended to use isolated cubicle rooms for each station.

The new basic elements developed for the paired preference test method influenced participants' performances. Audio instructions, pictures or photographs instructions, sticker symbol codes, a positive hedonic face to motivate participant's recognition that they should select the preferred sample, and an empty box drawn on a score sheet to direct participants where to paste a selected sticker symbol code, contributed to a better understanding of the test instructions for consumers with low-literacy levels. However some participants indicated that they experienced some difficulties to follow the audio instructions, photographs instructions and to understand the empty box concept. Those difficulties encountered by participants did affect the final outcome of the work, however through their comments and observations; they contributed to a better understanding of how low-literate consumers behave in tasks such as these.

Regarding pictorial instructions, some participants informed that images were small with poor quality presentation (too dark; difficult to follow) and for others they did not understand at all the message transmitted by the photographs. The inability to decode the photograph may be related to the perceived relationship between the symbol and its referent or iconicity. Iconicity was defined as a perceived relationship between a symbol and its referent, which is often described as a visual similarity (Miuko, 1987; Fristoe and Lloyd, 1980; Lloyd and Fuller, 1990; Blischack, Lloyd and Fuller, 1997; Schlosser and Sigafoos, 2002). Linney (1995), related this failure to decode picture instructions to a lack of visual literacy. Knickman and Gaus (1999), mentioned that picture quality (brightness, colour, the size of the photograph) is a key element for low-literate consumers to understand the message carried by a picture or photograph. Sieber, (2001) revealed that pictures or photographs aid human memory by creating a direct sensory connection between learners and the subjects that succeed interest and attention. For future research, it is suggested that photographs have to be taken by an expert with an appropriate and professional camera to ensure the clarity and precision of the images. The size of the photographs must be considerably large at least (27.9 cm x 35.6 cm) not (10.2 cm x 15.2 cm) to facilitate visual interpretation. Audio instructions played to participants should match exactly step by step with the photographs presented. The gender of the person whose voice was recorded should also match the gender of the person demonstrating all the steps on the picture instructions (if it is a female voice recorded and played, the gender of the person demonstrating different steps must be a female on the picture instructions).

Regarding audio instructions, for participants who understood the language instructions in English, some indicated that the speed of the audio instruction was too fast, and requested that the instructions be repeated. For future research, attention has to be put on the speed of voice and sound recording, use of a recording studio with adequate equipment and preferably not a rudimentary instrument such as a cell phone, might contributed to give better sound quality.

Some participants claimed that the audio instructions helped them to understand the picture instructions and vice versa while some were confused and either needed assistance to be able to perform the task. This complementarity between audio and picture instructions for a good understanding of the test instruction might be explaining via a dual Pavio coding model (simultaneous use of pictures and spoken input) which the model attempt to bridge the imagery tradition and the verbal tradition (Sadoski and Paivio 2004). Photographs (iconic symbols) simultaneously paired with spoken input which assisted them to understand the task and complete easily. So participants had visual (photographs) and auditory (spoken words) input which together helped them to process what they needed to do. For furthers research-using video modelling not picture might be benefit for consumers with low-literacy levels. Video is a multimedia source that combines a sequence of image to form a moving picture, process the order in which the scene captures should be shown, has usually audio components that correspond with pictures been shown on the screen instruction which is highly iconic will be interesting.

Some participants had difficulties to understand the concept of the empty box which was drawn on the score sheet to direct them where to stick the selected sticker symbol. The last section of the test instruction (Remove the sticker of the biscuit you prefer and paste it on the empty box) was a bit complex for the participants and some thought they had to stick the sticker on an empty carton box. Viswanathan and Da Silva (2009), identified this type of reaction as due to concrete thinking, rather than symbolic abstract thinking. It is recommended that for future research the concept of the empty box has to be removed and the instructions need to be reformulated in a simple way such as "Remove the sticker of the biscuit you prefer and paste it on the paper" to avoid the mentioning of a box.

In food sensory research, assistants always played important roles in data collection. They might unintentionally influence results during their duties by giving assistance to participants during the test. A limitation was that the not randomly allocated to the experimental

treatments or rotated among the stations. Since the assistants were fully aware of the purpose of the study, they did not deliberately or intentionally bias the data collected and operated in a systematic manner. However, this was not actively monitored and can therefore not be validated. During this work, no assistance was initially recommended to be given to participants but assistants were forced or felt obliged to give assistance to participants during the evolution of some test methods. The assistance given was considered as a drawback for this work. However, it helps to evaluate and understand how difficult or easy participants perceived the test methods. According to Mhlanga (2011), consumers with low-literacy levels developed confrontative mechanisms (making use of or demanding immediate assistance) when facing a difficult task which might justify the reason why assistance was given. In a semi-structured one-to-one interview (as was performed during the test), consumers with low literacy levels felt free and relaxed to ask any question to the interviewers (Mhlanga, 2011). Assistance given by different assistants were identified and noted. These contributed to understanding and evaluation of the suitability of all methods. For further research as recommendation it will be important to remind helpers or assistants to always stick to the task rules.

6.2 Guideline for the Kamdem paired preference test to use with consumers with a low literacy level.

The guideline developed was inspired by the ASTM E2263, (2013) test procedure for the paired preference test.

This guideline is an attempt to ensure excellent setup of the Kamdem paired preference method, including statistical analysis of results. It presents different steps and instructions to follow by researchers. The paired preference test is used to compare or to determine whether an overall preference exist for one of two samples. A set of two samples is presented simultaneously to each participant and one sample is to be selected.

Step one: Definition of test conditions

6.2.1 Definition of test sensitivity (α-risk, β-risk, P*max*)

-α (alpha) risk: probability of concluding that a preference exist when, in reality, one does not.

-β (beta) risk: probability of concluding that no preference exists when, in reality, one does.

-P*max*: proportion of common responses that the researcher wants the test to be able to detect with the probability of 1-β.

Example: if a researcher wants to have 95% confidence of detecting a 60:40 split in preference, then Pmax=75% α= 0.05 and β=0.05

6.2.2 Determine number of participants (N):

6.2.2.1 The number of participants required for the test depends on two factors: Firstly the test hypothesis and the objective of the test.

If the researcher's a priori interest is in only one of the samples being preferred, the test is identified as a one-sided test. The alternative hypothesis will express that a specific product is preferred over the other product, A > B or A < B. If the researcher has no a priori assumption in a particular sample being preferred, the test is identified as a two-sided test (in this case, the alternative hypothesis is that the two products are not equally preferred, A ≠ B).

Secondly, the test sensitivity Pmax, α-risk, β-risk.

These two conditions direct the researcher on how to determine the minimum number of participants required for his test using Table: 6-1 and Table: 6-2 respectively for one sided test and two sided tests. To avoid situation where the number of participants required for the test is less than the minimum required by the test condition, it is important to make provision by recruiting 10% more participants.

Step two: Test procedure

6.2.3 Test materials

- Samples of food should be representative of the problem or question that has to be investigated, it should be uniform in size and presentation (comparable) and no external variable or factor must be introduced.
- Selection of test venue, development of master sheet, audio instructions, picture instructions and sample presentation
- The test venue preferably has to be familiar to the target consumers and preferably be neutral, basic and clean (avoid any pictures or posters, colour that might distract participants). Low-literate consumers are easily distracted or their attention diverted (loss of concentration) by images and visual objects in an environment. Distance between test stations must be considerable large to avoid any interference or copying.
- Prepare a master sheet in a spreadsheet program e.g. Microsoft Excel to generate numerical digital code number to ensure a balanced order of presentation of the two samples. The master sheet should include date of the test, complete sample identification either by product name, test objective, number of participants.

NB: The Kamdem paired preference test uses symbols for coding of samples. It is important then to developed pairs of symbols using arithmetical figures such as triangle, square, rectangle (for examples see Figure: 5.3). The pairs of symbols developed will be randomly attributed to the different samples numerical digit code sets on the master sheet and printed on stickers to use as sample codes.

- Audio instructions for participants explaining what should be done during the test. It should be recorded using adequate instruments. The instructions will be played to participants during the task in place of written instructions. Ensure that the sound quality is excellent, and that the speed of the audio instructions is not too fast (it might be played more than once to the participant).
- Develop picture instructions through a series of photographs intended to describe exactly all the different stages of the task. This will then guide participants to understand clearly the audio instructions. The series of photographs have to be placed/printed in order of the test evolution (from receiving the tray to completion total of the test (e.g. see Figure: 5.2) from left to right or top to bottom. The photographs should be in good quality and printed large enough for participants to see clearly. The photographs can be positioned on a board or screen not too far from the participants.
- The picture and audio instructions should be in sync and explain exactly the same procedure. If the audio is e.g. of a female voice, then the model on the photographs should preferably be a female that represent the voice in terms of ethnicity, culture, character and age.

Prepare samples out of sight of participants and in an identical manner, code the vessels or bags containing the samples in a uniform manner with the symbols printed on stickers: e.g. same portion size, temperature, apparatus, and same vessels. Present the two samples in a set simultaneously on a tray, a score sheet (See appendix: A5), a palate cleaner e.g. glass of water. Follow the same spatial arrangement for each participant, respect with attention each set number to avoid any confusion with the code presented and selected. Limit movement and intervention of assistants' among participants.

6.2.4 Analysis and interpretation of Kamdem paired preference results

First, count the total numbers of score sheets collected representing the total number of participants that attended the test.

Use the master sheet to record which sample was selected by each participant.

For statistical analysis two approaches might be used to evaluate if there is a significant difference between the two samples: BINOMDIST test using Microsoft Excel or by directly identifying the number of common responses needed for significance difference using Table: 6-3 in case of one side test or Table: 6-4 in case of two sided test.

Finally write down your conclusion depending on the initial fixed test conditions (α, β, and Pmax).

6.3 Example of paired preference test: example of a one side test will be demonstrated

6.3.1 Background

Low-literate consumers represent a significant percentage of consumers of mageu (a traditional African fermented cereal beverage). A local company in South Africa decided to develop and launch a low cost mageu designed especially for the target group. Consumers found it too sour and rejected the product. They reformulated the product to reduce the sourness. The company decided to conduct a paired preference test with low-literate consumers from a township in the Pretoria area to find out if the new reformulated mageu is preferable to the initial sourer mageu.

6.3.1.1 Test objective and hypothesis

* To determine if the new reformulated sour mageu "B" is preferred over "A" the initial more sour mageu.

* Hypotheses: H_0: A=B

H_{AB}: B>A.

6.3.1.2 Number of participants

The test sensitivity conditions were defined, as follow α-risk = 0.05, and a *Pmax* of 75 % with β-risk = 0.01. Refer to the Table: 6-1 to determine the number of participant required, read the section corresponding to *Pmax* = 75 % and the column corresponding to β = 0.01, then read the row corresponding to α = 0.05, it indicates that a minimum of 58 participants

will be needed for the test. The recruitment agent recruited 60 participants identified as mageu consumers.

6.3.1.3 Conducting the test

The sensory test was done in an open space at a primary school located in the township. Four stations were arranged: a class room where participants were welcomed before the test and received each their individual identification number; two cubicle rooms separated with a samples preparation station at equal distance from each cubicle. In each cubicle room were respectively disposed a table with one chair for a participant, a board where picture instructions were pasted and a device to play the audio instruction.

A total of sixty glass ramekins (90 ml) with plastic lids containing mageu "A" and sixty glass ramekins of "B" was prepared at the sampling station, coded with the symbol stickers. Each sequence AB and BA was presented 30 times so as to cover 60 participants in a balanced random order. Each participant was serve with a tray (Figure 6.1) containing samples to taste, cup of water, spoon, and score sheet. The instructions were played using the audio device.

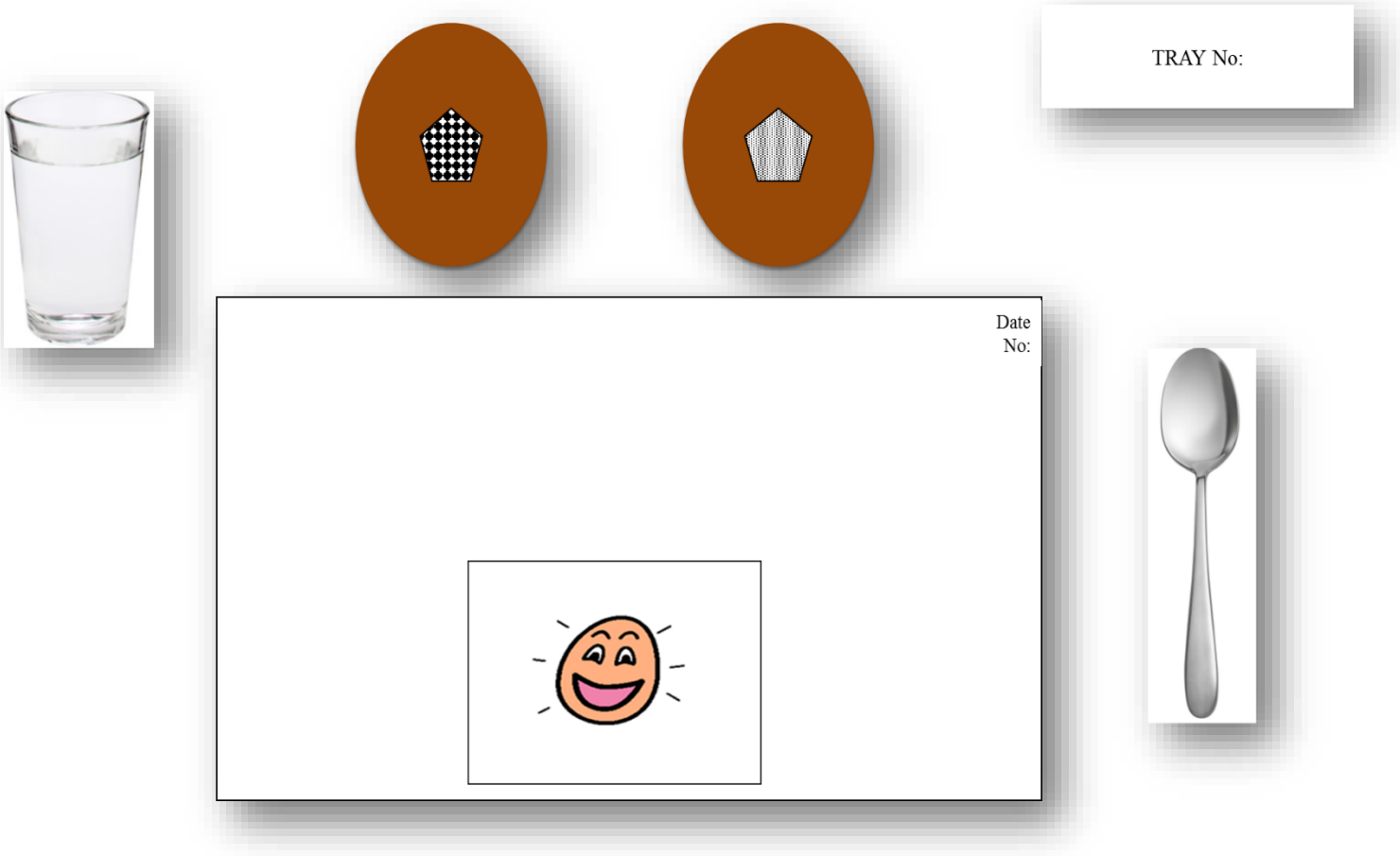


Figure 6.1: Tray presented to participants. Image of cup and spoon was accessed from

6.3.1.4 Analysis and interpretation of Results

Fifty six participants selected the sample "B" as preferred, and 4 selected sample "A". In Table 6-3, the row corresponding to 60 participants and the column corresponding to $\alpha = 0.05$, revealed that 37 common responses were needed in order to conclude that there is a preference for a specific product.

6.3.1.5 Conclusions

The manufacturer reports that there was a significant preference for the reformulated mageu "B" ($p < 0.001$). The manufacturer concludes that product "A" could be replaced with the reformulated yogurt to enhance consumer acceptance of the brand.

Table 6-1: Number of participants needed for a paired preference test one-sided alternative hypothesis [a] (ASTM E2263, 2013)

		β							
α		0.50	0.40	0.30	0.20	0.10	0.05	0.01	0.001
0.50	p_{max} = 75 %	2	4	4	4	8	12	20	34
0.40		2	4	4	6	10	14	28	42
0.30		2	6	8	10	14	20	30	48
0.20		6	6	10	12	20	26	40	58
0.10		10	10	14	20	26	34	48	70
0.05		14	16	18	24	34	42	58	82
0.01		22	28	34	40	50	60	80	108
0.001		38	44	52	62	72	84	108	140
0.50	p_{max} = 70 %	4	4	4	8	12	18	32	60
0.40		4	4	6	8	14	26	42	70
0.30		6	8	10	14	22	28	50	78
0.20		6	10	12	20	30	40	60	94
0.10		14	20	22	28	40	54	80	114
0.05		18	24	30	38	54	68	94	132
0.01		36	42	52	64	80	96	130	174
0.001		62	72	82	96	118	136	176	228
0.50	p_{max} = 65 %	4	4	4	8	18	32	62	102
0.40		4	6	8	14	30	42	76	120
0.30		8	10	14	24	40	54	88	144
0.20		10	18	22	32	50	68	110	166
0.10		22	28	38	54	72	96	146	208
0.05		30	42	54	70	94	120	174	244
0.01		64	78	90	112	144	174	236	320
0.001		108	126	144	172	210	246	318	412
0.50	p_{max} = 60 %	4	4	8	18	42	68	134	238
0.40		6	10	24	36	60	94	172	282
0.30		12	22	30	50	84	120	206	328
0.20		22	32	50	78	112	158	254	384
0.10		46	66	86	116	168	214	322	472
0.05		72	94	120	158	214	268	392	554
0.01		142	168	208	252	326	392	536	726
0.001		242	282	328	386	480	556	732	944
0.50	p_{max} = 55 %	4	8	28	74	164	272	542	952
0.40		10	36	62	124	238	362	672	1124
0.30		30	72	118	200	334	480	810	1302
0.20		82	130	194	294	452	618	1006	1556
0.10		170	240	338	462	658	862	1310	1906
0.05		282	370	476	620	866	1092	1584	2238
0.01		550	666	820	1008	1302	1582	2170	2928
0.001		962	1126	1310	1552	1908	2248	2938	3812

[a]The values recorded in this table have been rounded to the nearest whole number evenly divisible by two to allow for equal presentation of both paired combination (AB and BA).

Table 6.2: Number of common responses needed for significance in paired preference test, two-sided alternative hypothesis [a] (ASTM E2263, 2013)

		β							
α		0.50	0.40	0.30	0.20	0.10	0.05	0.01	0.001
0.50	p_{max} = 75 %	2	6	8	12	16	24	34	52
0.40		6	6	10	12	20	26	40	58
0.30		6	8	12	16	22	30	42	64
0.20		10	10	14	20	26	34	48	70
0.10		14	16	18	24	34	42	58	82
0.05		18	20	26	30	42	50	68	92
0.01		26	34	40	44	58	66	88	118
0.001		42	50	58	66	78	90	118	150
0.50	p_{max} = 70 %	6	8	12	16	26	34	54	86
0.40		6	10	12	20	30	40	60	94
0.30		8	14	18	22	34	44	68	102
0.20		14	20	22	28	40	54	80	114
0.10		18	24	30	38	54	68	94	132
0.05		26	36	40	50	66	80	110	150
0.01		44	50	60	74	92	108	144	192
0.001		68	78	90	102	126	148	188	240
0.50	p_{max} = 65 %	8	14	18	30	44	64	98	156
0.40		10	18	22	32	50	68	110	166
0.30		14	20	30	42	60	82	126	188
0.20		22	28	38	54	72	96	146	208
0.10		30	42	54	70	94	120	174	244
0.05		44	56	68	90	114	146	200	276
0.01		74	92	108	132	164	196	262	346
0.001		122	140	162	188	230	268	342	440
0.50	p_{max} = 60 %	16	28	36	64	98	136	230	352
0.40		22	32	50	78	112	158	254	384
0.30		32	44	66	90	134	180	284	426
0.20		46	66	86	116	168	214	322	472
0.10		72	94	120	158	214	268	392	554
0.05		102	126	158	200	264	328	456	636
0.01		172	204	242	292	374	446	596	796
0.001		276	318	364	426	520	604	782	1010
0.50	p_{max} = 55 %	50	96	156	240	394	544	910	1424
0.40		82	130	194	294	452	618	1006	1556
0.30		110	174	254	360	550	722	1130	1702
0.20		170	240	338	462	658	862	1310	1906
0.10		282	370	476	620	866	1092	1584	2238
0.05		390	498	620	786	1056	1302	1834	2544
0.01		670	802	964	1168	1494	1782	2408	3204
0.001		1090	1260	1462	1708	2094	2440	3152	4064

[a]The values recorded in this table have been rounded to the nearest whole number evenly divisible by two to allow for equal presentation of both paired combination (AB and BA).

Table 6-3: Number of Common Responses Needed for Significance in a Paired Preference Test, One-Sided Alternative (ASTM E2263, 2013)

NOTE: 1-Entries are the minimum number of common responses required for significance at the stated significance level (that is, column) for the corresponding number of participants "*n*" (that is, row). Reject the assumption of "no preference" if the number of correct responses is greater than or equal to the tabled value.

	Significance Level, %							Significance Level, %						
n	0.50	0.20	0.10	0.05	0.01	0.001	*n*	0.50	0.20	0.10	0.05	0.01	0.001
4	3	4	4	-	-	-	31	16	19	20	21	23	25
5	4	4	5	5	-	-	32	17	19	21	22	24	26
							33	17	20	21	22	24	26
6	4	5	6	6	-	-	34	18	20	22	23	25	27
7	4	6	6	7	7	-	35	19	21	22	23	25	27
8	5	6	7	7	8	-							
9	6	7	7	8	9	-	36	19	22	23	24	26	28
10	6	7	8	9	10	10	40	21	24	25	26	28	31
							44	23	26	27	28	31	33
11	6	8	9	9	10	11	48	25	28	29	31	33	36
12	7	8	9	10	11	12	52	27	30	32	33	35	38
13	7	9	10	10	12	13							
14	8	10	10	11	12	13	56	29	32	34	35	38	40
15	9	10	11	12	13	14	60	31	34	36	37	40	43
							64	33	36	38	40	42	45
16	9	11	12	12	14	15	68	35	38	40	42	45	48
17	9	11	12	13	14	16	72	37	41	42	44	47	50
18	10	12	13	13	15	16							
19	10	12	13	14	15	17	76	39	43	45	46	49	52
20	11	13	14	15	16	18	80	41	45	47	48	51	55
21	12	13	14	15	17	18	84	43	47	49	51	54	57
22	12	14	15	16	17	19	88	45	49	51	53	56	59
23	12	15	16	16	18	20	92	47	51	53	55	58	62
24	13	15	16	17	19	20							
25	13	16	17	18	19	21	96	49	53	55	57	60	64
							100	51	55	57	59	63	66
26	14	16	17	18	20	22							
27	14	17	18	19	20	22							
28	15	17	18	19	21	23							
29	16	18	19	20	22	24							
30	16	18	20	20	22	24							

[a]Adapted from Meilgaard, M., Civille, G. V., and Carr, B. T., *Sensory Evaluation Techniques, 2nd Edition*, CRC Press, Inc., Boca Raton, FL, 1991, p. 339.

NOTE 1- For values of *n* not in the table, compute the missing entry as follows: Minimum number of responses (x) = nearest whole number greater than $x = (n/2) + z\sqrt{n}/4$, where z varies with the significance level as follows: 0.84 for $\alpha = 0.20$; 1.28 for $\alpha = 0.10$; 1.64 for $\alpha = 0.05$; 2.33 for $\alpha = 0.01$; 3.10 for $\alpha = 0.001$. This calculation is an approximation. The value obtained may differ from the exact value as presented in the table, but the difference never exceeds one response. Exact values can be obtained from binomial distribution functions widely available in statistical computer packages.

Table 6-4: Number of Common Responses Needed for Significance in a Paired Preference Test, Two-Sided Alternative[A]

NOTE 1- Entries are the minimum number of common responses required for significance at the stated significance level (that is, column) for the corresponding number of participants "*n*" (that is, row). Reject the assumption of "no preference" if the number of correct responses is greater than or equal to the tabled value.

	Significance Level, %							Significance Level, %						
n	0.50	0.20	0.10	0.05	0.01	0.001	*n*	0.50	0.20	0.10	0.05	0.01	0.001
5	4	5	5	-	-	-	31	18	20	21	22	24	25
							32	19	21	22	23	24	26
6	5	6	6	6	-	-	33	19	21	22	23	25	27
7	5	6	7	7	-	-	34	20	22	23	24	25	27
8	6	7	7	8	8	-	35	20	22	23	24	26	28
9	7	7	8	8	9	-							
10	7	8	9	9	10	-	36	21	23	24	25	27	29
							40	23	25	26	27	29	31
11	8	9	9	10	11	11	44	25	27	28	29	31	34
12	8	9	10	10	11	12	48	27	29	31	32	34	36
13	9	10	10	11	12	13	52	29	32	33	34	36	39
14	9	10	11	12	13	14							
15	10	11	12	12	13	14							
16	10	12	12	13	14	15	56	32	34	35	36	39	41
17	11	12	13	13	15	16	60	34	36	37	39	41	44
18	11	13	13	14	15	17	64	36	38	40	41	43	46
19	12	13	14	15	16	17	68	38	40	42	43	46	48
20	13	14	15	15	17	18	72	40	42	44	45	48	51
21	13	14	15	16	17	19	76	42	45	46	48	50	53
22	14	15	16	17	18	19	80	44	47	48	50	52	56
23	14	16	16	17	19	20	84	46	49	51	52	55	58
24	15	16	17	18	19	21	88	48	51	53	54	57	60
25	15	17	18	18	20	21	92	50	53	55	56	59	63
							96	52	55	57	59	62	65
26	16	17	18	19	20	22	100	54	57	59	61	64	67
27	16	18	19	20	21	23							
28	17	18	19	20	22	23							
29	17	19	20	21	22	24							
30	18	20	20	21	23	25							

A Adapted from Meilgaard, M., Civille, G. V., and Carr, B. T., *Sensory Evaluation Techniques, 2nd Edition*, CRC Press, Inc., Boca Raton, FL, 1991, p. 340.

NOTE 1—For values of *n* not in the table, compute the missing entry as follows: Minimum number of responses (x) = nearest whole number greater than $x = (n/2) + z=n/4$, where z varies with the significance level as follows: 1.28 for $\alpha = 0.20$; 1.64 for $\alpha = 0.10$; 1.96 for $\alpha = 0.05$; 2.58 for $\alpha = 0.01$; 3.29 for $\alpha = 0.001$. This calculation is an approximation. The value obtained may differ from the exact value as presented in the table, but the difference never exceeds one response. Exact values can be obtained from binomial distribution functions widely available in statistical computer packages.

7 Conclusions and recommendations

This research was to study variations of basic elements to limit reading and writing commonly used when conducting conventional paired preference tests on task performance by consumers with low-literacy levels. It was found that the combination of new basic paired preference elements developed improved understanding the test by low-literate consumers. This to an extent that no assistance was required, less time was need and independent completion of the test by low-literate consumers.

Picture instructions guide participants understanding of audio instructions and vice versa. Coding symbols developed and printed on stickers in place of three-digit number codes limited reading and writing numbers, therefore eliminated utilisation of pen to write down the three-digit code for the preferred selected sample. An image of a happy face in a box motivated participants choice (preference) and where to paste the prefer sticker code symbol. However, participants found difficult to decode picture instructions when presented alone.

Consumers with low-literacy levels were more comfortable (appearances, comments) when all the new developed basics elements were associated together as part of the method. However some attentions has to be paid on picture instructions (quality and size of images), audio instructions (sound of the voice record and speed at which it plays) and grammatical terminology use (phrase formulation has to be simple as possible).

Therefore the appropriate paired preference test method for consumers with low-literacy level was developed and suitable to low-literate understanding: it is now called the Kamdem paired preference method. Further studies should be conducted to establish whether further enhancements can be made to ameliorate the method such as use of video instructions rather than photograph instruction, validation of coding symbols developed, ensure the repeatability of the method via a series of sensory tests using different test venues, different food products and using different groups of participants.

8 References

AACC International (2000). *Approved Methods of the American Association of Cereal chemists*, 10th edition. St. Paul, Minnesota, USA: American Association of Cereal Chemists, Inc.

ABEDE, Y., STOECKER, B.J., HINDS, M.J., GATES, G.E. (2006). Nutritive value and sensory acceptability of corn- and kocho-based foods supplemented with legumes for infant feeding in Southern Ethiopia. *African Journal of Food Agriculture, Nutrition and Development*, 6, 1-19.

ADKINS, N. R. and OZANNE, J. L. (2005a). Critical consumer education: Empowering the low-literate consumer. *Journal of Macro Marketing*, 25, 153-162.

ADKINS, N. R. and OZANNE, J. L. (2005b). The low-literate consumer. *Journal of Consumer Research*, 32, 93-105.

AOAC (2000). *Official method of analysis Volume I.* 17th edition. Association of Official Analytical Chemists, Inc., Maryland, USA.

ASTM E2263, (2013). Standard test method for paired preference test. Designation E: 2263-12. ASTM International. West Conshohocken, PA United States.

BALTSAVIAS, A., JURGENS, A., and VAN VLIET, T. (1999). Fracture properties of short-dough biscuits: effect of composition. *Journal of Cereal Science*, 29, 235-244.

BENITEZ, O., DEVAUX, D. and DAUSSET, J. (2002). Audio-visual documentation of oral consent: a new method of informed consent for illiterate populations. *The Lancet*, 359, 1406-1407.

BENTSON, A., and FIRAT, A.F. (2006). Brand Literacy: consumers' sense-making of brand management. *Advances in Consumer Research*, 33, 375-350.

BEUKELMAN, D., and MIRENDA, P. (2005). *Augmentative and alternative communication* 4th edition. Maryland, United State of America.

BLISCHAK, D. M., LLOYD, L. L., and FULLER, D. R. (1997). Terminology issues. In L. L. Lloyd , D. R. Fuller , & H. H. Arvidson (Eds.) , *Augmentative and alternative communication: A handbook of principles and practices*. Boston, MA: Allyn and Bacon.

BLOOMFIELD, L. (1927). Literate and Illiterate Speech. *American Speech*, 2, 432-439.

BWAMBALE, F.M., MAYER, C.A and KOMAKECH, I. (2013). The ten beads method, a novel way to collect quantitative data in rural Uganda. *Journal of Public Health*, 2, 29-31.

CARSTENS, A. (2004). Tailoring printing materials to match literacy levels: A challenge for document designers and practitioners in adult literacy. *Language mater*, 34, 459-484.

CHUNG, S. J. (2010). Effects of milk type and consumer factors on the acceptance of milk among Korean female consumers. *Food Science*, 74, 286–295.

COETZEE, H. (2001). Market testing new food products with illiterate and semi-literate consumers. *ITDG Food Chain*, 29, 19-21.

COETZEE, H. and TAYLOR, J. R. N. (1996). The use and adaptation of the paired-comparison method in the sensory evaluation of hamburger-type patties by illiterate/semi-literate consumers. *Food Quality and Preference*, 7, 81-85.

COOPER, D.R. and SCHINDLER, P.S. (2006). *Business research methods.* 9th edition. New York, NY: McGraw-Hill.

COURCOUX, P. and SEMENOU, M. (1997). Preference data analysis using a paired comparison model. *Food Quality and Preference*, 8, 353-358.

CRESWELL, J.W. (2003). *Research design: qualitative, quantitative and mixed methods approach*. 2nd edition. Thousand Oaks. C A: Sage. California 91320.

CURIA, A., HOUGH, G., MARTÍNEZ, C. and MARGALEF, M. 2001. How Argentine consumers understand the Spanish translation of the 9-point hedonic scale. *Food Quality and Preference*, 12, 217–221.

DADA, S., HUGUET, A. and BORMAN, J. (2013). The iconicity of picture communication symbols for children with English additional language and mild intellectual disability. *Augmentative and Alternative Communication*, 29, 360-373.

DANNER, L., SIDORKINA, L., JOECHL, M., and DUERRSCHMID, K. (2013). Make a face! Implicit and explicit measurement of facial expressions elicited by orange juices using face reading technology. *Food Quality and Preference*, 32, 167-172.

DE BRUIN, C. and MINAAR, A. (1994). Experience with a single acceptance sensory test method to determine the acceptability of soya products using consumers with a low level of literacy. *The South African Journal of Food Science and Nutrition*, 6, 24-25.

DOWSE, R and EHLERS, M.S. (2008). The evaluation of pharmaceutical pictograms in a low-literate South African population. *Patient Education and Counselling*, 45, 87-99.

DRAGER, K. D. R., POSTAL, V. J., CARROLUS, L., CASTELLANO, M., GAGLIANO, C., and GLYNN, J. (2006). The effect of aided language modelling on symbol comprehension and production in two preschoolers with autism. *American Journal of Speech-Language Pathology*, 15, 112–125.

ERICKSON, K., DREVETS, W. and SCHULKIN, J. 2003. Glucocorticoid regulation of diverse cognitive functions in normal and pathological emotional states. *Neuroscience and Biobehavioral Reviews*, 27, 233-246.

F2M FOOD MULTIMEDIAS (2007). Bread market in South Africa. Online http: www.google.co.za/F2M+FOOD+MULTIMEDIAS/. Accessed 02/09/2014.

FILIPCEV, B., SIMURINA, O., SAKAC, M., SEDEJ, I., JOVANOV, P., PESTORI, M., and BONDROZA-SOLARO, M. (2011). Feasibility of buckwheat flour as an ingredient in ginger nut biscuit formulation. *Journal of Food Chemistry*, 125, 164-170.

FINGERET, H. A. (1994). *Adult literacy education: Current & future directions*. DIANE Publishing. Washington. USA.

FINGERET, H. A. and DRENNON, C. (1997). *Literacy for life: Adult learners, new practices*. Teacher College Press. New York; United States of America.

FOOD AND AGRICULTURE ORGANISATION. (2003). Food energy: Methods of analysis and conversion factors. FAO Food and paper Nutrition 77, 18-37. Rome FAO.

FRISTOE, M., and LLOYD, L. L. (1980). Planning an initial expressive sign lexicon for persons with severe communication impairment. *Journal of Speech and Hearing Disorders*, 45, 170 – 180.

FU, B.X., SAPIRSTEIN, H.D., BUSHUK, W. (1996). Salt-induced disaggregation / solubilisation of gliadin and gluten proteins in water. *Journal of Cereal Science*, 24, 241-246.

GAU, R., JAE, H. and VISWANATHAN, M. (2012). Studying low-literate consumers through experimental methods: Implications for subsistence marketplaces. *Journal of Business Research*, 65, 1683-1691.

GOETZE, M. and STROTHOTTE, T. (2001). An approach to help functionally illiterate people with graphical reading aids. *Smart Graphics Symposium* UK. Citeseer, 21-23.

GOODENOUGH, B., DONGEN, K., BROUWER, N., ABU-SAAD, H. H., and CHAMPION, G. D. (1999). A comparison of the Faces Pain Scale and the Facial Affective Scale for children's estimates of the intensity and unpleasantness of needle pain during blood sampling. *European Journal of Pain*, 3, 301-315.

GUINARD, J.X (2001). Sensory and consumer testing with children. *Trends in Food Science and Technology*, 11, 273-283.

HATTWIG, D., BUSSERT, K., MEDAILLE, A., and BURGESS, J. (2013). Visual literacy standards in higher education: New opportunities for libraries and student learning *Portal: Libraries and the Academy*, 13, 61-89.

HEGENBART, S. L. (1998). Alternative enhancers. *Food Product Design*, *2*, 60-71.

HEIN, K. A., JAEGER, S. R., CARR, B. T and DELAHUNTY, C. M. (2008). Comparison of five common acceptance and preference methods. *Food Quality and Preference*, 19, 651-661.

HOOGWEGT, H. (2007). *How do low educated audiences understand motion in static visuals? Two explorative studies into low educated South Africans' comprehension of motion suggestion in static visuals* (Doctoral dissertation).Tillburg University: Netherlands.

HOOVER, W. A. and GOUGH, P. B. (1990). The simple view of reading. *Reading and Writing*, 2, 127-160.

HOSSAIN, A., KUMAR SARKER, A. and PARVEEN, S. (2013). Physicochemical and Microbiological quality of fortified high-energy biscuits served in school of poverty prone areas in Bangladesh. *Journal of Pharmaceutical and Biological Sciences*, 1, 16-20.

ILD, (2015). International literacy day-2015. Online http://www.gov.za/international-literacy-day-2015 accessed 15/10/2015.

INDRANI, D., and RAO, W.G. (2007). Rheological characteristics of wheat flour dough as influenced by ingredients of parotta. *Journal of Food Engineering*, 79, 100-105.

JAE, H. and DELVECCHIO, D. (2004). Decision making by low- literate consumers in the presence of point-of-purchase information. *Journal of Consumer Affairs*, 38, 342-354.

JAE, H. and VISWANATHAN, M. (2012). Effects of pictorial product-warnings on low-literate consumers. *Journal of Business Research*, 65, 1674-1682.

KEEFE, E. B. and COPELAND, S. R. (2011). What is literacy? The power of a definition. *Research and Practice for Persons with Severe Disabilities*, 36, 92-99.

KEMPT, S. E., HOLLOWOOD, T., Hort, J. (2009). Sensory evaluation: *A practical handbook*. John Wiley & Sons, Ltd. Oxford, UK.

KNICKMAN, J.R and GAUS, C.R. (1999). Consumer survey information in a reforming health care system. DIANE publishing. Vienna, Virginia.

KUMAR, R. (2005). *Research methodology: a step by step guide for beginners*. 2nd edition. London: Sage.

LAWLESS, H. T. and HEYMANN, H. (1999). *Sensory Evaluation of Food*. Springer. New York.

LAWLESS, H.T., POPPER, R., KROLL, B.J. (2010).A comparison of labelled magnitude (LAM) scale, an 11-point category scale and traditional 9-point hedonic scale. *Food Quality and Preference*, 21, 4-12.

LEEDY, P.D. and ORMROD, J.E. (2005). *Practical research: planning and design*. 8th edition. New Jersey: Pearson.

LEON, F., COURONNE, T., MARCUZ, M.C., KOSTER, E.P. (1999). Measuring food liking in children: a comparison of nonverbal methods. *Food Quality and Preference*, 10, 93-100.

LIM, J. (2011). Hedonic scaling: A review of methods and theory. *Food Quality and Preference*, 22,733-747.

LINNEY, B. (1995). *Pictures, people and power: people-centred visual aids for development*. Macmillan Press Ltd. UK.

LLOYD, L. L., and FULLER, D. R. (1990). The role of iconicity in augmentative and alternative communication symbol learning. In W. I. Fraser (Ed.), *Key issues in mental retardation issues*. London: Routledge.

LOMBARD, A., KEMP, M., VILJOEN-TOET, N., and BOOYZEN, M. (2012). An integrated developmental model for poverty reduction in South Africa: An NGO'S perspective. *Journal of Community Practice*, 20, 178-195.

MALHOTRA, N.K. (1988). A methodology of measuring consumer preferences in developing countries. *International Marketing Review*, 5, 52-66.

MARCOTTE, M., and RAMASWAMY, H. (2005). *Food processing: Principles and Application*. Boca Raton. CRC Press.

MAYER-JOHNSON, R. (1985). *The Picture Communication Symbols*. Solana Beach, CA: Mayer-Johnson.

MERRIAM, S. B. (1998). *Qualitative research and case study applications in education. Revised and expanded from" Case Study Research in Education*." Jossey-Bass Publishers, 350 Sansome St, San Francisco, CA 94104.

MHLANGA, S. (2011). *An exploration of the decision making processes and coping mechanism of functionally illiterate South African consumers*. Marketing Management Dissertation. University of Pretoria.

MIZUKO, M. (1987). Transparency and ease of learning of symbols represented by Blissymbols, PCS, and Picsyms. *Augmentative and Alternative Communication,* 3, 129 – 136.

MUHIMBULA, H.S., ISSA-ZACHARIA, A and KINABO, J. (2011). Formulation and sensory evaluation of complementary foods from local, cheap and readily available cereals and legumes in Iringa, Tanzania. *African Journal of Food Science.* 5, 26-31

NICOLAS, L., MARQUILLY, C. and O'MAHONY, M. (2010). The 9-point hedonic scale: Are words and numbers compatible? *Food Quality and Preference*, 21, 1008-1015.

O'MAHONY, M. (1985). *Sensory evaluation of food* (statistical methods and procedures). Pub. Marcel Dekker Inc. New York and Basel.

PEREIRA, D., CORREIA, P. M., and GUINE, R. P. (2013). Analysis of the physical-chemical and sensorial properties of Maria type cookies. *Acta Chimica Slovaca*, 6, 269-280.

POPPER, R., ROSENSTOCT, W., SCHRAIDIT, M., KROLL, B.J. (2004). The effect of attribute questions on overall liking rating. *Food Quality and Preference*, 12, 853-858.

REICKS, M., SMITH, C., HENRY, H., REIMER, K., ATWELL, J. and THOMAS, R. (2003). Use of the think aloud method to examine fruit and vegetable purchasing behaviours among low-income African American women. *Journal of Nutrition Education and Behaviour*, 35, 154-160.

RITCHIE, J., LEWIS, J., NICHOLLS, C. M., and ORMSTON, R. (Eds.). (2003). *Qualitative research practice: A guide for social science students and researchers*. Thousand Oaks. California. Sage.

RUBIN, H.J. and RUBIN, I.S. (2005). *Qualitative interviewing: the art of hearing data*. 2nd edition. Thousand Oaks. California: Sage.

RUE, N. N. (1990). *Coping with an Illiterate Parent*. The Rosen Publishing Group Inc. New York.

SADOSKI, M., and PAIVIO, A. (2004). A dual coding theoretical model of reading. In R. R. Ruddell and N. J. Unrau, (Eds.), *Theoretical models and processes of reading* (5th edition.), pp. 1329–1362. Newark, DE: International Reading Association.

SAUNDERS, M., LEWIS, P. and THORNHILL, A. (2007). *Research methods for business students* 4th edition. Harlow: Financial Times / Prentice Hall.

SCHLOSSER, R. W., and SIGAFOOS, J. (2002). Selecting graphic symbols for an initial request lexicon: Integrative view. *Augmentative and Alternative Communication*, 18, 102 – 123.

SIEBER, E. (2001).*Teaching with object and photographs: Supporting and enhancing your curriculum*. A Guide for teachers. ERIC. Bloomington. India.

SOSA, M., MARTINEZ, C., MARQUEZ, F. and HOUGH, G. (2008). Location and scale influence on sensory acceptability measurements among low income consumers. *Journal of Sensory Studies*, 23, 707- 719.

STEINER, J. E. (1973). The gusto facial response: observation on normal and anencephalic new born infants. *Symp Oral Sens Percept*, 4, 254-278.

STEVENSON, A. (Ed.). (2010). *Oxford dictionary of English*. Oxford University Press. Auckland Cape Town.

STONE, H., BLEIBAUM, R. and THOMAS, H. A. (2012). *Sensory evaluation practices*. 4th edition. Academic press. Waltham. United States of America.

THOMPKINS, A. C. and BINDER, K. S. (2003). A comparison of the factors affecting reading performance of functionally illiterate adults and children matched by reading level. *Reading Research Quarterly*, 38, 236-258.

TOURANGEAU, R. and ELLSWORTH, P. C. (1979). The role of facial response in the experience of emotion. *Journal of Personality and Social Psychology*, 37, 15-19.

UNESCO (2014). Literacy data show persistent gender gap. Online http://www.uis.unesco.org/literacy/Pages/literacy-day-2014.aspx. Access 10/03/2015.

USI (2014). UNESCO Institute of Statistics. Online: http://www.uis.unesco.org (access 10/05/2015).

VAN DER BERG, S., TAYLOR, S., GUSTAFSSON, M., SPAULL, N., and ARMSTRONG, P. (2011). Improving education quality in South Africa. Rapport for the national planning commission. University of Stellenbosch Cape Town. (Internet document) URL http://resep.sun.ac.za/wp-content/uploads/2012/10/2011-Report-for-NPC. Pdf. Access 12/05/2015.

VILLANUEVA, N. D. M., and DA SILVA, M. A. A. P. (2009). Comparative performance of the nine-point hedonic, hybrid and self-adjusting scales in the generation of internal preference maps. *Food Quality and Preference*, 20, 1–12.

VISWANATHAN, M., ROSA, J. A. and HARRIS, J. E. (2005). Decision making and coping of functionally illiterate consumers and some implications for marketing management. *Journal of Marketing*, 69, 15-31.

VISWANATHAN, M., GAJENDIRAN, S. and VENKATESAN, R. (2008). *Enabling consumer and entrepreneurial literacy in subsistence marketplaces: A research-based approach to educational programs.* Springer, New York.

VISWANATHAN, M., TORELLI, C. J., XIA, L. and GAU, R. (2009). Understanding the influence of literacy on consumer memory: The role of pictorial elements. *Journal of Consumer Psychology*, 19, 389-402.

WENDIN, K., ALLENSENS-HOLM, B., and BREDIE, L. P. W. (2011). Do facia l reactions add new dimension to meaning sensory responses to basic taste? *Food Quality and Preference*, 22, 346-354.

WIESER, H. (2007). Chemistry of gluten protein. *Journal of Food Microbiology*, 25, 115-119.

YEU, K., LEE, Y., and LEE, S. Y. (2008). Consumer acceptance of an extruded soy-based high-protein breakfast cereal. *Journal of Food Science*, 73, 20–25.

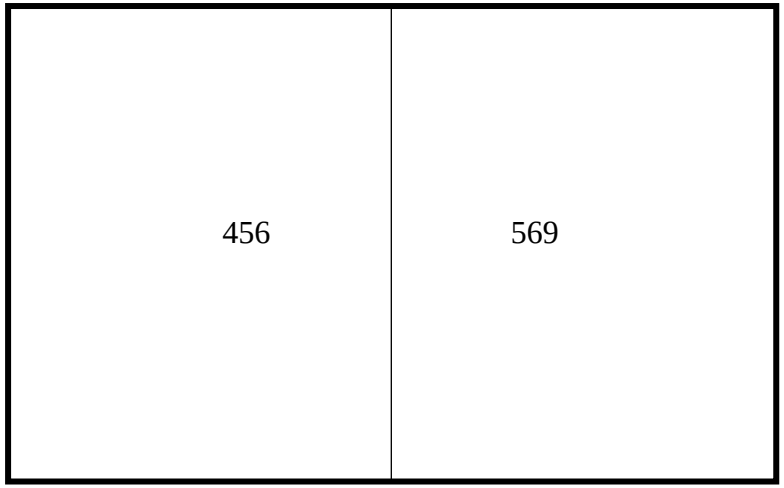
ZEINSTRA, G.G., KOELEN, M.A., COLINDRES, D., KOK, F.J and GRAAF, C. (2009). Facial expressions in school–age children are good indicator of dislikes but not for likes. *Food Quality and Preference*, 20, 620- 624.

9 Appendix A, B, C

Appendix A1 Date:

Method 1 No:

You have been given two biscuits. First eat one of the biscuit, drink water then eat the second biscuit. Use the pen to make a mark in the box of the biscuit you prefer.



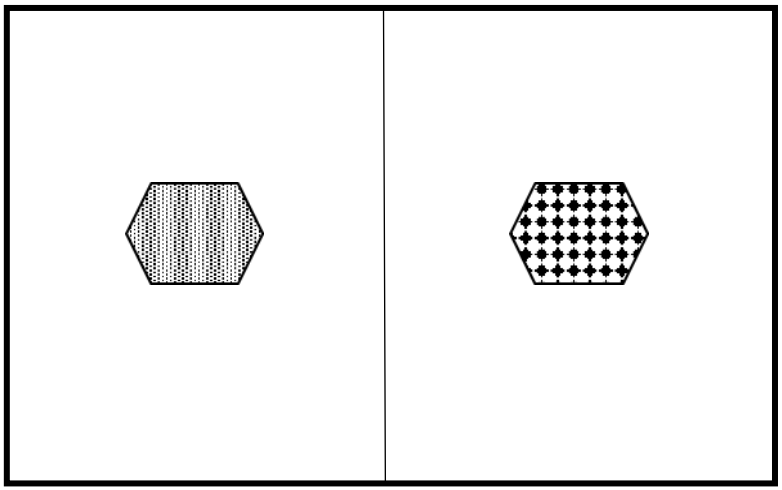
AppendixA2 Date:

Method 2 No:

456	569

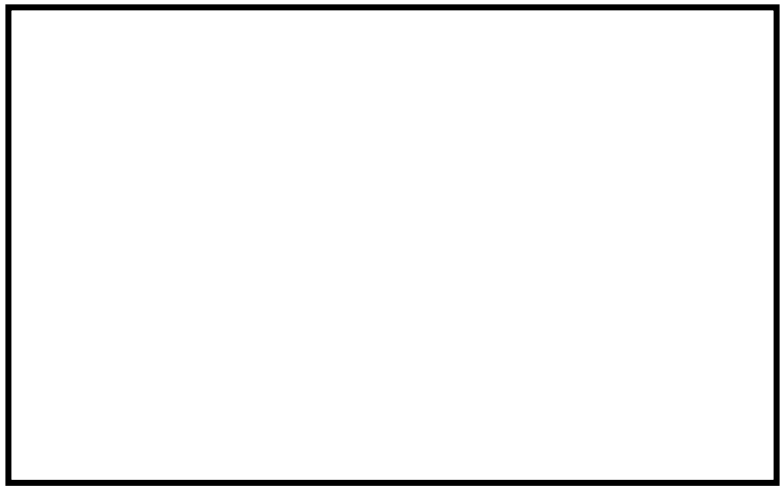
Appendix A3 Date:

Method 3 No:



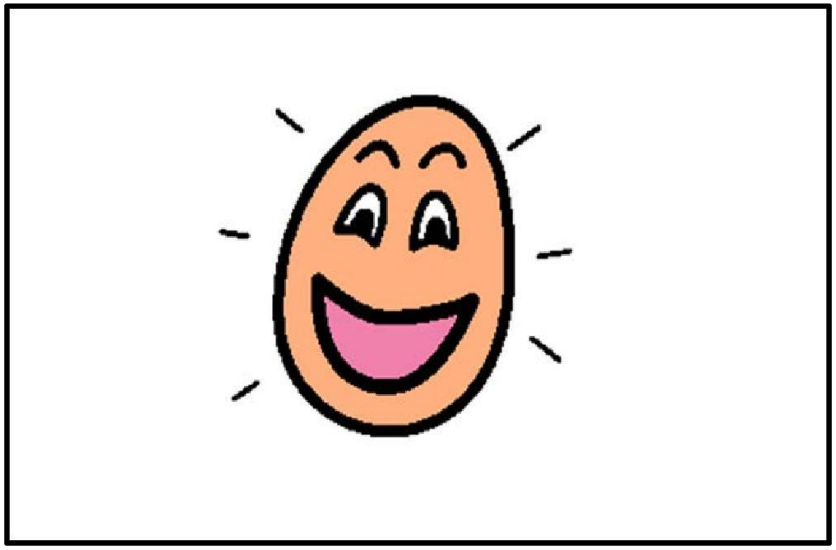
Appendix A4 Date:

Method 4 No:



Appendix A5, A6, A7 Date:

Method 5-6-7 No:



Appendix B

Qualitative questionnaire

Date:

No:

1-Test method

1 2 3 4 5 6 7

2- Time:

Start:	End:	Total:

3- Consumer Attitude during test evolution:

No anxiety	Little bit	Little more	Even more	Whole lot	Very anxious

3-1-Comments

Gender

Male	

3-2 Age (*In what year were you born?*)

4- What is your home language?

IsiZulu	IsiXhosa	Afrikaan	English	SeSoth	Sepedi
Tswana	Swazi	Venda	Ndebele	Tsonga	Others (specify)

5- School level: (*what is your highest level of education?)*

Did not attend school	Up to grade 7- some primary school

6-How did you think the task was? (*If no answer from consumer assistant must propose to them the three alternatives choice below and tick the correct choice)* mark one option

Difficult	Okay	Easy

7-1. you said it was _____ what could be your reason?

Thank the consumer for participating

Can we include the answers that you gave us in our data set?

Yes	no

Hereby, I declare that the information collected during this interview was provided by the consumer or base on my observation.

Helpers Name and Surname _____ Signature _____

Appendix C: Audio Instruction

-Audio 1 (Method 2)

Please listen carefully. You have been given two biscuits. First eat one of the biscuit, drink water, then eat the second biscuit. Use the pen and make a mark in the box of the biscuit you prefer

-Audio 2 (Method 3)

Please listen carefully you have been given two biscuits. First eat one of the biscuit, drink water then eat the second biscuit. Use the pen and make a mark in the box with the symbol of the biscuit you prefer

-Audio 3 (method 4)

Please listen carefully. You have been given two biscuits. First eat one of the biscuit, drink water, then eat the second biscuit. Remove the sticker of the biscuit you prefer and paste it on the empty box.

-Audio 4 (method 5 and 7)

Please listen carefully. You have been given two biscuits. First eat one of the biscuit, drink water, then eat the second biscuit. Remove the sticker of the biscuit you prefer and paste it on the smiley face box.