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How to Account for "No Difference/Preference" Counts

Daniel M. Ennis and John M. Ennis

Background: Data obtained from many forced choice procedures such as the 2- and 3-alternative forced choice (2-AFC and 3-AFC), the duo-trio and the triangular methods, are often tested using the binomial distribution. In some applications of either difference or preference testing it is desirable to include a *no difference* or *no preference* option. One example occurs in claims support where there is a preference to include this option, but there are many other such applications in product testing for product development or quality assurance. Note that in this report we refer only to no difference counts although the ideas we present apply equally well to no preference counts. Also note that we refer to a two-alternative task with a no difference option as the 2-AC (2-alternative choice) in which the instruction is to choose the item of two (*A* and *B*) with the greatest or least amount of some attribute, or to indicate no difference.

The treatment of no difference counts has been the subject of much debate in the product testing community for years. Some practitioners prefer to distribute the no difference counts proportional to the item choices, others prefer to distribute them equally, and still others prefer to drop them entirely and qualify their results as being among those who reported a difference. Models that account for the no difference counts have also been developed and in particular there is a Thurstonian model that estimates the size of the difference between the items as well as the likelihood of generating no difference responses. An important issue then is to determine the best way of accounting for the no difference counts from the various possibilities proposed.

A Sweeter	*B* Sweeter	No Difference	Total
53	37	10	100

Table 1. Choice counts in a comparison of two beverages on sweetness.

Scenario: You are interested in establishing the basis for a claim that your beverage product is sweeter than a rival product that has a greater caloric content. You conduct a pilot study with 100 consumers in which you instruct consumers to choose the alternative that is sweeter or to indicate no difference. The test is conducted in a double blind format in a balanced design. The results are shown in Table 1. You are aware of the four options mentioned earlier and typically analyze this type of data by only considering those who expressed a difference. Even so you would prefer not to have to qualify your claim with this restriction and would like to consider other options that include all of the data.

Four Analytic Options: The four options under consideration are: a) Proportional redistribution of no difference counts; b) Equal distribution of no difference counts, c) Dropping the no difference counts, and d) Including the no difference counts in the analysis and accounting for them using a Thurstonian model. In the first three cases, the binomial distribution is used to determine whether to reject a null hypothesis that the choice probability, P_c, is 0.5. A minor issue arises when there is an odd number of no difference counts as we can allocate all but one of the counts equally. In this report we allocate the one remaining count to the competitor and an analogous practice will be used for proportional redistribution. This issue does not arise when we drop the no difference counts or when we use a Thurstonian model. Figure 1 illustrates the way in which item choice probabilities arise under the Thurstonian model assumptions. We assume that the subject perceives one intensity for each item and that a decision to choose the no difference option depends on whether the difference between the intensities falls within an interval -*b* and +*b*. In the figure, *b* = 0.3 so the interval is (-0.3, +0.3). If the difference exceeds +*b*, the subject chooses *A* and if the difference is less than –*b*, the subject chooses *B*.

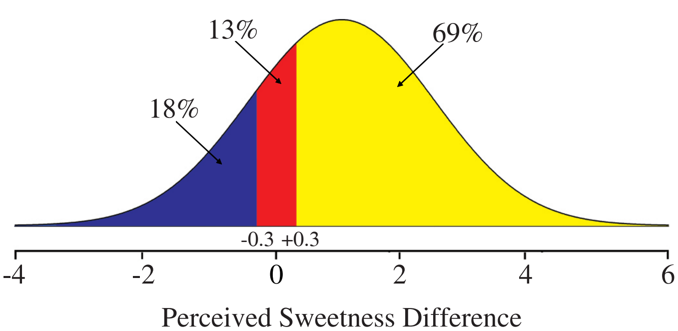

Figure 1. The distribution of the difference between product *A* and *B* with δ = 1 and P(*A* greater) = 69%, P(*No difference*) = 13% and P(*B* greater) = 18%.

Power Comparisons of the Options: One way of comparing the alternative options for analyzing 2-AC data is to compare their power curves. Of particular interest is to determine if any of the options proposed are liberal or conservative by assessing the power when there is no difference, i.e. when the choice probability, P_c, is

0.5. Assuming a 5% one-tailed test, we would expect this value to be 5%. For a particular method, if the power at $P_c = 0.5$ is greater than 5% the test is liberal and should not be used. If the power is less than 5% the test is conservative and could be used under the realization that the method may not detect differences as often as less conservative methods. The ideal method would have a power of 5% at $P_c = 0.5$ with high power when alternative values of P_c exceed 0.5. Figure 2 shows the power curves for the four options under consideration when the sample size, *n*, is 100 and the true no difference probability is 30%. Figure 3 shows the corresponding curves for n = 300. It can be seen from these figures that the proportional distribution method is liberal and should not be used. The power at $P_c = 0.5$ exceeds the nominal α of 0.05. The equal allocation option is conservative and its power curve is lower than the other options. This option is admissable but there are more powerful alternatives. The Thurstonian model for the 2-AC is neither liberal nor conservative and makes use of all of the data instead of dropping the no difference counts. Moreover the power curves demonstrate that dropping the difference counts offers no advantage to the Thurstonian model even though its conclusions must be qualified. The Thurstonian 2-AC analysis can be conducted in IFPrograms™ and can also be evaluated using tables such as the one shown in Table 2. Table 2 is a subset of a larger set of tables for the Thurstonian 2-AC that can be accessed at www.ifpress.com.

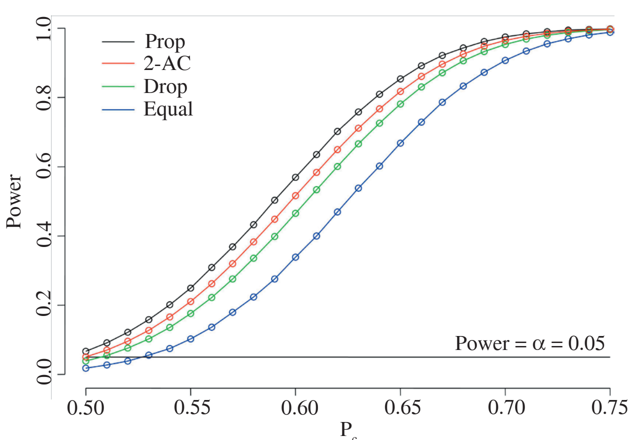

Figure 2. Power curves for four options with $n = 100$ and P(*No difference*) = 0.3.

Interpretation of Pilot Test Results: In the pilot test, there were 53 choice counts in favor of the decision that *A* is sweeter than *B* and 37 that *B* is sweeter than *A*. There were 10 no differences. According to Table 2, this result is significant at the 95% one-tailed level based on the Thurstonian model for the 2-AC. The

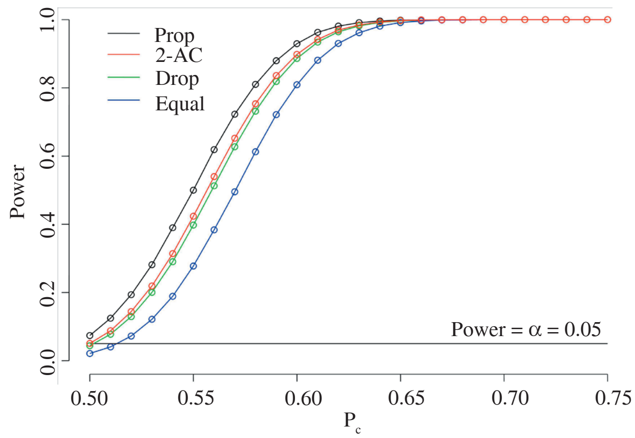

Figure 3. Power curves for four options with $n = 300$ and P(*No difference*) = 0.3.

more conservative equal splitting approach leads to a non signficiant difference ($p = 0.067$) and dropping the no difference counts is also not significant at the 95% level ($p = 0.057$). You conclude that there is a good basis for the position that your product is sweeter than your competitor and your next step is to plan a national test to explore this possibility further.

Sample Size	0	1	2	3	4	5	6	7	8	9
90	48	49	49	50	51	51	52	52	53	53
100	53	54	54	55	55	56	57	57	58	58
110	59	59	59	60	60	61	61	62	63	63
120	64	64	65	65	65	66	66	67	67	68
130	68	69	70	70	70	71	71	72	72	73
140	73	74	74	75	75	75	76	76	77	78
150	78	79	79	80	80	81	81	81	82	82

Table 2. Values of choice counts that must be met or exceeded to declare significance at the 95% level (one tailed) based on a Thurstonian 2-AC model when the observed no difference proportion is rounded up to 10%. Add the tens column entries to the unit row entries to determine sample size.

Conclusions: In this report we illustrated the differences between various treatments of no difference data using power curves and we showed that proportional splitting is not recommended due to its liberality. We also showed that dropping the no difference counts offers no power advantage over the Thurstonian 2-AC and can only support qualified statements. Finally we showed that the practice of equal splitting is conservative. Thus we conclude that although equal splitting is acceptable it is preferable for practitioners to apply the Thurstonian 2-AC model through either software or tables.