# Sensitivity and Usefulness of Tetrad Testing Compared to Triangle Testing on Beverages Containing High Potency Sweeteners

NestléHealthScience

Stephanie Williams, B. Thomas Carr, Christine Van Dongen

## Introduction

The triangle test is the most widely used discrimination test due to the simplicity of the task, relative ease of preparation, and analysis. The relative power of the triangle test, however, has been under scrutiny for some time. Although the unspecified tetrad test has equal guessing probability to that of the triangle test, the theoretical power under the Thurstonian model is greater for the tetrad test. Therefore, the tetrad will theoretically have greater power and sensitivity with the same number of panelists. Conversely, fewer panelists would be needed for a tetrad test to achieve equal power and sensitivity to a triangle test. This research compared the efficacy of the triangle test versus the tetrad test in finding differences between products containing sucrose and high potency sweeteners, using equal numbers of panelists for each method.

## Objective & Hypotheses

**Objective:** Compare the tetrad test's sensitivity to that of the triangle test at n = 30.

**Hypotheses:**

1) Tetrad is more sensitive at detecting differences than is the triangle method if the stimuli are not fatiguing.

$H_0$ = Tetrad = Triangle Sensitivity

$H_a$ = Tetrad > Triangle Sensitivity

2) Tetrad is at least of equal sensitivity compared to the triangle method when the stimuli are fatiguing, for example when the stimuli contain high potency sweeteners.

$H_0$ = Tetrad < Triangle Sensitivity

$H_a$ = Tetrad ≥ Triangle Sensitivity

## Materials & Methods

### Materials

Table 1. Product information: 36 test sets were completed on 23 unique product pairs.

| | Products | Panelists |
|---|---|---|
| **Round 1** 8 sets in duplicate | Milk with added ingredients (i.e. flavor, caffeine, salt) | The same panelists completed both the triangle and the tetrad test for a product pair. |
| **Round 2** 5 sets in duplicate | Milk with high potency sweeteners added (i.e. sucralose, stevia, monk fruit extract) | The same panelists completed both the triangle and the tetrad test for a product pair |
| **Round 3** 10 sets individual | Complete nutritional beverages with and without high potency sweeteners | The same panelists were not required to complete both tests for a product pair |

There were a total of 22 product sets tested that did not include high potency sweeteners and 14 product sets that did include high potency sweeteners.

## Materials & Methods

### Internal Testing Method

**Location:** One Nestlé R&D Center
**Respondents:** N= 30 Nestlé employees or contractors for each test
**Procedure:** Employees completed 72 tests, 36 triangle and 36 tetrad. Test and sample orders were balanced. Products for each test were served at the same time with the standard method of asking the question. Following the completion of the discrimination task, panelists were asked additional questions on the confidence in their response, the difficulty of the task, and the number of samples.

**Tetrad Test**

(1) Please take a sip of water to cleanse your palate before you start and in-between samples.
(2) Please taste the samples in order from Left to Right
(3) Sort the samples into two groups of two samples based on similarity. Click TWO of the samples to group them. The other two samples will be the other group. If you cannot detect a difference, please guess.

111 222 333 444

**Triangle Test**

(1) Please take a sip of water to cleanse your palate before you start and in-between samples.
(2) Two of these samples are identical, one is different.
(3) Please taste the samples in order from Left to Right
(4) Determine which is the ODD sample and select the number below. You may re-taste the samples. If you cannot detect a difference, please guess.

111 222 333

Figure 1. Instructions given to panelists for tetrad and triangle tests.

## Results

### Hypothesis 1) False

When samples did not include high potency sweeteners (were not fatiguing) the tetrad test was not more sensitive at detecting differences than the triangle test. The d' values are not consistently higher for the tetrad method compared to the triangle method.

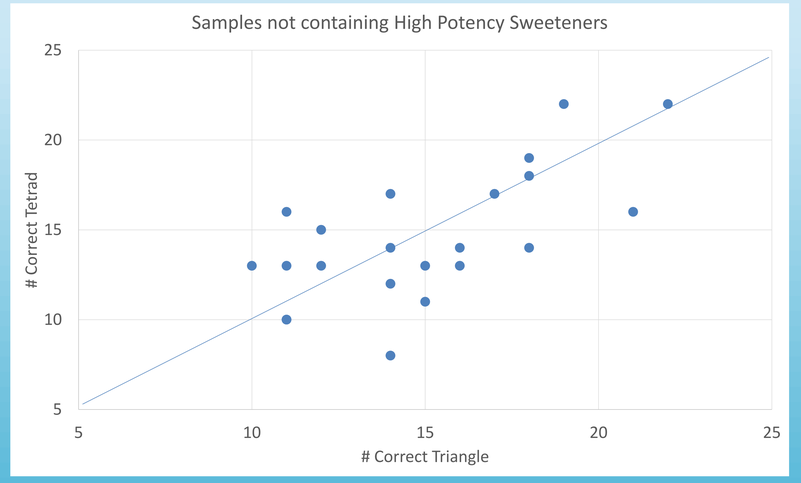


Figure 2. Number of correct answers for each method when products did not include high potency sweeteners. N = 30 for each test.

## Results

### Hypothesis 2) True

When the samples contained high potency sweeteners, the tetrad method and the triangle method were equally sensitive. However, the tetrad method did not provide an advantage in terms of test sensitivity over the triangle method. In comparing the triangle and the tetrad methods when high potency sweeteners are used versus when they are not used, again no difference was found.

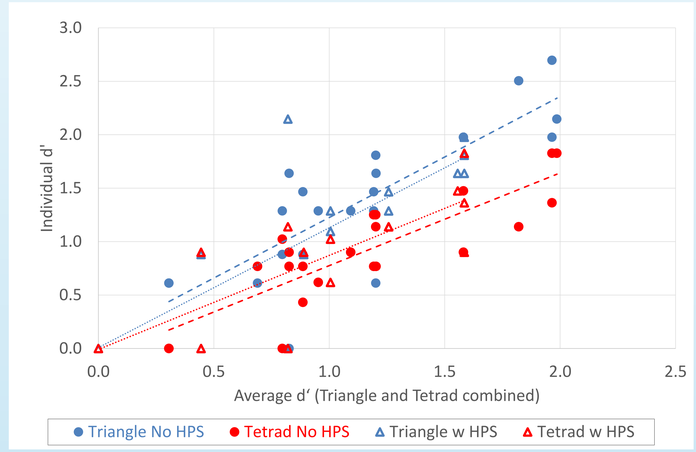


Figure 3. Individual versus average d' values for triangle and tetrad tests when samples included and did not include High Potency Sweeteners (HPS).

### Summary

When comparing the two methods overall, the sensitivity of the two test methods seem to be similar, whether the samples tested include high potency sweeteners or not. The panelists were less confident overall with their response in the tetrad compared to the triangle and found the task of the tetrad test more difficult. Interestingly, within a test method, the inclusion or not of HPS did not have any impact on the panelist's confidence or perceived difficulty.

## Conclusions

The results of this research indicate that there is not a significant advantage to using the tetrad method in place of the triangle method with the type of products tested, either with high potency sweeteners or without them. These results suggest the advantage of the tetrad method over the triangle method may be product-specific.

**Contact Information**

Stephanie Williams at stephanie.williams@rd.nestle.com
Tom Carr at tom.carr@carrconsulting.net
Christine Van Dongen at christine.vandongen@rd.nestle.com