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Triangle Taste Test and Sensory Evaluation: A Novel Application for Determining Supplement-Placebo Match in a Clinical Trial

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Abstract

The aim of this taste test was to determine if participants could perceive the differences between a powdered inulin fibre supplement and a crystallized xylitol sweetener when mixed with a masking substance (i.e. orange juice) to be used in an upcoming randomized controlled trial. To assess any detectable taste differences, the triangle test for similarity was used. Respondents were blinded and randomly selected to receive either the inulin fibre or xylitol sweetener, however, the investigators were not blinded. For this project, 42 judges were gathered. Out of these judges, 18 correctly picked the odd sample and 24 could not distinguish between samples. Further test to examine the proportion of discriminators showed that 6 (14.2%) of the judges were considered as discriminators or judges who were able to detect a difference with the upper end of the confidence interval at 16%. These results showed that the number of people who could discriminate between the different samples remained small and within the accepted range.

Practical Applications:

While supplement and placebo used regularly used in many clinical trials, their match is seldom tested. In this study, the taste match between the inulin fibre and the most commonly used placebo in intervention studies using inulin was testing using a triangle taste test. The results showed that people could not discriminate between groups. This provides further support to the methodological rigor for clinical trials where the group allocation is based on the assumption of similarity and seldom tested. Guidelines for clinical trials should mandate group comparability as a necessary test prior to the start of the trial to avoid potential bias what will compromise the methodological integrity.

Keywords: Triangle sensory test; Discriminative tests; Perception; Inulin; Xylitol

Introduction

Sensory evaluation has been an important part of research and development and marketing efforts in food and other industries. They help industry experts and researchers determine customers preference for certain products over another (affective), if customers can distinguish the differences in specific characteristics such as sweetness (descriptive), and/or if the products are perceived to differ in any way at all (discrimination). Typically, sensory evaluation are used for product development and marketing. While different intervention and placebo products are often used in randomized control trials involving humans, studies seldom report on whether study participants differentiate the difference between the experimental project and placebo in any way or in specific characteristics. Testing such a difference would be novel application in the use of sensory evaluation and seldom used or reported in randomized clinical trials. In clinical trials, comparability of groups' area assumed and this is important for methodological integrity.

Prior to starting a randomized controlled trial (RCT) in which two groups of participants consumed two different substances, inulin (powdered fibre supplement) and xylitol (crystallized natural sweetener), the present study was conducted to determine whether any noticeable discrepancies in taste existed. For testing discrimination, various tests such as the triangle taste test, tetrad, or duo-trio are used. The choice however depends on a number of factors like the complexity of the product, test sensitivity, and panellists to be used. Although tetrad is emerging as a preferred option given its superior sensitivity and requirement for smaller sample size among other advantages [1], the traditional triangle taste test remains acceptable with strategies adopted to reduce response bias, cognitive strategy change and sequence of tasting [2, 3]. The present study examined if there would be any discernible differences between the inulin-based fibre supplement and crystallized xylitol sweetener that was used as a placebo when mixed with a masking agent (orange juice) using a triangle taste test for similarity.

Materials and Methods

A triangle test for similarity was used. Respondents or judges (n = 42) were recruited from the Dr. Paul Schwann Applied Health and Research Centre (DPSC) at the University of Regina. All participants were older adults who regularly participated in the tri-weekly Cardiac Rehabilitation program. An equal number of males and females were recruited for this test. Older adults were recruited because the sample being used for the future RCT would be recruiting subjects from this segment of the population.

Six large, separate containers of orange juice were mixed with either inulin fibre or a xylitol sweetener. Three containers contained the inulin fibre and the remaining three contained the xylitol sweetener. Each container held one litre of orange juice. The study took place in a small isolated room in the DPSC so that each participant could assess the samples independently. Samples were coded using six possible combinations (ABB, BAA, AAB, BBA, ABA, and BAB). Study participants were randomly presented with three coded samples of orange juice in small taste cups, with a capacity of 2 fl oz. and a glass of water. These codes were based on the previously mentioned six combinations. Participants were instructed that two samples are identical and one was different. Participants were asked to taste each product from left to right and take a sip of water between each sample, in order to mask the taste of the previous sample. Once all three samples had been tasted, participants were given a score sheet and asked to select the odd sample. The values of β and Pd were set to 0.05 and 0.3 respectively. That is, there was a 95% certainty that no more than 30% of the population could detect a difference between samples.

Results

In a 42-response triangle taste test for similarity only a maximum of 16 people can correctly identify the odd sample in order for the test to be valid [4]. Out of the 42 respondents, 18 correctly selected the odd sample. This value was slightly out of the accepted range for the similarity test (i.e., the number of correct responses ≤ 16). The true proportion of *distinguishers* in the population was calculated using the following formula for the normal approximation to the binomial:

$$P_{\max(95\%)} = [1.5(x/n) - 0.5] + Z_{\beta}\sqrt{[2.25(x/n)(1-(x/n))]/n}$$

Where x is the observed number of correct response, n is the number of respondents, and is the upper 100 x β percentile point of the standard normal distribution. The value in this case was determined to be 32.86% which means that with 95% certainty; no more than 32.86% of the population can distinguish the samples. Given that the proportion of discriminators is more sensitive, we calculated this using the following formula. D = 1.5 (X)-0.5(N) where X represents the number of correct responses, D is the number of discriminators, and N is the total number of panellists.

This assessment showed that there were 6 discriminators or 6/42 or 14.2% of judges detect a difference The Standard Error (SE) and upper end confidence intervals were calculated as shown below.

$$1.5\frac{\sqrt{\frac{x}{n}\left[1-\left(\frac{x}{n}\right)\right]}}{n} \qquad 1.5\sqrt{\frac{\left(\frac{18}{42}\right)\left[1-\left(\frac{18}{42}\right)\right]}{42}} = 1.14$$

Upper Bound Confidence Interval

Z (SE)+proportion of discriminators = 1.65(1.14)+ 0.142 = 0.1601 =16%

The upper level of the confidence interval was 16% well within the 95% certainly level that no more than 30% will discriminate the products.

Discussion

An important aspect of this project which must be considered is the lack of blinding which occurred since the investigators had both composed the samples and administered the sensory test. This single-blind nature of this study occurred to control costs associated with this project. However, this effort to control costs could have contributed to a poor quality RCT because evidence exists that high quality RCT are more likely to be expensive.

Since the xylitol used was a sweetener it would have been expected that those samples containing xylitol would have a sweeter taste than the samples which contained the inulin fibre. However, the reasoning used by seven of the participants who "correctly" identified the odd sample belies this fact. One respondent stated that all the samples tasted the same, two respondents made a random guess, and the remaining respondents (n = 4) either described the fibre containing sample as sweeter, or the sweetener containing sample as less sweet. Either description is incorrect. The two respondents who made a random guess had stated to the sensory analyst that they could detect no difference between the samples, but as they were required to pick a sample, they did. If these seven responses were removed, then the number of correct responses would be 11, which would be well within the accepted range for the similarity tests. These differences likely occurred because it is unlikely that all assessors employed the same definition of sweetness. If the definition of sweetness was too lax or to strict there would be an increase in the level of bias in the respective responses of the assessors [3]. While some researchers felt that utilizing forced choice methods such as the triangle sensory test, eliminated response bias [3] this concept of forced-guessing was thought to likely increase the bias within the results [5]. The triangle sensory test is a type of discrimination test that has been utilized by researchers for years [6].

The triangle sensory test requires subjects to evaluate three products at one time and render an immediate judgment [7]. This increases the complexity of the task and thus increases the bias of the resulting answer responses. To decrease the bias, and therefore increase the accuracy of the results, a triangle test is often replicated during a session (i.e. each assessor performs the triangle test twice). Previous research [2, 8] has indicated that replication increases the power of the triangle test and also increases the detection ability of the assessor. It has also been suggested that utilizing economic incentives can increase the effectiveness of a triangle sensory test [9]. A limitation of the present study is that the triangle test was not done in duplicates or compared to a duo-trio or other sensory tests. Future research should also consider using tetrad or other advanced sensory evaluation techniques in collaboration with sensory scientists.

These are interesting findings, as it is widely assumed that foods and beverages can be easily recognized by using a sensory taste test, such as the triangle taste test. One explanation for this may be that only one sensory modality (e.g. taste) was used in this sensory test. A variety of sensory modalities, such as taste, olfaction, touch, typically contribute to ones experience of flavour [10, 11]. The lone use of taste would have hampered the participants' ability to properly discern any apparent differences which existed between the inulin and xylitol mixtures. Further research is needed to explore this in greater depth.

The results of the study have practical implications. For example, while supplement and placebo used regularly used in many clinical trials, their match is seldom tested. The two substances tested in this study have been used in several other intervention trials involving different age and clinical groups [12]. In this study, the taste match between the inulin fibre and the most commonly used placebo in intervention studies using inulin was testing using a triangle taste test. The results showed that people could distinguish between groups. This raises methodological concerns for clinical trials where the group allocation is based on the assumption of similarity and seldom tested. Guidelines for clinical trials should mandate group comparability as a necessary test prior to the start of the trial to avoid potential bias what will compromise the methodological integrity.

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