A COMPARISON OF A TRADITIONAL RANKING FORMAT TO A
DRAG-AND-DROP FORMAT WITH STACKING

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A COMPARISON OF A TRADITIONAL RANKING FORMAT TO A
DRAG-AND-DROP FORMAT WITH STACKING

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ABSTRACT

A COMPARISON OF A TRADITIONAL RANKING FORMAT TO A DRAG-AND-DROP FORMAT WITH STACKING

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This study investigated the differences between a modified version of the traditional ranking format (MTF) and a novel ranking format called the BINS format. The BINS format utilizes drag-and-drop technology to rank alternatives, allows respondents to indicate distance between ranks, and also allows respondents to assign ties to the same alternatives.

Seventy-two participants completed two ranking tasks: a ranking of items from the Rokeach Value Survey – Form D (RVS) and a ranking of aspects according to how important they were in a participant’s decision to attend the University of Dayton (UD). Participants used the MTF to complete one ranking task, and the BINS format for the other. Four variables were examined for each ranking format: Completion Time (as recorded by a computer control system and as self-reported by participants), Usability on the System Usability Scale (SUS), Format Preference, and Number of Repositionings (as recorded by a computer control system and as self-reported by participants).
Participants completed the RVS ranking task more quickly using the MTF when compared to the BINS format. There were no significant differences in completion time when participants ranked aspects related to UD. However, for both the RVS and aspects related to UD, significantly more participants self-reported that the BINS format allowed them to complete their ranking task faster than the MTF. Participants rated the BINS format as significantly more usable than the MTF. The majority of participants (78%) preferred to use the BINS format more than the MTF. Participants reported repositioning alternatives (ranking an alternative and then re-ranking the same alternative) significantly more often using the BINS format than the MTF. There was not a significant difference in actual repositionings between the MTF and the BINS format as reported by the computer control system.

Overall, the results of this study established that the BINS format is a clear improvement over the MTF. The BINS format outperformed the MTF on measures of usability, preference, and reported number of repositionings. Furthermore, the BINS format reduces respondent burden by displaying an ordered list of ranked alternatives throughout a ranking task. By capturing information on the distance between ranks and by permitting ties between alternatives, the BINS format allows researchers to collect rich ranking data that is also compatible with factor analytic techniques. These unique features of the BINS format make it an ideal tool for implementation in the field of electronic survey research.
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TABLE OF CONTENTS

ABSTRACT ........................................................................................................................................ iv

ACKNOWLEDGEMENTS .................................................................................................................. vi

LIST OF FIGURES ............................................................................................................................ x

LIST OF TABLES ............................................................................................................................... xii

I. INTRODUCTION ........................................................................................................................... 1

Benefits of Forced Ranking Scales .................................................................................................. 2
Limitations of Forced Ranking Scales .............................................................................................. 2
Forced Ranking Formats .................................................................................................................. 6
   Paper-based implementations of forced ranking ................................................................. 6
      Number assignment format ......................................................................................... 7
      Line drawing format .................................................................................................. 8
      Rokeach value survey (RVS) – form D .................................................................... 9
   Electronic implementations of forced ranking ................................................................. 11
      Modified traditional format .................................................................................... 12
      Drag and drop assisted ranking task ................................................................... 13
Other Strategies Which Yield Ranking Data ............................................................................... 16
   Point allocation technique .......................................................................................... 16
   Dense ranking .............................................................................................................. 17
   Rating scale ............................................................................................................... 19
   Paired comparisons format ........................................................................................ 21
   Card sort ...................................................................................................................... 22
   Visual analogue scale ............................................................................................... 23
The BINS Format ......................................................................................................................... 26
Overview of Present Studies ........................................................................................................ 32

II. METHOD ..................................................................................................................................... 33

Participants ..................................................................................................................................... 33
Materials ......................................................................................................................................... 33
   BINS format .................................................................................................................... 33
   Modified traditional format (MTF) ........................................................................... 35
Procedure ....................................................................................................................................... 36
E. BINS FORMAT, ELECTRONIC VERSION, EXPERIMENTAL TASK, UD ASPECTS .......................................................... 77
F. MTF, ELECTRONIC VERSION, EXPERIMENTAL TASK, UD ASPECTS ... 78
G. BINS FORMAT, ELECTRONIC VERSION, EXPERIMENTAL TASK, RVS .................................................................................. 79
H. MTF, ELECTRONIC VERSION, EXPERIMENTAL TASK, RVS .......... 80
I. MODIFIED SYSTEM USABILITY SCALE (SUS) ............................................. 81
J. PREFERENCE AND PROCEDURES QUESTIONNAIRE ............................. 82
K. DEMOGRAPHICS QUESTIONS .................................................................. 91
L. DEBRIEFING .......................................................................................... 92
M. NUMBER OF RECORDED REPOSITIONINGS BY RANKING FORMAT ... 95
N. PRELIMINARY STUDY BINS FORMAT, PAPER VERSION, EXPLICIT CONTINUUM .................................................................................. 96
O. PRELIMINARY STUDY BINS FORMAT, PAPER VERSION, IMPLICIT CONTINUUM .................................................................................. 97
P. PRELIMINARY STUDY ALTERNATIVES FOR EXPERIMENTAL TASK .. 98
Q. PRELIMINARY STUDY RANKING TASK INSTRUCTIONS ..................... 99
R. PRELIMINARY STUDY DECISION MAKING PROCESS QUESTIONNAIRE .................................................................................. 101
S. PRELIMINARY STUDY USABILITY SCALE .............................................. 104
T. PRELIMINARY STUDY SURVEY COMPLETION QUESTIONS ............. 107
# LIST OF FIGURES

1. Number assignment format........................................................................................................... 8
2. Line drawing format........................................................................................................................ 9
3. Illustration of the Rokeach Value Survey (RVS) – Form D...................................................... 10
4. Modified traditional format........................................................................................................... 13
5. Drag and drop assisted ranking task .......................................................................................... 15
6. Point allocation technique........................................................................................................... 17
7. Number assignment format/dense ranking comparison............................................................. 18
8. Rating scale................................................................................................................................... 19
9. Paired comparisons format .......................................................................................................... 22
10. Illustration of a partially completed card-sorting task with instructions.............................. 23
11. VAS scales................................................................................................................................. 24
12. Illustration of a computerized VAS with a moveable response mark..................................... 26
13. BINS format.............................................................................................................................. 27
14. BINS stacking............................................................................................................................. 29
15. BINS format, electronic version, UD Aspects task................................................................. 34
16. MTF, electronic version, UD Aspects task................................................................................ 36
17. Participant protocol..................................................................................................................... 39
18. Completion time of each task by format at Time 1 .................................................................... 43
19. Completion time of each task by format at Time 2 ................................................................. 44
20. SUS score of each format by task at Time 1.................................................................46
21. SUS score of each format by task at Time 2.................................................................47
22. Number of participants’ recorded repositionings by format...........................................49
23. Number of participants reporting repositionings by format. ........................................50
24. Completion time at each time series by format. ..............................................................53
# LIST OF TABLES

1. Comparison of Features between Ranking Formats .............................................31
2. Metrics and Methods of Measurement .................................................................40
3. Mean Task Completion Time (in Seconds) ............................................................43
4. Reported Ranking Task Speed by Format ............................................................44
5. Mean System Usability Scale (SUS) Scores ..........................................................46
6. Subjective Format Usability ..................................................................................47
7. Number and Percent of Respondents Preferring MTF, BINS, or Neither Format ......48
8. Descriptive Statistics for Number of Recorded Repositionings by Ranking Format.. .49
9. Summary of Findings .............................................................................................51
A1. Continuum Preference ..........................................................................................67
A2. Question 14 Results - Does stacking indicate an equivalent rank? ....................68
A3. Stacking Questions Results ..................................................................................69
A4. Question 16 Results - Did participants consider a numeric relationship between bins? .................................................................................................................69
A5. Question 13 Results - Is the relationship between bins multiplicative? ............71
A6. Question 15 Results - Is the relationship between bins divisible? .......................72
CHAPTER I
INTRODUCTION

A forced ranking scale requires respondents to order a set of researcher-provided alternatives. Respondents assign a rank value (usually a whole number from 1 to X, where X is the total number of alternatives to rank) based upon a continuum provided by the researcher. Each rank value can only be used once. This scale provides information about the relative relationships among the alternatives (Krosnick, 1999; Alreck & Settle, 2004). However, a forced ranking scale is incompatible with factor analysis, produces only ordinal data, does not allow respondents to express a tie between alternatives, and requires a high cognitive effort from respondents during completion. These limitations restrict the forced ranking scale’s utility in survey research.

The purpose of the present study was to develop and evaluate a new ranking format that addresses these limitations. This chapter is divided into four sections. First, the above-mentioned benefits and limitations of forced ranking scales are examined in detail. Second, the specific formats that employ forced ranking are explored. Third, ranking strategies other than forced ranking are reviewed. Finally, an overview of the present study is presented.
Benefits of Forced Ranking Scales

A major benefit of forced ranking is that it mirrors real-life situations common to all respondents (Alreck & Settle, 2004). When shopping for peanut butter at the grocery store, an individual must make a choice between several brands. A forced ranking scale can help a researcher understand what that choice is likely to be. As alternatives are ranked in relation to one another, ranking scales offer a unique perspective on the opinions, preferences and attitudes of respondents (Dillman, Smyth, & Christian, 2009).

Limitations of Forced Ranking Scales

Although forced ranking scales can be powerful research tools, they are not without their limitations. First, a forced ranking scale produces ordinal data, and therefore does not provide information about the interval between alternatives. Second, forced ranking scales are ipsative and therefore cannot be analyzed using factor analysis. Third, ties between alternatives are not permitted, and therefore, the information a researcher can obtain from a participant is limited. Fourth, the cognitive effort required to complete a forced ranking task is large, and may adversely affect the responses given by a participant. Finally, forced ranking scales have been shown to be impacted by response order effects.

The data produced by a forced ranking scale are ordinal in type (Alreck & Settle, 2004). Due to the nature of ordinal data, information about the distance between alternatives is limited. For example, consider a respondent that ranks three alternatives. The alternative that is ranked highest may be preferred over the other two ranked alternatives, but the scale provides no information regarding the magnitude of that preference. It is possible that the alternative ranked highest is preferred much more than
the alternatives that are ranked second and third. It is also possible that a respondent’s preference for the alternatives ranked first, second, and third varies only slightly in magnitude. As a forced ranking scale is not sensitive enough to detect these differences, potentially valuable information about the interval relationships between alternatives is ignored. Therefore, the statistical procedures that are available for examining ordinal data are limited to those that do not require equal intervals (Alreck & Settle, 2004).

A second limitation of forced ranking is that the format is incompatible with factor analysis due to the ipsative nature of the scale. First explored by Cattell (1944), the term “ipsative measure” refers to a scale in which the scores of the scale are dependent on the other scores within the same measure. When the scores of an ipsative measure are summed, each participant’s total is equal to the total of each other participant (Brady, 1990; Dunlap & Cornwell, 1994). In the case of ranking, alternatives are given a score (rank) relative to all other alternatives. When one alternative is given the rank of “first,” all other alternatives are scored relative to the “first” alternative. As these rankings are not independent of one another, the forced ranking method of measurement is ipsative (Hino & Imai, 2008). This dependent nature of forced ranking results in a negative correlation between the ranked items (Dunlap & Cornwell, 1994). When using factor analysis to analyze ipsative measurements, the negative correlations elicited by an ipsative measure bias the results, thereby making any underlying relationships between the variables unclear (Dunlap & Cornwell, 1994).

A third limitation of forced ranking is that the scale can only be used in situations where ties between alternatives are not allowed. When using a forced ranking scale, a respondent has no way to indicate that two alternatives are equal. If a participant values
two alternatives to the same degree, they are required to rank one alternative higher than the other. In cases such as these, the distinction between the two alternatives is arbitrary, and the data do not reflect the respondent’s true opinion.

A fourth limitation of forced ranking concerns the cognitive effort required to complete the format. Respondents completing a forced ranking scale must use considerable mental resources to evaluate and reorder alternatives (Alreck & Settle, 2004; Stern, 2006; Dillman et al., 2009). The total cognitive demand of a forced ranking task is the sum of two components. First, forced ranking tasks are demanding because each of the alternatives is ranked in relation to one another (Stern, 2006). Consider a scenario in which a researcher asks a participant to rank five alternatives. When deciding the rank of an individual alternative, participants must compare that alternative to each of the other four alternatives to be ranked. For this reason, the cognitive demands of the forced ranking task increase as the number of alternatives to be ranked increase (Stern, 2006). If the number of alternatives to be ranked in the previous example was increased from five to six, the number of comparisons a respondent must make will increase. To determine an individual alternative’s rank, each alternative must now be compared to each of the five other alternatives (rather than four). Due to the high cognitive requirement elicited by a large number of alternatives, it is important to limit the number of alternatives that the respondent is asked to rank (Alreck & Settle, 2004; Dillman et al., 2009). To ensure that the ranking task is not too cumbersome for the respondent, Alreck and Settle (2004) recommend that the number of alternatives to be ranked should be less than 10.

A second cognitive difficulty that respondents face when completing a forced ranking task is that they must carry information from the question prompt to the list of
alternatives to be ranked (Stern, 2006). While evaluating alternatives, respondents must remember the continuum along which they are being asked to rank the alternatives (from “Least Preferred” to “Most Preferred,” for example). Additionally, respondents must remember the directionality of the continuum (for example: if a score of “1” represents “Most Preferred” or “Least Preferred”). If a respondent confuses either of these items, then the data produced by that respondent are invalid.

The high cognitive load imposed by forced ranking scales also limits the modalities in which forced ranking scales can be administered. Most notably, the limits of short-term memory prevent ranking tasks from being administered verbally. Short-term memory has a capacity of seven plus or minus two units (Miller, 1956). Should the alternatives and instructions provided to the respondent exceed this capacity, respondents will not be able to accurately evaluate the alternatives, and will not provide an accurate ranking. For this reason, ranking surveys cannot be easily administered over the phone (Ovadia, 2004).

Fifth, recent research suggests that forced ranking scales are susceptible to response order effects. Response order effects occur when the presentation order of alternatives affects the distribution of responses. Stern (2006) presented participants with a ranking task. In one condition, participants were asked to rank eight alternatives from “Largest Problem” to “Smallest Problem,” with a score of “1” representing the “Largest Problem.” In the second condition, the order in which the eight alternatives were presented was changed. The first two alternatives from Condition 1 became the last two alternatives for Condition 2. The last two alternatives from Condition 1 became the first two alternatives for Condition 2. The middle four alternatives were consistent across both
conditions. The researcher found that when response items appeared on the top of the list, participants assigned these options a score of “1” significantly more often than when the same option appeared on the bottom of the list of alternatives. For this reason, it is important to randomize alternatives when administering a forced ranking scale (Dillman et al., 2009).

**Forced Ranking Formats**

A variety of formats have been developed to obtain forced ranking data from participants. These formats can be broken into two general categories: paper-based implementations of forced ranking and electronic implementations of forced ranking. Paper-based formats include the number assignment format, the line drawing format, and the Rokeach Value Survey – Form D (RVS). Electronic formats include the modified traditional format and the drag and drop assisted ranking task. A description of each format (including associated benefits and limitations) is provided below.

**Paper-based implementations of forced ranking.**

In the realm of survey research, one of the most common methodologies for obtaining information from a respondent is the use of paper-based questionnaires (de Leeuw, Hox, & Dillman, 2008; Dillman et al., 2009). Once respondents understand the instructions of a paper-based rank task, they can then complete their task in the absence of an interviewer (de Leeuw et al., 2008). Additionally, since most respondents have experience completing paper-based forms, the effort required to teach respondents how to complete a paper-based questionnaire is low (de Leeuw et al., 2008).

Paper-based forced ranking scales are not without their drawbacks. As respondents are responsible for their own error-checking, paper-based rankings are
susceptible to human error. If respondents misunderstand or fail to read the instructions of their questionnaire, they might provide an invalid ranking. For example, a respondent completing a forced ranking task might rank an alternative as 11 when the instructions only allow for a ranking between 1 and 10. The respondent may also neglect to rank all possible alternatives, leaving the task incomplete. Also, the respondent may accidentally assign the same rank to two alternatives. An additional drawback of paper-based rankings is that researchers must manually data enter all respondents’ rankings (Gosling, Vazire, Srivastava, & John, 2004). Depending on the amount of data that needs to be entered, this process can be very time consuming.

**Number assignment format.**

The number assignment format, shown in Figure 1, presents a list of alternatives to respondents. Next to each alternative is a blank space. In each of these blank spaces, respondents are asked to write the ranking that they believe best corresponds to the alternative that they are evaluating. If respondents wish to change a previously-written ranking, they must erase or mark out the previous ranking and write in a new one. The task of repositioning alternatives can be particularly cumbersome for this format as the rankings are mutually exclusive (Karth, 2011). For example, if a respondent wishes to change the rank of an alternative from fourth to first, the respondent will need to erase and re-rank all alternatives between the first and fourth ranks.
Please rank each cookie type in order of preference. Place a 1 in front of your most preferred, a 2 in front of your second most preferred, and so forth.

4  Sugar
1  Chocolate Chip
3  Peanut Butter
2  Oatmeal Raisin
___ Ginger

*Figure 1.* Number assignment format.

**Line drawing format.**

The line drawing format, shown in Figure 2, presents two columns to respondents: a column of alternatives, and a column of all possible ranks. Respondents draw a line from the alternative to the rank that they believe best corresponds to the alternative that they are evaluating. Rankings in the line drawing format are also mutually exclusive, and place the same repositioning burden on respondents as the number assignment format (Karth, 2011). The line drawing format is especially useful because the ranks are provided to the respondent and are listed in order. When using the number assignment format, participants must provide the ranks on their own. Additionally, when respondents complete their ranking task using the line drawing format, the respondents can easily see which ranks have not yet been used.
Please rank each cookie type in order of preference. Draw a line from your most preferred cookie type to 1, your second most preferred to 2, and so forth.

<table>
<thead>
<tr>
<th>Cookie Type</th>
<th>Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>1</td>
</tr>
<tr>
<td>Chocolate Chip</td>
<td>2</td>
</tr>
<tr>
<td>Peanut Butter</td>
<td>3</td>
</tr>
<tr>
<td>Oatmeal Raisin</td>
<td>4</td>
</tr>
<tr>
<td>Ginger</td>
<td>5</td>
</tr>
</tbody>
</table>

*Figure 2. Line drawing format.*

**Rokeach value survey (RVS) – form D.**

Rokeach (1973) developed a mail-based questionnaire asking respondents to rank 18 alternatives relating to human values. 18 empty boxes line the left-hand side of the page, with each box numbered between 1 and 18. The 18 human values alternatives are listed on the right-hand side of the page in alphabetical order. Respondents are asked to rank the 18 alternatives in order of importance, with an alternative in Box 1 indicating that it is the most important alternative in the list and an alternative in Box 18 indicating that it is the least important alternative in the list. Each alternative is presented on a removable gummed label. Respondents indicate an alternative’s rank by peeling an alternative from the right-hand side of the page and manually pasting it into one of the boxes on the left-hand side of the page. Additionally, the gummed adhesive on the back of each alternative allows for alternatives to be removed and repositioned even after they are affixed to a box on the left-hand side of the page. The survey’s instructions encourage respondents to rearrange their alternatives if they so desire. An example of a participant completing Form D is shown in Figure 3.
Rokeach’s (1973) method offers several improvements over traditional paper-based ranking tasks. First, respondents are able to see ranked alternatives in relation to one another. As respondents are directly affixing an alternative onto a desired rank (instead of assigning the alternative a number), they are more clearly reminded of the current position of the other items that they have already ranked. Having this information readily available reduces the mental effort required of respondents (Dillman et al., 2009). Additionally, the ability to reposition response items easily within the left-hand side of the page encourages respondents to edit their rankings so that the rankings accurately reflect respondents’ actual beliefs.
The Rokeach Value Survey – Form D (Rokeach, 1973) also has drawbacks. Since the form is not commonly used in survey research, thorough instructions are required to ensure that respondents know how to complete the measure properly. Additionally, it is possible that the gummed labels could lose their adhesion and fall off after being completed by respondents, causing respondents’ data to be lost.

**Electronic implementations of forced ranking**

The emergence of computers and the Internet has profoundly affected distribution and data collection in the realm of survey research. Many of the drawbacks of paper-based ranking scales are ameliorated by using electronic versions of the scale. While it is difficult for a ranking scale to be administered over the telephone, electronic ranking scales can be easily distributed to any respondent with a computer and access to the Internet. As an additional benefit, electronic versions of ranking scales provide for a certain degree of error checking (Baker, Crawford, & Swinehart, 2004). If respondents have not ranked all items in an electronic ranking task or have provided an invalid ranking, the program can prompt respondents to finish or correct their ranking task before proceeding to the next question. Another major advantage of using computer-based questionnaires is that researchers do not need to pay for paper copies of a questionnaire. Computer-based surveys are therefore much more inexpensive to administer than paper-based surveys (Van Selm & Jankowski, 2006). Data from computer-based surveys are often collated automatically by the survey itself, eliminating the need for a researcher to manually enter respondents’ data. This offers a substantial time savings over paper-based surveys (Gosling et al., 2004). Using recruiting websites like Amazon’s Mechanical
Turk, the Internet also gives researchers swift access to inexpensive, reliable, and demographically diverse participant pools (Buhrmester, Kwang, & Gosling, 2011).

Although electronic surveys present substantial benefits to researchers, it is important to evaluate the ways in which the medium might affect the survey’s results (Dillman et al., 2009). Technical problems may plague respondents’ online questionnaire-completion experience. A very slow internet connection may prevent potential respondents from loading their questionnaire. Internet browsers may crash in the middle of completing a questionnaire and respondents may not be able (or want) to resume answering questions where they left off. Respondents that are new to using computers may not understand how to complete questions asked in an electronic format properly.

**Modified traditional format.**

The Modified Traditional Format (MTF; Figure 4) is an electronic implementation of the number assignment format (Karth, 2011). Respondents are presented with a list of alternatives, but instead of writing their rank next to the alternative by hand, respondents type in their desired rank using a keyboard. This electronic format provides error checking for invalid rankings, duplicate rankings, and missing rankings. Like its number assignment counterpart, alternatives in the MTF are mutually exclusive. Similar to the number assignment format and the line drawing format, repositioning alternatives using the MTF places a large cognitive burden on respondents if several alternatives have to be repositioned to accommodate a new ranking. For example, if respondents wish to change the rank of an alternative from
fourth to first, they will need to use the keyboard to erase and reposition all alternatives between the first and fourth ranks.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Chocolate Chip</td>
</tr>
<tr>
<td>3</td>
<td>Oatmeal Rasin</td>
</tr>
<tr>
<td>1</td>
<td>Sugar</td>
</tr>
<tr>
<td></td>
<td>Ginger</td>
</tr>
<tr>
<td>3</td>
<td>Peanut Butter</td>
</tr>
</tbody>
</table>

Submit

Figure 4. Modified traditional format.

*Drag and drop assisted ranking task.*

The Drag and Drop Assisted Ranking Task (DDART; Figure 5) is an electronic forced ranking scale that uses drag and drop technology (Karth, 2011). Drag and drop technology allows users to manipulate objects in an electronic environment (Neubarth, 2010). A geometric figure (containing text, pictures, or both) can be dragged by users from one location on the screen and dropped in another location. To grab an object, users hover over it with the mouse and hold down a “grab” button (usually the left mouse button). While holding down the grab button, the object can be moved by the mouse to another location on the screen. The object is dropped by releasing the grab button.
When using the DDART, respondents are given an option column that is populated with alternatives to rank. An adjacent response column contains the same number of cells as the option column, but each cell is blank. The blank cells are numbered sequentially. Using a mouse, respondents click an alternative from the option column and drag it to the cell in the response column that contains the numerical rank the respondents wish to assign to that alternative. Alternatives in the response column can be repositioned by dragging and dropping the alternative to a new ranking. Other alternatives in the response column shift up or down to accommodate a repositioned alternative’s new rank.

Karth (2011) compared the DDART format to the MTF on several dimensions. The DDART and the MTF did not differ significantly in the amount of time it took to complete the ranking task. However, participants felt subjectively that their ranking task was completed faster when using the DDART format. Participants indicated a significantly higher preference for the DDART when compared to the MTF. Each alternative’s rank on the MTF significantly correlated to its DDART rank, indicating that the information obtained by the DDART is similar to the information obtained by the MTF (the significance of all correlations was < .005). The researcher also examined ratings, and found that alternative ratings were significantly related to both the MTF and DDART rankings, further indicating that the data obtained by each of the two methodologies were similar ($r = .515$ for MTF rankings and ratings; $r = .535$ for DDART rankings and ratings).

One factor possibly affecting the outcome of Karth’s (2011) study is related to the DDART’s ability to reposition ranked alternatives. Respondents could not reposition
alternatives within the response column until all alternatives in the options column had been ranked. This meant that if a participant moved an alternative from the options column to the response column cell that indicated a rank of “2,” the participant could not change the rank of that alternative in the response column until all other alternatives from the options column have been moved to the response column. It is possible that participants would have made more adjustments to their rankings if they had been able to do so throughout the entire task.

Before we move on to the next question, I would like to familiarize you with our ranking procedure, by using the following example. For the following question I ask you to rank five different types of cookies from your most favorite to your least favorite. There are 5 cookies in total to rank. Please place the type of cookie you like the most in the 1st position, the type of cookie you like the 2nd most in the 2nd position, and so on until all the types of cookies have been ranked. This is accomplished by dragging and dropping the various types cookies. Click and hold the left mouse button on a cookie type and drag it to desired rank position in the adjacent column. Release the mouse button to drop the type of cookie in the desired position. Once all types of cookies have been ranked, changes can be made. Changes can be made by dragging the type of cookie you wish to move up or down to the position you prefer. Types are cookies that are not being moved will slide or up or down depending on where you reposition your selected cookie type. Once you are satisfied with the rankings, please click the submit button to continue. You may also click the reset button if you wish to start over.

<table>
<thead>
<tr>
<th>Option column</th>
<th>Response column</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oatmeal Rasin</td>
<td>1. Sugar</td>
</tr>
<tr>
<td></td>
<td>2. &lt;empty&gt;</td>
</tr>
<tr>
<td>Ginger</td>
<td>3. &lt;empty&gt;</td>
</tr>
<tr>
<td>Peanut Buttor</td>
<td>4. Chocolate Chip</td>
</tr>
<tr>
<td></td>
<td>5. &lt;empty&gt;</td>
</tr>
</tbody>
</table>

Submit

*Figure 5. Drag and drop assisted ranking task.*
Other Strategies Which Yield Ranking Data

Although the forced ranking scale is a common method for obtaining ranking data, it is not the only strategy available to researchers. Other scales exist that provide ranking data, but such scales do not necessarily prohibit ties between two alternatives to be ranked. Examples of these scales (including the point allocation technique, dense ranking, rating scales, paired comparisons, card sort, and the visual analog scale) are described in detail in the following section.

Point allocation technique.

Duffy and Webber (1974) describe a Point Allocation Technique (PAT; Figure 6) for ranking alternatives in relation to one another. In this format, respondents are given a total number of “points” that can be distributed among alternatives any way they wish. For example, a respondent is given 100 points to allocate among three alternatives. The respondent allocates 50 points to the highest ranked alternative, 30 points to the second highest alternative, and 20 points to the lowest ranked alternative. Duffy and Webber (1974) point out that this technique should only be used for lists with a small number of alternatives. A large number of alternatives can result in a large cognitive burden to participants as they will be required to keep a running tally of how many points have been used and how many points are unallocated.

PAT is not considered a forced ranking format as it offers respondents the ability to communicate a tie between two alternatives. This can be accomplished by assigning the same number of points to two alternatives. Additionally, researchers can gain some insight into the magnitude of the relationship between two alternatives. By assigning 50 points to the highest alternative and 30 points to the second highest alternative, the
respondent has communicated not only the relative rank of two alternatives, but also the distance between the two alternatives.

| Please distribute 100 points among these cookies based on your preference. |
| --- | --- | --- | --- | --- |
| 10  | Sugar | 60  | Chocolate Chip | 5  |
|      | Peanut Butter | 5  | Oatmeal Raisin | 20 |

*Figure 6. Point allocation technique.*

**Dense ranking.**

Dense ranking is a task similar to forced ranking in that respondents are asked to order a set of alternatives on some specified continuum. Unlike forced ranking tasks, two alternatives in a dense ranking task can share the same rank should their importance within a list of alternatives be equal to one other (Allen, Bryla, & Kuhn, 2009). For example, two equal alternatives would share the rank value of “2” if they were both the second most important values in a particular list of alternatives. The alternative that is the third most important (i.e., the alternative that would be ranked after the two second-place alternatives) would be given a rank value of “3.” Tied rankings require special consideration when analyzing data. For example, calculation of the Spearman rank-order correlation coefficient must incorporate a correction factor if dense ranking is used. Dense ranking is most commonly used in database administration (Allen et al., 2009).
The following example demonstrates the difference between forced and dense ranking. A respondent is asked to rank four cookie flavors (Sugar, Chocolate Chip, Peanut Butter, and Oatmeal Raisin). The respondent prefers Chocolate Chip the most, then has an equal preference for both Peanut Butter and Oatmeal Raisin, and prefers Sugar the least. If the respondent were asked to describe his or her preference using the number assignment format, the response could be one of two possibilities. If the respondent were to assign Oatmeal Raisin the higher rank arbitrarily, the ranking would match Figure 7a, Possibility 1. If the respondent were to assign Peanut Butter the higher rank arbitrarily, the ranking would match Figure 7a, Possibility 2. Using a dense ranking task, the respondent would be able to describe the tie between Peanut Butter and Oatmeal Raisin, and create a ranking that reflects his or her true opinion (See Figure 7b).

<table>
<thead>
<tr>
<th>7a. Number Assignment Format</th>
<th>Possibility 1</th>
<th>Possibility 2</th>
<th>7b. Dense Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Sugar</td>
<td>4</td>
<td>Sugar</td>
</tr>
<tr>
<td>1</td>
<td>Chocolate Chip</td>
<td>1</td>
<td>Chocolate Chip</td>
</tr>
<tr>
<td>3</td>
<td>Peanut Butter</td>
<td>2</td>
<td>Peanut Butter</td>
</tr>
<tr>
<td>2</td>
<td>Oatmeal Raisin</td>
<td>3</td>
<td>Oatmeal Raisin</td>
</tr>
</tbody>
</table>

*Figure 7. Number assignment format/dense ranking comparison. This figure illustrates two possible rankings using the number assignment format, as well as its corresponding dense ranking.*

By allowing ties between two alternatives, researchers may gain knowledge of a respondent’s true ranking, but they lose one piece of information uniquely offered by forced ranking scales: when alternatives are tied in ranking, which of those alternatives would respondents pick if they were forced to make a choice? If a researcher is solely
interested in predicting what selection a respondent will make between two alternatives, forced ranking is more appropriate than dense ranking. However, if a researcher is interested in learning how a respondent sees alternatives in relation to one another, dense ranking is a more appropriate choice.

**Rating scale.**

Rating scales, shown in Figure 8, are one of the most popular types of questions used in surveys (Dillman et al., 2009). Rating scales are close-ended measures that ask respondents to evaluate an item on a given continuum (Alreck & Settle, 2004; Dillman et al., 2009). For example, respondents could be asked to rate the item of “maid service” at a hotel along the continuum of “very satisfied” to “very dissatisfied.” One of the most common implementations of the rating scale is the Likert-type scale, which asks respondents to describe their level of agreement or disagreement with a certain issue or opinion (Alreck & Settle, 2004).

<table>
<thead>
<tr>
<th></th>
<th>Strongly prefer</th>
<th>Prefer</th>
<th>Neither prefer nor do not prefer</th>
<th>Do not prefer</th>
<th>Strongly do not prefer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Chocolate Chip</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Peanut Butter</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Oatmeal Raisin</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Ginger</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

*Figure 8. Rating scale.*

A significant benefit of a rating scale is that it can yield equal interval data (Alreck & Settle, 2004). This allows a researcher to explore the absolute distance
between options. Rating scales are also valued for being simple and easy to understand by respondents (Alreck & Settle, 2004; Ovadia, 2004). Use of a rating scale can shorten the length of a questionnaire as many survey items can share the same instructions and continuum. As items are presented individually, respondents can easily evaluate each item without having to compare it to other alternatives in a list (Ovadia, 2004).

Rating scales, however, are not without their drawbacks. Rating scales are particularly susceptible to response bias (Alwin & Krosnick, 1985; Krosnick, 1999; Hino & Imai, 2008). In a 1999 meta-analysis, Knauper found that an increase in age is related to higher response bias when completing rating scales. Older participants, when compared to younger participants, were more likely to be influenced by the order in which alternatives were presented. Ovadia (2004) found that rating scales allow respondents that are not highly motivated to proceed quickly through a questionnaire by providing the same response for all rating questions. This “non-differentiation” reduces the validity of a survey’s results.

Rating scales can be used in lieu of a ranking scale to determine ranking information (Krosnick, 1999; Alreck & Settle, 2004; Hino & Imai, 2008). Using this method, respondents rate a series of individual options along the same continuum. The ratings for each item are used to derive the overall ranking of the alternatives. Krosnick’s (1999) meta-analysis outlined several studies assessing the benefits of using rating scales over ranking scales. Ranking scales, in general, take longer to complete than rating scales. Additionally, respondents enjoy completing rating scales more than ranking scales, and believe that rating scales are more valid than ranking scales. Rating scales
have the added benefit of being easily administered over the telephone, whereas ranking scales do not (Alwin & Krosnick, 1985).

Rating scales, however, fall short of ranking scales in several ways. According to Krosnick’s 1999 review, survey respondents are more likely to fail to answer a question using a rating scale than a ranking scale. Rankings are more reliable than rating scales (Krosnick, 1999). Ranking scales also have higher discriminant validity than rating scales. Although it was previously mentioned that rating scales can be completed more quickly than ranking scales, it does not necessarily follow that a quick completion time is a virtue of a rating scale. The quality of the data produced by a rating scale may not be as high as the quality of the data produced by a ranking scale (Alwin & Krosnick, 1985). If a rating task is easy to complete, participants may not be willing to consider how the rating of an individual item relates to the rating of other items (Feather, 1973). Ranking scales require respondents to rank all alternatives at the same time, thereby forcing them to consider the relative relationships between alternatives. Therefore, the higher speed at which ratings are completed may come at the cost of the precision of the data obtained by the scale.

**Paired comparisons format.**

A paired comparison, shown in Figure 9, offers respondents a choice between two alternatives (Alreck & Settle, 2004). Like a forced ranking, paired comparisons ask respondents to give information about the relative relationship between alternatives, but only two rankings are obtained at a time. Like forced ranking, paired comparisons produce ordinal data.
Although one might assume that a researcher can infer ranking by using paired comparisons for a group of alternatives, such is not always the case. For example, when completing a paired comparisons format task, a respondent might report preferring oatmeal cookies to chocolate chip cookies, and chocolate chip cookies to peanut butter cookies. However, it does not always hold that a respondent will prefer oatmeal cookies to peanut butter cookies (Alreck & Settle, 2004).

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>✓</td>
</tr>
<tr>
<td>Chocolate Chip</td>
<td></td>
</tr>
<tr>
<td>Chocolate Chip</td>
<td></td>
</tr>
<tr>
<td>Peanut Butter</td>
<td>✓</td>
</tr>
<tr>
<td>Sugar</td>
<td>✓</td>
</tr>
<tr>
<td>Oatmeal Raisin</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 9. Paired comparisons format.*

**Card sort.**

In a card sort (shown in Figure 10), respondents are given several cards that each have an alternative written on it. Respondents are asked to rank the cards by placing them in a vertical column. The top of the column represents the highest rank, and the bottom of the column represents the lowest rank. Like the Rokeach Value Survey – Form D and the electronic drag and drop format, respondents can quickly and easily re-rank alternatives. Respondents can also easily see all items in relation to one another, easing the cognitive load. As the card sort is a manual task, it can be time consuming for researchers to code
respondents’ data. Additionally, extensive production costs and preparation time make the card sort task impractical for use with a large sample (Karth, 2011).

Figure 10. Illustration of a partially completed card-sorting task with instructions.

**Visual analogue scale.**

The visual analogue scale (VAS) is a vertical or horizontal line that is anchored on both ends by the poles of the variable being measured (Svensson, 2000). The variable itself can be expressed on either a unipolar scale (sometimes called a mono-polar scale) or a bipolar scale (Wewers & Lowe, 1990; Svensson, 2000; Couper, Tourangeau, & Conrad, 2006). A unipolar scale is used to represent a continuum ranging from “completely absent” to “most extreme.” For example, the anchors of a unipolar VAS for the variable of pain would read “No Pain” and “Unbearable Pain” (see Figure 11a
below). A bipolar scale measures a variable using two opposing adjectives. For example, the anchors of a bipolar VAS for the variable of pain would read “Extremely Comfortable” and “Extremely Painful” (see Figure 11b below). A VAS using a unipolar scale is preferred over a VAS using a bipolar scale as participants often find bipolar scales more difficult to understand than unipolar scales (Wewers & Lowe, 1990).

Respondents indicate their response on a VAS by making a mark on the line at the point that most resembles their position on the continuum. The locations of respondents’ marks are measured in relation to one end of the scale (Wewers & Lowe, 1990; Couper et al., 2006). This measurement represents the respondents’ scores on the scale, and is usually recorded in millimeters (Wewers & Lowe, 1990).

![Figure 11. VAS scales. Illustration of a VAS with both a Unipolar and a Bipolar Scale](image)

The ideal physical length of a VAS is 10 centimeters (3.94 inches; Wewers & Lowe, 1990). Additionally, a horizontal VAS is preferred over a vertical VAS because
the scores obtained using a horizontal VAS are distributed more uniformly than the scores obtained by using a vertical VAS (Scott & Huskisson, 1976). Each end of the VAS should be accented by a perpendicular line, forming a right angle “stop” (Huskisson, 1983). Other end caps (such as arrows) are less effective as they fail to indicate unquestionably where the continuum begins and ends. This confusion can lead to respondents making a response mark beyond the ends of the line. The verbal anchors of a scale should be placed past the right angle stops, putting them outside of the VAS continuum. The VAS can yield ranking data similar to the way in which rating scales yield ranking data. Respondents are asked to complete a series of individual VAS tasks using an identical continuum. The numerical responses from each VAS task can be ordered to derive the overall ranking of the alternatives.

The VAS is not commonly used in the field of survey research, but is more often used in the fields of healthcare and health research (Wewers & Lowe, 1990; Couper et al., 2006). The visual nature of the VAS prevents it from being administered over the telephone. Additionally, a large amount of time is required to score a VAS because a respondent’s mark must be carefully measured (Couper et al., 2006). However, the availability of electronic questionnaires mitigates these criticisms of the VAS. Computerized versions of the VAS (see Figure 12 below) can easily be distributed via web links and e-mail, allowing for the remote administration of a VAS. Additionally, the location of a respondent’s mark relative to the endpoint can be measured and recorded automatically by the computer administering the VAS. This obviates the time-consuming practice of having researchers manually measure respondents’ marks on the VAS. The
VAS can also be programmed into smaller electronic devices such as cell phones, making the VAS portable (Kreindler, Levitt, Woolridge, & Lumsden, 2003).

![Figure 12. Illustration of a computerized VAS with a moveable response mark.](image)

In a 2006 study, Couper and colleagues compared an electronic VAS to an electronic Likert-type scale (examining two types of input: radio buttons and a direct-type input field). The researchers found that Cronbach’s alpha values for the three input types were not significantly different. However, when comparing completion time among the three types of input, the researchers found that it took participants significantly longer to complete a VAS than it did to complete a single Likert-type question via radio buttons or direct-type input.

**The BINS Format**

The BINS format (Figure 13) is a new electronic ranking system designed to address many of the problems associated with the forced ranking format. Respondents interact with the BINS format via drag and drop technology. In order to rank an alternative, respondents drag an item from the alternatives list and drop it into one of several “bins.” When an alternative is moved from the alternatives list and dropped into a
bin, this ranked alternative is removed from the alternatives lists. This collapsing list of alternatives allows respondents to quickly see which alternatives are left to rank.

![Figure 13. BINS format. Illustration of the BINS format with 5 bins and 5 alternatives.]

The bins are numbered, vertical columns of equal length and height. These bins are arranged along a horizontal continuum and are anchored on both ends by the variable being measured. If a respondent places an alternative in the bin closest to the label of...
“Most Favorite,” that respondent is indicating that they like that alternative the most. By placing an alternative in the bin closest to the label of “Least Favorite,” a respondent is indicating that they like that alternative the least.

By placing the poles of the variable being measured directly on the continuum, the BINS format obviates the need for respondents to remember information such as the directionality of the continuum or the poles of the continuum from the ranking task instructions. As alternatives are ranked along a continuum contained within a single page, respondents have a “clear picture” of the position of alternatives that have already been ranked. In combination, these features of the BINS format reduce the cognitive burden placed on respondents who are completing a ranking task. Unlike most other ranking formats, respondents using the BINS format can indicate an equivalent rank by stacking alternatives on top of one another within the same bin (Figure 14). Each bin can have as many or as few alternatives in them as a respondent desires. A preliminary study using a paper version of the BINS format confirmed the utility and intuitiveness of stacking (Timbrook, 2011). As more than one alternative can receive the same rank, the summation of a particular respondent’s scores will not necessarily equal the sum of each other respondent’s scores. This means that the BINS format is not an ipsative measure.
Figure 14. BINS stacking. This figure illustrates two alternatives stacked on top of one another to indicate an equivalent rank of “3” using the BINS format.

Using the BINS format, respondents can also communicate distance between two alternatives. For example, consider 2 respondents that are asked to rank three alternatives from “Most Important” to “Least Important” using the BINS format. One respondent might drop Alternative A in the first bin, Alternative B in the second bin, and Alternative C in the third bin. Another respondent might drop Alternative A in the first bin, Alternative B in the third bin, and Alternative C in the fourth bin. Both respondents are indicating a rank of 1 to Alternative A, a rank of 2 to Alternative B, and a rank of 3 to Alternative C. However, the first respondent is indicating that Alternatives A, B and C are equally spaced in preference, but the second respondent is indicating that Alternative B is closer to Alternative C than to Alternative A in preference. A preliminary study using a paper version of the BINS format confirmed the intuitiveness of this design (Timbrook, 2011).
In order to reposition an alternative, respondents drag an alternative from one bin and drop it into another bin. When an alternative is removed from a bin, all other alternatives left in the source bin shift to the bottom of the bin. Unlike many other ranking formats, repositioning with the BINS format does not require respondents to reposition more than one previously ranked alternative.

Table 1 summarizes the main features of the BINS format. Additionally, these features are contrasted with the features of the other ranking formats outlined in this chapter.
Table 1

Comparison of Features between Ranking Formats

<table>
<thead>
<tr>
<th>Feature</th>
<th>BINS</th>
<th>MTF</th>
<th>DDART</th>
<th>Number Assignment Format</th>
<th>Rokeach Value Survey – Form D</th>
<th>Point Allocation Technique</th>
<th>Computerized VAS</th>
<th>Computerized Rating Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuum Orientation</td>
<td>Horizontal</td>
<td>Vertical</td>
<td>Vertical</td>
<td>Vertical</td>
<td>Vertical</td>
<td>Vertical</td>
<td>Horizontal</td>
<td>Horizontal</td>
</tr>
<tr>
<td>Input Method</td>
<td>Drag and Drop</td>
<td>Keyboard</td>
<td>Drag and Drop</td>
<td>Pencil and Paper</td>
<td>Adhesive Labels</td>
<td>Pencil and Paper</td>
<td>Drag and Drop</td>
<td>Mouse</td>
</tr>
<tr>
<td>Automated Error Checking</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Electronic Data</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ability to Communicate Equivalent Ranks</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ability to Communicate Absolute Distance between Ranks</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ability to View Ordered Ranking</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Overview of Present Studies

The purpose of the present research was to investigate the usefulness of the BINS format. Two studies were conducted to examine the BINS format. The first study, a Preliminary Study (Appendix A), was conducted using a paper version of the BINS ranking format to inform the design of an electronic drag-and-drop version of the BINS format. The main study (outlined in Chapter II) was conducted to compare an electronic version of the BINS format to an electronic version of the MTF. The two formats were compared on completion time (recorded and reported), usability, format preference, and number of repositionings (recorded and reported). The study was a global comparison of all of the features of both formats, and was not a comparison of the individual features of each format.
CHAPTER II

METHOD

Participants

The participants were 72 undergraduate students in an introductory psychology class, and included 34 men and 38 women. Each participant signed up for the study via the SONA System (the University’s subject pool management software) and received course credit for their contribution. Participants were told that they would be completing a study related to their decision to come to the University of Dayton and their decision’s relationship to their personal values. This cover story was used so that participants would not know that they were being timed and would complete their ranking tasks at their natural pace. The study was approved by the University of Dayton Department of Psychology Research Review and Ethics Committee.

Materials

Participants completed two ranking tasks using the BINS format and the Modified Traditional Format (MTF). A description of each of these formats follows.

BINS format.

An electronic version of the BINS format (the features of which are outlined in Chapter I) with 10 bins (see Figure 15) was developed using the Java programming
language. The format was accessed by connecting to a secure server located on the University of Dayton’s campus. The format was programmed for a resolution of 1024 x 768 pixels, and was contained entirely within one webpage. The ranking task instructions were printed at the top of the screen in 12 point font. In a Preliminary Study (Appendix A), significantly more participants saw the BINS format as having equal intervals when the continuum was numbered when compared to a continuum that was not numbered. Therefore, each of the bins was explicitly numbered from 1 to 10.

![Figure 15. BINS format, electronic version, UD Aspects task.](image)

Participants clicked the “Submit” button (located below the alternatives list) to indicate that they had completed their ranking task. Once the “Submit” button had been
pressed, the system verified that all alternatives were ranked. If all alternatives had not been ranked, participants were asked to complete their ranking. If there were no problems with the participants’ ranking, participants were told to review their ranking. Participants were then asked to indicate if they would like to continue ranking (adjust their ranking) or if they had completed their ranking task.

**Modified traditional format (MTF).**

An electronic version of the MTF (Figure 16) was developed using the Java programming language. The format was accessed by connecting to a secure server located on the University of Dayton’s campus. The MTF format was programmed for a resolution of 1024 x 768 pixels, and was contained entirely within one webpage. The ranking task instructions were printed at the top of the screen in 12 point font.

Each alternative to be ranked was randomly populated into a list located in the middle of the screen. Participants indicated the ranking of an alternative by typing a number in the text box to the left of the alternative. To re-order an alternative, a participant deleted the number in the text box and typed a new number in its place.
Participants clicked the “Submit” button (located at the bottom of the screen) to indicate that they had completed their ranking task. Once the “Submit” button had been pressed, the system ensured that the participant’s rankings did not include any duplicate rankings and that all alternatives were ranked. If all alternatives were not ranked or if an inappropriate ranking was provided (a ranking of “11” when only 1-10 was acceptable, for example), participants were asked to correct their ranking. If there were no problems with the participants’ ranking, participants were told to review their ranking. Participants were then asked to indicate if they would like to continue ranking (adjust their ranking) or if they had completed their ranking task.

**Procedure**

A flow chart of the study’s progression is presented in Figure 17. Participants read and signed the informed consent form (Appendix B) which indicated their willingness to
participate in the study. Participants sat at a computer workstation. The computers and displays at each workstation were identical (same brand, CPU speed, screen size, etc.). Each computer was connected to the Internet via WiFi. The researcher logged participants into the experiment using the Firefox web browser in full-screen mode. The researcher asked the participants to read the onscreen instructions. Participants watched a video explaining how to use the first ranking format (BINS: http://www.youtube.com/watch?v=2I17_eN13kY; MTF: http://www.youtube.com/watch?v=sp5Kt0ZYsFE). Half of the participants began with the BINS format, and the other half began with the MTF. The explanation videos were filmed using the computer program Camtasia. Each participant wore headphones so that the audio from the instructional video would not distract other participants. After watching the video, participants completed a practice question using their first ranking format. Participants ranked five cookies from their “Most Favorite” cookie to their “Least Favorite” cookie (see Appendices C and D for the BINS format and MTF practice task, respectively). Participants then completed their first experimental ranking task (referred to hereafter as Time 1). Half of the participants ranked 10 aspects of the University of Dayton according to how important those aspects were in their decision to attend the university. Aspects were ranked from “Most Important” to “Least Important” (see Appendices E and F for the BINS format and MTF UD aspects task, respectively). The other half of the participants ranked 10 items from the Rokeach Value Survey – Form D (RVS; Rokeach, 1973) according to how important those values were to them personally. Alternatives were ranked from “Most Important” to “Least Important” (see Appendices G and H for the BINS format and MTF RVS task, respectively). Participants then
completed a modified version of the System Usability Scale (SUS; Appendix I; Brooke, 1996) for the format they used at Time 1.

Participants then watched a second video explaining how to use the next ranking format. After watching the video, participants completed a practice question using the ranking format they did not use at Time 1 (i.e., if they used the BINS format to complete their first experimental ranking task, they used the MTF for their second task). Again, participants completed a practice question by ranking five cookies from their “Most Favorite” cookie to their “Least Favorite” cookie ((see Appendices C and D for the BINS format and MTF practice task, respectively). Participants then completed a second experimental ranking task using the ranking scale that they did not use previously (referred to hereafter as Time 2). Participants again completed the System Usability Scale (SUS; Appendix I; Brooke, 1996) for the format they used at Time 2.

After completing the experimental ranking tasks at Time 1 and Time 2, participants completed two final questionnaires developed in the SurveyMonkey online questionnaire tool. The first questionnaire asked participants several questions about their preference in ranking format and how they completed their ranking tasks (Appendix J). The second questionnaire was a demographics questionnaire, and asked participants about items such as their gender and academic standing (Appendix K). Finally, participants were given a debriefing sheet (Appendix L), were verbally debriefed, and were thanked for their time.
Figure 17. Participant protocol.

* = Administered using SurveyMonkey online software. All other questionnaires were administered using the Computer Control System.
Metrics.

Table 2 lists the six metrics that were obtained for each ranking task. Unless otherwise noted, all metrics were obtained from the computer control system.

Table 2

*Metrics and Methods of Measurement*

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recorded Completion Time</td>
<td>The time elapsed from the loading of the ranking format to when the participant clicked the submit button.</td>
</tr>
<tr>
<td>Reported Completion Time**</td>
<td>Each participant’s selection for which format allowed them to complete their ranking task fastest</td>
</tr>
<tr>
<td>Usability</td>
<td>Each participant’s response on the Modified System Usability Scale (Appendix I)</td>
</tr>
<tr>
<td>Format Preference*</td>
<td>Each participant’s preference for either the MTF or the BINS format.</td>
</tr>
<tr>
<td>Number of Recorded Repositionings</td>
<td>The actual number of times a participant changed the rank of an alternative.</td>
</tr>
<tr>
<td>Number of Reported Repositionings*</td>
<td>The number of times a participant recalled changing the rank of an alternative.</td>
</tr>
</tbody>
</table>

* = Metric obtained using SurveyMonkey online survey software. All other metrics were obtained using the Computer Control System.
CHAPTER III

RESULTS

The present study investigated four dependent variables: completion time, format usability, format preference, and the number of repositioned alternatives per format. All four dependent measures were obtained for both the MTF and the BINS format. Recorded data from 3 outliers were removed from the study since their scores were greater than 3 standard deviations from the mean. Data from one of the three participants were removed because of an outlying completion time on the MTF. The remaining two participants’ data were removed due to outlying SUS scores for the MTF.

Completion Time

Recorded completion time.

Each participant’s completion time spanned from the moment the format’s web page loaded until the participant clicked the “submit” button. If a participant indicated a wish to continue ranking after hitting the submit button, the timer resumed until the participant indicated that he or she was finished ranking. This variable was recorded twice: once for the participant’s first ranking task (Time 1) and once for the participant’s second ranking task (Time 2). Table 3 displays the means and standard deviations for participants’ completion time at Time 1 and Time 2.

At Time 1, a 2 x 2 ANOVA was used to examine the effect of ranking format (the BINS format and the MTF) and ranking task (items from the Rokeach Value Survey –
Form D and aspects related to the University of Dayton) on completion time. There was no main effect of ranking format on completion time, $F(1, 65) = 1.31, MSE = 181.72, p = .26$. Additionally, there was no main effect of ranking task on completion time, $F(1, 65) = .462, p = .50$. The $MSE$ of 181.72, from the omnibus ANOVA, was used as the error term to test the interaction effect and all post hoc analyses for Time 1.

However, at Time 1, there was a significant interaction between ranking format and ranking task $F(1, 65) = 9.23, p = .003, \eta^2 = .12$. A post-hoc analysis of simple effects revealed that when ranking items from the Rokeach Value Survey – Form D, participants using the BINS format ($M = 58.82, SD = 9.84$) took significantly longer than participants using the MTF ($M = 45.24, SD = 10.81$), $F(1, 65) = 8.87, p = .004, \eta^2 = .12$. When ranking aspects related to UD, participants using the BINS format ($M = 51.16, SD = 10.8$) did not significantly differ from participants using the MTF ($M = 57.31, SD = 20.05$), $F(1, 65) = 1.77, p = .189$. Figure 18 displays a chart of the completion time scores from Time 1.

At Time 2, a $2 \times 2$ ANOVA was again used to examine the effect of ranking format and ranking task on completion time. There was no main effect of ranking format on completion time, $F(1, 65) = 1.07, MSE = 132.98, p = .305$. There was no main effect of ranking task on completion time, $F(1, 65) = .024, p = .878$, nor was there a significant interaction between ranking task and ranking format, $F(1, 65) = 2.90, p = .093$. The $MSE$ of 132.98, from the omnibus ANOVA, was used as the error term to test the interaction effect for Time 2. Figure 19 displays a chart of the completion time scores from Time 2.
Table 3

Mean Task Completion Time (in Seconds)

<table>
<thead>
<tr>
<th>Task</th>
<th>Format</th>
<th>Time 1 Mean (SD)</th>
<th>N</th>
<th>Time 2 Mean (SD)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>RVS BINS</td>
<td></td>
<td>58.82 (9.84)</td>
<td>18</td>
<td>41.21 (12.79)</td>
<td>17</td>
</tr>
<tr>
<td>MTF</td>
<td></td>
<td>45.24 (10.81)</td>
<td>17</td>
<td>33.61 (8.84)</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Task Overall</td>
<td>52.22 (12.28)</td>
<td>35</td>
<td>37.41 (11.49)</td>
<td>34</td>
</tr>
<tr>
<td>UD BINS</td>
<td></td>
<td>51.16 (10.8)</td>
<td>17</td>
<td>36.06 (14.77)</td>
<td>17</td>
</tr>
<tr>
<td>MTF</td>
<td></td>
<td>57.31 (20.05)</td>
<td>17</td>
<td>35.91 (8.70)</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Task Overall</td>
<td>54.23 (16.16)</td>
<td>34</td>
<td>37.01 (8.91)</td>
<td>35</td>
</tr>
<tr>
<td>BINS Overall</td>
<td></td>
<td>55.1 (10.88)</td>
<td>35</td>
<td>38.63 (13.85)</td>
<td>34</td>
</tr>
<tr>
<td>MTF Overall</td>
<td></td>
<td>51.27 (17)</td>
<td>34</td>
<td>35.82 (8.91)</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>53.21 (14.25)</td>
<td>69</td>
<td>37.21 (11.61)</td>
<td>69</td>
</tr>
</tbody>
</table>

![Figure 18. Completion time of each task by format at Time 1.](image-url)
**Figure 19.** Completion time of each task by format at Time 2.

**Reported completion time.**

Participants were asked which format allowed them to complete their ranking task faster (Appendix J, Screen 5). As shown in Table 4, 62.3% of the participants indicated that, in their opinion, the BINS format allowed them to complete their ranking task faster, \( \chi^2(1, N = 69) = 4.18, p = .04 \).

**Table 4**

*Reported Ranking Task Speed by Format*

<table>
<thead>
<tr>
<th>Which format allowed you to complete your ranking task the fastest?</th>
<th>MTF</th>
<th>BINS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of responses</td>
<td>26 (37.7%)</td>
<td>43 (62.3%)</td>
<td>69 (100%)</td>
</tr>
</tbody>
</table>

**Usability**

Each participant completed the System Usability Scale (SUS) to assess the overall usability of each ranking format. This variable was recorded twice: once for the first ranking format completed by a participant (Time 1) and once for the second ranking
format completed by a participant (Time 2). Table 5 displays the means and standard deviations for each format’s usability score (as measured by the SUS).

At Time 1, a 2 x 2 ANOVA was used to examine the effect of ranking format and ranking task on usability. Participants rated the BINS format ($M = 85.14$, $SD = 10.45$) as significantly more usable than the MTF ($M = 78.60$, $SD = 9.27$), $F(1, 65) = 6.148$, $MSE = 119.49$, $p = .016$, $\eta^2 = .09$. There was no main effect of ranking task on usability, $F(1, 65) = .479$, $p = .491$. There was not a significant interaction between ranking task and ranking format, $F(1, 65) = .136$, $p = .713$. Figure 20 below displays a chart of the SUS scores from Time 1.

At Time 2, a 2 x 2 ANOVA was again used to examine the effect of ranking format and ranking task on usability. There was no main effect of ranking format on usability, $F(1, 65) = .422$, $MSE = 131.25$, $p = .518$. Additionally, there was no main effect of ranking task on usability, $F(1, 65) = 2.94$, $p = .091$, nor was there a significant interaction between ranking task and ranking format, $F(1, 65) = 3.85$, $p = .054$. Figure 21 below displays a chart of the SUS scores from Time 2.
Table 5
Mean System Usability Scale (SUS) Scores

<table>
<thead>
<tr>
<th>Format</th>
<th>Task</th>
<th>Time 1</th>
<th>Time 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean (SD)</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BINS</td>
<td>RVS</td>
<td>85.56 (6.84)</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>UD</td>
<td>84.71 (13.49)</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Format Overall</td>
<td></td>
<td>85.14 (10.45)</td>
<td>35</td>
<td>34</td>
</tr>
<tr>
<td>MTF</td>
<td>RVS</td>
<td>80 (12.96)</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>UD</td>
<td>77.21 (9.27)</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Format Overall</td>
<td></td>
<td>78.6 (11.18)</td>
<td>34</td>
<td>35</td>
</tr>
<tr>
<td>BINS</td>
<td>RVS</td>
<td>82.86 (10.5)</td>
<td>35</td>
<td>34</td>
</tr>
<tr>
<td>and MTF</td>
<td>UD</td>
<td>80.96 (12.01)</td>
<td>34</td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>81.92 (11.23)</td>
<td>69</td>
<td>69</td>
</tr>
</tbody>
</table>

Figure 20. SUS score of each format by task at Time 1.
Participants were also asked, in a single question, which format was easiest to use (Appendix J, Screen 5). As shown in Table 6, 76.8% of the participants indicated that the BINS format was easiest to use, $\chi^2(1, N = 69) = 19.84, p < .001$.

Table 6

Subjective Format Usability

<table>
<thead>
<tr>
<th></th>
<th>MTF</th>
<th>BINS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>16</td>
<td>53</td>
<td>69</td>
</tr>
<tr>
<td>(23.2%)</td>
<td>(76.8%)</td>
<td>(100%)</td>
<td></td>
</tr>
</tbody>
</table>

Format Preference

Participants indicated their choice of preference by selecting either BINS Format, MTF, or “I did not prefer either format.” A screen shot of both formats was provided with this question for the participants’ reference (Appendix J, Screen 1). As shown in Table 7,
77% of participants indicated that they preferred to use the BINS format, $\chi^2(2, N = 69) = 60.87, p < .001$.

Table 7

<table>
<thead>
<tr>
<th>Number of preferences</th>
<th>MTF</th>
<th>BINS</th>
<th>Neither</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13 (18.8%)</td>
<td>53 (76.8%)</td>
<td>3 (4.3%)</td>
<td>69 (100%)</td>
</tr>
</tbody>
</table>

In a separate question, the three participants who indicated that they did not prefer either format made a forced choice of preference between the MTF and the BINS format. All three participants indicated that, if forced to make a choice between the BINS format and the MTF, they preferred the BINS format. In this case, 81.2% of participants preferred the BINS format, $\chi^2(1, N = 69) = 26.80, p < .001$.

Number of Repositionings

Recorded number of repositionings.

The number of alternatives repositioned by each participant was recorded electronically by the computer control system. Table 8 displays the collapsed descriptive statistics for the participants’ recorded repositionings (a detailed table of recorded repositionings is displayed in Appendix M). Figure 22 displays the frequency of each response by format. There was not a significant relationship between format and number of recorded repositionings, $\chi^2(2, N = 138) = 2.25, p = .324$, nor was there a significant relationship between ranking task and number of recorded repositionings, $\chi^2(2, N = 138) = 1.84, p = .398$. 
Table 8

**Descriptive Statistics for Number of Recorded Repositionings by Ranking Format**

<table>
<thead>
<tr>
<th>Number of Repositionings</th>
<th>MTF</th>
<th>BINS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>37</td>
<td>30</td>
</tr>
<tr>
<td>1 - 2</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>3 or more</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>.96 (1.6)</td>
<td>1.8 (3.1)</td>
</tr>
<tr>
<td>Mode</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Median</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Minimum</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Maximum</td>
<td>9</td>
<td>18</td>
</tr>
</tbody>
</table>

*Figure 22. Number of participants’ recorded repositionings by format.*
Reported number of repositionings.

Participants reported whether or not they had repositioned any alternatives while using each format (Appendix J, Screens 6 and 11). Participants that reported a reposition then indicated how many alternatives were repositioned by selecting either “1-2,” “3-4,” “5-6,” “7-8”, or “More than 8” (Appendix J, Screens 7 and 12). Figure 23 displays the frequency of each response by format. There was a significant relationship between format and number of reported repositionings, $\chi^2(2, N = 138) = 6.28, p = .043$, such that more participants reported repositioning 0-2 alternatives using the MTF than the BINS format, but more participants reported repositioning 3 or more alternatives using the BINS format than they did when using the MTF.

![Figure 23. Number of participants reporting repositionings by format.](image-url)
CHAPTER IV

DISCUSSION

Table 9 summarizes the main findings of the present study’s comparison between the BINS ranking format and the MTF. This chapter explores the implications of these results. This discussion is divided into four sections: one for each of the dependent variables (completion time, usability score on the SUS, format preference, and number of repositionings). Future studies using the BINS format are also proposed.

Table 9

Summary of Findings

<table>
<thead>
<tr>
<th>Variable</th>
<th>BINS</th>
<th>Result</th>
<th>MTF</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recorded Completion Time</td>
<td>55.1 seconds</td>
<td>was not faster</td>
<td>51.27 seconds</td>
<td>.26</td>
</tr>
<tr>
<td>Reported Completion Time</td>
<td>43 participants</td>
<td>was faster</td>
<td>26 participants</td>
<td>.04*</td>
</tr>
<tr>
<td>Usability</td>
<td>Mean SUS score of 85.14</td>
<td>was more usable</td>
<td>Mean SUS score of 78.60</td>
<td>.016*</td>
</tr>
<tr>
<td>Format Preference</td>
<td>53 preferences</td>
<td>was preferred over</td>
<td>13 preferences</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Number of Recorded Repositionings**</td>
<td>did not have more repositionings than</td>
<td></td>
<td></td>
<td>.324</td>
</tr>
<tr>
<td>Number of Reported Repositionings**</td>
<td>did have more repositionings than</td>
<td></td>
<td></td>
<td>.043*</td>
</tr>
</tbody>
</table>

* indicates a significant difference at the .05 level
** indicates a categorical variable
The recorded completion time and usability dependent variables were statistically examined twice: once for the first ranking task participants completed (referred to as Time 1), and once for the second ranking task participants completed (referred to as Time 2). The present discussion focuses on the effects of these variables at Time 1 in order to ignore the confounding impact of order and practice effects.

**Completion Time**

The present study revealed a two-way interaction between ranking format and ranking task at Time 1. The interaction was such that when participants ranked items from the Rokeach Value Survey – Form D, they took longer to do so using the BINS format than they did when using the MTF. Additionally, when ranking aspects related to UD, participants took the same amount of time to complete their ranking task when using the BINS format and the MTF. The topic of the RVS and UD aspects ranking tasks might be responsible for this difference in completion time. All participants were UD students (91% of whom were either first- or second-year students), and it is possible that explaining their rationale for attending the University of Dayton is a common exercise for them. If the participants’ thoughts on this topic were already organized, the UD Aspects ranking task may not have encouraged participants to evaluate all of the alternatives very deeply. This may have resulted in an equivalent completion time on the UD aspects task for both formats. Conversely, the RVS is a less common exercise for university students. The topical novelty of the RVS may have encouraged participants to more fully explore the benefits of the BINS format as they considered their rankings on this uncommon scale, resulting in a longer completion time on the RVS when using the BINS format. To
examine this possibility, future studies should include ranking tasks with topics that are both familiar and unfamiliar to the sample.

As seen in Figure 24, recorded completion times at Time 2 tended to be faster than recorded completion times at Time 1. This indicates the possible presence of a familiarization effect. Specifically, as participants proceeded through the questionnaire, it is possible that their reaction time decreased because they became more accustomed to the concept of ranking in general. These findings are similar to those highlighted by Anders (2004), who found that participants spent more time completing rating questions at the beginning of a questionnaire than when rating questions at the end of the questionnaire. In order to fully explore any extant differences in completion time between the MTF and the BINS format, future studies should include more than two ranking tasks in order to level out any possible familiarization effects.

Figure 24. Completion time at each time series by format.
In comparison to system-recorded completion times, 43 of 69 participants (62.3%) reported that the BINS format allowed them to complete their ranking task faster than the MTF. This finding is important when considering online survey completion rates. Survey respondents are more likely to complete shorter online surveys than longer online surveys (Deutskens, De Ruyter, Wetzels, & Oosterveld, 2004). Therefore, if survey respondents perceive that they are completing a ranking task more quickly using the BINS format, they might be more likely to complete a survey using the BINS format than respondents using a more traditional format like the MTF.

**Usability**

Participants rated the BINS format as more usable than the MTF on the SUS. Additionally, when asked which format was easiest to use, 53 of 69 participants (76.8%) indicated that the BINS format was easier to use than the MTF. These results can be attributed to two factors. The first is that the BINS format is more usable due to the intuitive nature of the drag and drop technology employed in the format. The benefits of drag and drop technology are described by Neubarth (2010) and Karth (2011). Anecdotal reports from participants also support this interpretation: 14 of the 69 participants (20.3%) indicated in a free response question that the BINS format’s ease of use when positioning and repositioning alternatives via drag and drop technology was the aspect of the BINS format that they liked best.

Second, the BINS format is more usable than the MTF because it was designed to reduce cognitive burden. As highlighted by Stern (2006), traditional ranking formats such as the MTF require respondents to maintain an awareness of the intensity and directionality of the continuum. This process requires considerable mental resources. The
intensity and directionality of the ranking task are provided on the BINS format, thereby reducing the amount of information participants carry in their minds from the question prompt to the ranking task itself.

In support of this argument, 9 of the 69 participants (13%) indicated in a free response question that the ability to visualize their holistic ranking instantly was the feature they liked best about the BINS format. Respondents using the BINS format do not need to retain information about the intensity or directionality of the continuum from the ranking task instructions, and can instantly visualize the current position of each ranked alternative (as well as their relationship to other ranked alternatives) at any time during their ranking task. These features of the BINS format represent a clear benefit over the MTF.

**Format Preference**

Seventy-seven percent of participants preferred the BINS format over the MTF. The magnitude of this preference is a strong indication that the BINS format engages survey respondents in ranking tasks. Using the BINS format, 66 of the 69 participants (95.7%) stacked at least two alternatives within the same bin to indicate an equivalent rank. Anecdotally, 31 of the 69 participants (44.9%) indicated in a free response question that the ability to stack alternatives to communicate equivalent ranks was the aspect of the BINS format that they liked best. This evidence, in combination with the results of the Preliminary Study presented in Appendix A, supports the notion that participants desire the ability to indicate ties when completing a ranking task, and that the BINS format’s method of stacking allows them to effectively communicate this opinion. The stacking feature of the BINS format represents another key benefit over the MTF.
Number of Repositionings

**Recorded number of repositionings.**

There was not a significant relationship between the recorded number of repositionings in the BINS format and the MTF. Although participants repositioned alternatives an average of 1.8 times using the BINS format compared to an average of .96 times using the MTF, the skewness of the data obtained for the BINS format may have artificially inflated the mean recorded repositionings for the BINS format (one participant repositioned 14 alternatives using the BINS format, and another repositioned 18 alternatives; see Appendix M for a detailed table of recorded repositionings). Future studies should include more participants to determine whether or not the skew of the present data is an artifact of the sample.

**Reported number of repositionings.**

There was a significant relationship between the reported number of repositionings in the BINS format and the MTF. More participants reported repositioning 0 alternatives using the MTF (31 participants) than the BINS format (23 participants). Participants reported repositioning 1-2 alternatives an approximately equal number of times (BINS = 25; MTF = 29). More participants reported repositioning 3 or more alternatives using the BINS format (21 participants) than the MTF (9 participants). These results indicate that participants felt that they repositioned more alternatives using the BINS format than they did using the MTF. This finding differs from the recorded number of repositionings, which did not show a significant pattern of repositionings between the two ranking formats. Although participants did not actually perform more repositionings using the BINS format when compared to the MTF, they believed that they had made
more repositionings. As participants performed repositionings on the BINS format using drag and drop technology, these data provide further support for the notion that participants responded positively to the drag and drop technology of the BINS format. As mentioned in the discussion of usability, 14 of the 69 participants (20.3%) indicated that the BINS format’s ease of use when positioning and repositioning alternatives via drag and drop technology was the aspect of the BINS format that they liked best.

Although the present study found a relationship between reported number of repositionings and format, the question used to measure this variable was imprecise. Participants reported the range into which their number of repositionings fell (“1-2”, “3-4,” etc.). Future studies should ask participants to indicate the exact number of repositionings they performed using each format. This change is especially important as the mean number of recorded repositionings in the MTF was .96 and the mean of repositionings in the BINS format was 1.8. Participants were not given the option of distinguishing 1 reposition from 2 repositions, and therefore the categorical scale used in the present study may not have been sensitive enough to detect a more robust difference between the two formats.

**Considerations for Future Studies**

As noted in Chapter I, this study was a global comparison between the MTF and the BINS format. Although this exploratory study found general support for the BINS format, a more specific comparison between the BINS format and the MTF could be conducted to determine which individual features of the BINS format are most responsible for the BINS format outperforming the MTF. A possible avenue of future research involves isolating individual features of the BINS format and comparing them to
the MTF. Such feature comparisons could include: the orientation of the continuum (horizontal versus vertical), the inclusion/exclusion of the intensity and poles of the continuum on the format itself, the inclusion/exclusion of stacking to indicate equivalent ranks, and the inclusion/exclusion of the drag and drop technology of the BINS format.

In response to an open-ended question asking participants which feature of the BINS format they would change, 10 of the 69 participants (14.5%) indicated that there were too many bins into which they could rank alternatives. Another possible study could manipulate the number of bins within the format. This study would define the appropriate range for the number of bins in the BINS format, and would also determine how participants’ ranking task performance changes when the number of bins in the format is varied. Conversely, a similar study could vary the number of alternatives to rank while holding the number of bins constant. The results of this study would define the ideal number of alternatives to be ranked for the BINS format.

As Karth’s (2011) DDART format and the BINS format have both demonstrated benefits over the MTF, the DDART format and the BINS format should be compared directly. Both formats share the ability to drag and drop alternatives, and the ability to visualize a holistic ranking. However, the formats have different continuum orientations (DDART is vertical and BINS is horizontal) and the BINS format allows for ties whereas the DDART format does not. It should be noted that in such a comparison, the DDART should be reprogrammed to allow respondents to reposition alternatives at any time. This will allow the DDART to mirror the BINS format more closely.
Conclusion

The BINS ranking format differs from the MTF in that it employs drag and drop technology, allows respondents to communicate an equivalent rank between two alternatives by stacking, allows respondents to indicate intervals between alternatives, and presents a current, holistic image of respondents’ rankings. The findings of the present study demonstrate that the BINS ranking format outperformed the MTF on several measures. The overall results of each variable are listed below.

- **Completion Time:** Participants completed the RVS more quickly using the MTF format than the BINS format. When ranking aspects related to UD, participants completed their ranking task in an equivalent amount of time for both formats. Additionally, participants indicated that in their opinion, the BINS format was faster than the MTF when completing their ranking tasks.

- **Usability:** The BINS format was rated as more usable than the MTF on the SUS, and was also described as easier to use than the MTF.

- **Format Preference:** Participants indicated that they preferred the BINS format over the MTF when completing their ranking tasks.

- **Number of Repositionings:** Participants objectively repositioned the same number of alternatives using the BINS format as they did using the MTF. When asked how many alternatives they repositioned using each format, participants indicated that they repositioned more alternatives using the BINS format than they did with the MTF.

  Overall, the results of this study established that, in comparison to the MTF, the novel BINS format is a useable, preferred, and time-efficient method for collecting ranked interval data from survey respondents.
REFERENCES


APPENDIX A

PRELIMINARY STUDY

Prior to examining the research questions outlined in Chapter I, it was necessary to complete a Preliminary Study. The Preliminary Study was conducted to inform the design of an electronic version of the BINS format. There were three goals to the Preliminary Study. The first goal was to determine if an explicit (numbered) continuum was preferred over an implicit (unnumbered) continuum when using the BINS format. Hyland and Sodergren (1996) found that participants preferred scales with both numeric and verbal labels over verbal labels alone. Therefore, it was hypothesized that when given a choice between an implicit and explicit continuum, participants would prefer to complete a ranking task with the BINS format using the numbered continuum.

The second goal of the Preliminary Study was to ensure that the concept of stacking alternatives to communicate an equivalent rank was easy to learn and a desirable feature of the BINS format. It was expected that participants would not have difficulty understanding the concept of stacking, and would prefer a ranking format that uses stacking over one that does not.
The third goal of the Preliminary Study was to determine if participants perceived the distance from one bin to another as an equal psychological interval. It was expected that participants in both continuum conditions would see the BINS format as having equal intervals, but the effect would be more pronounced in the explicit continuum condition.

Method

Participants.

The participants were 48 undergraduate students in an introductory psychology class, 22 men and 26 women. The mean age of the participants was 19 (SD = 1.56). Each participant signed up for the study via the SONA System (the University’s subject pool management software) and received course credit for their involvement in the study. The study was approved by the University of Dayton Department of Psychology Research Review and Ethics Committee.

Materials.

Two versions of the BINS format were used in the Preliminary Study. In the “explicit continuum” version, each bin was numbered (from “1” to “10”, left to right; Appendix N). The “implicit continuum” version of the BINS format did not have numbered bins (Appendix O). Each version of the format (including ranking task instructions) was printed on a 20 x 30 inch sheet of foam board.

Each alternative to be ranked was printed inside of a bordered 1.75 x 1.25 inch square of paper (Appendix P). These alternatives were glued to a piece of white cardboard with the same dimensions. A strip of adhesive putty was placed on the back of
each alternative (allowing participants to easily rank and reposition the alternatives on the foam board).

**Procedure.**

Participants were randomly assigned to answer questions using either the implicit continuum or the explicit continuum version of the BINS format. After completing a demographics questionnaire, participants listened as the experimenter explained the BINS ranking format (Appendix Q). As a practice question, participants ranked five cookies from their “Most Favorite” cookie to their “Least Favorite” cookie using the BINS format. The researcher then answered any questions the participants had about the ranking format. Participants then ranked 10 aspects of the University of Dayton according to how important those aspects were in their decision to attend the university. Aspects were ranked from “Most Important” to “Least Important” (Appendices N and O).

After returning their completed ranking to the researcher, participants completed three questionnaires. The first questionnaire asked participants to detail their decision making process while using the ranking format (Appendix R). The second questionnaire asked participants to complete a usability questionnaire focusing on the BINS ranking format (Appendix S). The third questionnaire asked participants to describe their thoughts on the ranking format as well as how they completed their ranking task (Appendix T).

**Results and Discussion**

**Continuum preference.**

As a part of the final questionnaire, participants were shown a diagram of the BINS format that they did not use. Those participants that used the implicit continuum were shown a picture of the explicit continuum, and vice versa. Participants were then
asked if they felt that their ranking task would have been easier if they had used the other continuum format. The majority (64%) of participants that used the implicit continuum indicated that they would have preferred to use the explicit continuum. The majority (83%) of participants that used the explicit continuum indicated that they would have preferred to continue using their own continuum. These results (Table A1) indicate that an overwhelming majority of participants in both conditions (73%) would have preferred to use the explicit continuum version of the BINS ranking format rather than the implicit continuum version.

Table A1

<table>
<thead>
<tr>
<th>Continuum Preference</th>
<th>Implicit</th>
<th></th>
<th>Explicit</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think your ranking task would have been easier if you used [the other ranking format]?</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Yes</td>
<td>16</td>
<td>64</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>No</td>
<td>9</td>
<td>36</td>
<td>19</td>
<td>83</td>
</tr>
</tbody>
</table>

**Stacking.**

Participants were asked to consider the relationship between alternatives that were stacked on top of one another (Appendix T, Question 14). There was near-unanimous agreement across both conditions that the two alternatives were of equal importance on the given scale. These results (Table A2) suggest that participants easily saw that two stacked alternatives represented equivalent ranks.

When considering participant satisfaction with stacking, results were positive overall (Table A3). Participants indicated that they saw the stacking process as easy, and did not believe that it was a difficult procedure to learn. Additionally, participants that
employed stacking in their final ranking believed that the ability to stack alternatives aided them in communicating their intended final ranking. These results reinforce the notion that the ability to communicate alternatives as equivalent in rank via stacking was a simple and intuitive process. Additionally, the results suggest that stacking allowed participants to describe what they felt to be their actual rank.

Table A2

*Question 14 Results – Does stacking indicate an equivalent rank?*

According to the ranking that Sally provided the researcher, [Aspect 1] was _____ [Aspect 2] in Sally’s decision to attend the University of Dayton.

<table>
<thead>
<tr>
<th>Possible Response</th>
<th>Implicit</th>
<th></th>
<th>Explicit</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Half as important as</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Equally as important as</td>
<td>23</td>
<td>92</td>
<td>23</td>
<td>100</td>
</tr>
<tr>
<td>Twice as important as</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>None of these are correct</td>
<td>2</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

When asked if they would prefer a ranking format that did not allow them to stack alternatives, participants expressed a preference for stacking. These results were not derived from a direct comparison between a stacking format and a non-stacking format, but the data do imply that given a choice between two formats, participants would prefer to use a stacking format.
Table A3

<table>
<thead>
<tr>
<th>Stacking Question Results</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>It was easy to stack aspects on top of one another.</td>
<td>1.82</td>
<td>1.48</td>
</tr>
<tr>
<td>I would prefer a ranking task that did NOT allow me to stack aspects on top of one another.</td>
<td>5.71</td>
<td>1.49</td>
</tr>
<tr>
<td>Stacking aspects on top of one another helped me produce the ranking that I intended.</td>
<td>2.09</td>
<td>1.48</td>
</tr>
<tr>
<td>Learning to stack aspects on top of one another took a long time.</td>
<td>6.27</td>
<td>1.40</td>
</tr>
</tbody>
</table>

NOTE: Participants answered these questions using a 7-point scale (1 = Strongly Agree, 7 = Strongly Disagree). As one-way ANOVAs revealed no significant differences between the two conditions for any of the four questions, these results were collapsed for reporting.

**Equal intervals.**

Participants were asked two questions in order to examine whether or not they saw either version of the BINS format as having equal intervals. First, participants were asked whether or not they considered the numeric relationship between bins while completing their ranking task (Appendix T, Question 16). The majority of participants (see Table A4) across both conditions reported that they did not consciously consider the numeric relationship between bins when completing their ranking task.

Table A4

| Question 16 Results – Did participants consider a numeric relationship between bins? |
|-----------------------------------------------|---------|---------|---------|
| When positioning aspects, did you consider the numeric relationship between the bins? | Implicit | Explicit | Total   |
| N    | %       | N       | %       | N       | %       |
| Yes  | 3  | 12       | 4  | 17.4   | 7  | 14.6   |
| No   | 22 | 88       | 19 | 82.6   | 41 | 85.4   |
Second, participants were asked whether or not they saw the distance between bins as having equal intervals. Participants were shown a diagram of a ranking completed by Sally, a fictional character. The participants were then asked to explain what Sally was attempting to communicate through her ranking (Appendix T, Questions 13 and 15). Question 13 was designed to determine if participants saw the relationship between bins as being multiplicative (i.e., that an alternative in the 3rd bin was twice as important as an alternative in the 6th bin). Conversely, Question 15 was designed to determine if participants saw the relationship between bins as divisible (i.e., that an alternative in the 6th bin was half as important as an alternative in the 3rd bin).

When considering Question 13, a chi-square test of independence using the Yates’ correction for continuity was performed to examine the relationship between continuum type (implicit vs. explicit) and response on Question 13 (identifying the relationship between bins as multiplicative or not identifying the relationship between bins as multiplicative). The relationship between these two variables was significant, \( \chi^2(1, N = 48) = 15.57, p < .001 \). As show in Table A5, more participants in the explicit continuum condition indicated that they saw a numerical relationship between two alternatives in different bins when compared to participants in the implicit continuum condition. Less than half of the participants in the implicit continuum condition saw the relationship between bins as being multiplicative (44%). The majority of participants in the implicit continuum condition saw no numerical relationship when comparing two alternatives in different bins (52%). In the explicit condition, every participant viewed the relationship between the bins as multiplicative (100%).
Table A5

*Question 13 Results – Is the relationship between bins multiplicative?*

<table>
<thead>
<tr>
<th>Data</th>
<th>Implicit</th>
<th>Explicit</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiplicative</td>
<td>11</td>
<td>23</td>
<td>34</td>
</tr>
<tr>
<td>Not Multiplicative</td>
<td>14</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>23</strong></td>
<td><strong>48</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expected</th>
<th>Implicit</th>
<th>Explicit</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiplicative</td>
<td>17.71</td>
<td>16.29</td>
<td>34</td>
</tr>
<tr>
<td>Not Multiplicative</td>
<td>7.29</td>
<td>6.71</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>23</strong></td>
<td><strong>48</strong></td>
</tr>
</tbody>
</table>

For Question 15, a chi-square test of independence using the Yates’ correction for continuity was performed to examine the relationship between continuum type (implicit vs. explicit) and response on Question 15 (identifying the relationship between bins as divisible or not identifying the relationship between bins as divisible). The relationship between these two variables was significant, $\chi^2(1, N = 48) = 6.52, p < .01$. As shown in Table A6, more participants in the explicit continuum condition saw the relationship between bins as divisible than participants in the implicit continuum condition. Less than half of participants in the implicit continuum condition (48%) saw the relationship between BINS as numerically divisible. However, a large majority of participants in the explicit continuum condition (87%) expressed that the relationship between alternatives in different BINS was numerically divisible.
Table A6

Question 15 Results – Is the relationship between bins divisible?

Data

<table>
<thead>
<tr>
<th>Response</th>
<th>Implicit</th>
<th>Explicit</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Divisible</td>
<td>12</td>
<td>20</td>
<td>32</td>
</tr>
<tr>
<td>Not Divisible</td>
<td>13</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>23</td>
<td>48</td>
</tr>
</tbody>
</table>

Expected

<table>
<thead>
<tr>
<th>Response</th>
<th>Implicit</th>
<th>Explicit</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Divisible</td>
<td>16.67</td>
<td>15.33</td>
<td>32</td>
</tr>
<tr>
<td>Not Divisible</td>
<td>8.33</td>
<td>7.67</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>23</td>
<td>48</td>
</tr>
</tbody>
</table>

These results paint a clear picture about the BINS format. When using an implicit continuum, a precise numeric relationship between the BINS is not communicated to participants. However, when the continuum is made explicit through numbering the BINS, participants can easily express numeric relationships between alternatives in different BINS. This lends support to the notion that participants consider the BINS format (with an explicit continuum) to have equal intervals.
APPENDIX B

INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT

Project Title: "The Relationship between UD Enrollment and Human Values."

Investigator(s): Jerry Timbrook and William F. Moroney, Ph. D.

Description of Study: Participants will be asked to complete several questionnaires including: a demographics questionnaire, two practice ranking questionnaires, a ranking questionnaire related to the UD application and enrollment process, a ranking questionnaire related to personal values, a preference questionnaire, and three questionnaires about the participants’ completion of the study.

Adverse Effects and Risks: There are no anticipated risks or discomfort that would arise from this study.

Duration of Study: The study will be conducted in one session which should last approximately one hour.

Confidentiality of Data: Your name will be kept separate from the data. Both your name and the data will be kept in a locked filing cabinet. Only the investigators named above will have access to the locked filing cabinet. Your name will never be associated with the responses you provide, and your name will never be revealed in any document resulting from this study.

Contact Person: Students may contact Jerry Timbrook (jtimbrok1@notes.udayton.edu; 937-229-5032) or Dr. William F. Moroney (william.moroney@notes.udayton.edu, 937-229-2767) if they have questions or problems after the study. If participants have any questions regarding their rights in psychological studies as outlined by the APA Code of Ethics they may also contact the Chair of the Psychology Department’s Research Review and Ethics Committee at the University of Dayton, Dr. Greg Elvers in SJ 312 (greg.elvers@notes.udayton.edu; 937-229-2171).
Consent to Participate:

“I have voluntarily decided to participate in this study. The investigators named above have adequately answered any and all questions I have about this study, the procedures involved, and my participation. I understand that the investigators named above will be available to answer any questions about research procedures throughout this study. I also understand that I may voluntarily terminate my participation in this study at any time and still receive full credit. I also understand that the investigators named above may terminate my participation in this study if they feel this to be in my best interest. In addition, I certify that I am 18 (eighteen) years of age or older.”

<table>
<thead>
<tr>
<th>Signature of Student</th>
<th>Student’s Name (printed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Signature of Witness</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D

MTF, ELECTRONIC VERSION, PRACTICE TASK

Your ranking task. Please hit the reaction button with the same rank click the 'Submit' button when you have completed your ranking task if you wish to start over at any point during the session. Please write down the number (1-5) that you would choose in each scenario that you can change your rank. Do not change the rank of any scenario after clicking the 'Submit' button.

Rank each one of the five cookies from your most favorite. Place a "X" in front of the style of cookie you like the most.
<table>
<thead>
<tr>
<th>Importance</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
</table>

**APPENDIX E**

**BINS FORMAT, ELECTRONIC VERSION, EXPERIMENTAL TASK, UD ASPECTS**

- Quality of Audio File (Clean vs. Noisy)
- Accuracy of Audio File (Clean vs. Noisy)
- Quality of Audio File (Clean vs. Noisy)
- Quality of Audio File (Clean vs. Noisy)
- Quality of Audio File (Clean vs. Noisy)
- Quality of Audio File (Clean vs. Noisy)
- Quality of Audio File (Clean vs. Noisy)
- Quality of Audio File (Clean vs. Noisy)
- Quality of Audio File (Clean vs. Noisy)
- Quality of Audio File (Clean vs. Noisy)
An Exciting Life
A Comfortable Life
A World of Beauty
National Security
Success
Wisdom
Social Recognition
Empathy
Happiness
True Friendship

be used once, which means that two parts cannot be used more than one time. Click the "Submit" button when you have completed your ranking task.

You can change the rank of a value by dragging the number in front of it and then clicking on a new number. Each number (1 - 10) can only

dead and non-mannerless as following principles: in your life, a "3" in front of your second choice and so on until all choices have been ranked.
APPENDIX I
MODIFIED SYSTEM USABILITY SCALE (SUS)

Note: The phrase “MTF” was replaced with “BINS format” for the BINS version of the SUS.

Instructions: For each statement, click the button that best describes your opinion on the Modified Traditional Format (MTF)/BINS Format.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Strongly Agree</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I think that I would like to use the MTF frequently</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>2. I found the MTF unnecessarily complex</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>3. I thought the MTF was easy to use</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>4. I think that I would need the support of a technical person to be able to use the MTF</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>5. I found the various functions in the MTF were well integrated</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>6. I thought there was too much inconsistency in the MTF</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>7. I would imagine that most people would learn to use the MTF very quickly</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>8. I found the MTF very cumbersome to use</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>9. I felt very confident using the MTF</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>10. I needed to learn a lot of things before I could get going with the MTF</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
</tbody>
</table>

Submit
APPENDIX J
PREFERENCE AND PROCEDURES QUESTIONNAIRE

Screen 1:

Which format did you prefer? (An image of both formats is provided below for your reference.)

- BINS Format
- Modified Traditional Format (MTF)
- I did not prefer either format

Screen 2: This question was asked if “I did not prefer either format” was chosen on Screen 1.

If you were forced to make a choice of format preference, which format would you prefer? (An image of both formats is provided below for your reference.)

- BINS Format
- Modified Traditional Format (MTF)
**Screen 3:** These questions were asked if “BINS format” was chosen on Screens 1 or 2

You indicated that you preferred the BINS format. Please explain why you selected that format.

Please explain why you did NOT prefer the MTF.

**Screen 4:** These questions were asked if “Modified Traditional Format” was chosen on Screens 1 or 2

You indicated that you preferred the MTF. Please explain why you selected that format.

Please explain why you did NOT prefer the BINS format.

**Screen 5:**

Which format was easiest to use? (An image of both formats is provided below for your reference.)

- [ ] BINS
- [ ] Modified Traditional Format (MTF)

Which format allowed you to complete your ranking task the fastest? (An image of both formats is provided below for your reference.)

- [ ] BINS
- [ ] Modified Traditional Format (MTF)
While completing my ranking task using the MTF, I repositioned the rank of at least 1 alternative from its initial rank. (For example - Sally initially ranked the “Oatmeal Raisin” aspect with a value of "1." However, after ranking several other aspects, Sally moved the “Oatmeal Raisin” aspect to a value of "2." Therefore, Sally would answer “Yes” to this question as she has repositioned the rank of at least one alternative.)

Yes
No

Screen 7: This question was asked if “Yes” was chosen on Screen 6

I repositioned ______ alternative(s) when using the MTF.

1-2
3-4
5-6
7-8
More than 8
Screen 8:

After reading the statement below, please click the response that most closely describes your review process using the MTF.

I very carefully reviewed the ranking I produced using the MTF before I submitted my ranking.

The next question focuses on the clarity of the instructions SPOKEN ALOUD during the explanation video for the MTF. Please click the response that most closely corresponds to your opinion.

The instructions in the explanation video were easy to understand.

Did you read the written instructions provided on the MTF?

- Yes
- No

Screen 9: This question was asked if “Yes” was chosen on Screen 8

The next question focuses on the clarity of the instructions WRITTEN on the MTF. Please click the response that most closely corresponds to your opinion.

The written instructions provided on the MTF were easy to understand.
When learning to use the MTF, did you prefer the written instructions or the explanation video?
- Written instructions
- Explanation video

**Screen 10:**

What is the one thing that you liked best about the MTF? Why?

What is the one thing that you liked least about the MTF? Why?

If there was one thing that you could change about the MTF, what would it be? Why?
While completing my ranking task using the BINS format, I repositioned the rank of at least 1 alternative from its initial rank.
(For example - Sally initially ranked the “Oatmeal Raisin” aspect with a value of "1." However, after ranking several other aspects, Sally moved the “Oatmeal Raisin” aspect to a value of "2." Therefore, Sally would answer “Yes” to this question as she has repositioned the rank of at least one alternative.)

☐ Yes
☐ No

Screen 12: This question was asked if “Yes” was chosen on Screen 11

The following question deals with the ranking task you completed while using the BINS format.

I repositioned _______ alternative(s) when using the BINS format.

☐ 1-2
☐ 3-4
☐ 5-6
☐ 7-8
☐ More than 8
Screen 13:

After reading the statement below, please click the response that most closely describes your review process using the BINS format.

I very carefully reviewed the ranking I produced using the BINS format before I submitted my ranking.

The next question focuses on the clarity of the instructions SPOKEN ALOUD during the explanation video for the BINS format. Please click the response that most closely corresponds to your opinion.

The instructions in the explanation video were easy to understand.

Screen 14: This question was asked if “Yes” was chosen on Screen 13

The next question focuses on the clarity of the instructions WRITTEN on the BINS format. Please click the response that most closely corresponds to your opinion.

The written instructions provided on the BINS format were easy to understand.

When learning to use the BINS format, did you prefer the written instructions or the explanation video?

- Written instructions
- Explanation video
**Screen 15:**

Think back to when YOU were completing your ranking task using the BINS format. When positioning aspects, did you consider the numeric relationship between the bins? For example, did you believe that an aspect in the fourth bin was half as important as an aspect in the second bin?

- Yes
- No

**What is the one thing that you liked best about the BINS format? Why?**

**What is the one thing that you liked least about the BINS format? Why?**

**If there was one thing that you could change about the BINS format, what would it be? Why?**

**Screen 16:**

While completing the ranking task using the BINS format, I stacked at least one aspect on top of another aspect within the same bin.

- Yes
- No
**Screen 17: This question was asked if “Yes” was chosen on Screen 16**

After reading the statement below, please click the response that most closely describes your experience using the BINS format.

It was easy to stack aspects on top of one another.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I would prefer a ranking task that did NOT allow me to stack aspects on top of one another.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Stacking aspects on top of one another helped me produce the ranking that I intended.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Learning to stack aspects on top of one another took a long time.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX K
DEMographics QUESTIONS

What is your gender?

☐ Male
☐ Female
☐ Other
☐ Prefer not to answer

What is your current academic standing?

☐ First Year
☐ Second Year
☐ Third Year
☐ Fourth Year
☐ Fifth Year
☐ Graduate Student

Please choose the answer(s) that best describe your race. You may choose more than one answer if you wish.

☐ White or Caucasian
☐ African American
☐ American Indian or Alaska Native
☐ Asian, Asian American, or Pacific Islander
☐ Hispanic, Latino, or Spanish Origin
☐ Arab or Persian
☐ Prefer not to specify
☐ Please specify if not listed
APPENDIX L
DEBRIEFING

Thank you for participating in this research. The study you just participated in was designed to examine an issue in the field of psychometrics (the study of psychological measurements). Psychological measurements are used to collect information about mental phenomena such as attitudes, preferences, knowledge, and emotions. Researchers in a wide variety of fields rely on psychological measurements to gather data. Research in psychometrics guides the creation of these instruments, and ensures that these instruments are efficient, intuitive, and accurate. The instrument that we are interested in for this study is a ranking system (an instrument that allows a respondent to indicate the relative relationship among two or more items).

Deception: You were told that this was a study related to your decision to come to UD and its relationship to your personal values. In actuality, you were measured on your performance while completing four ranking tasks (two practice tasks ranking cookies, one ranking task about aspects related to UD and one ranking task about personal values [the Rokeach Value Survey]) using the BINS format and the Modified Traditional Format. The time it took you to complete each ranking task was recorded, as well as the rank that you gave for each alternative. Your completion time on each ranking task provides the investigators with valuable information about each ranking format. Your completion time does not indicate “good” or “bad” performance on that task. Rather, completion time gives the investigators a measure of how long it takes the average individual to complete ranking tasks using a particular ranking format. Completion times can be used to compare ranking formats to one another, and to help researchers identify ranking formats that will obtain information from respondents in the shortest amount of time possible.

Deception is a technique that is not used without thoughtful consideration – it is used only as a last resort when participants would not behave naturally otherwise. Deception was necessary in this particular study to gain a true picture of how you would use the two ranking formats. Knowledge that you were being timed may have biased your performance on the ranking tasks. When an individual completes a survey in a real-world setting, they are not normally under the impression that they are being timed. As the investigators of this study were interested in how you completed the ranking tasks in such a setting, it was necessary to use deception to create an environment that was as similar to a real-world setting
as possible. If you had known that you were being timed, you may have focused on
the speed with which you completed your ranking task rather than focusing on the
alternatives that you ranked. This may have increased or decreased your completion
time from what it would have been if you had not known that you were being timed.

If for any reason you do not wish for your data to be included in our analyses, you can
inform the researcher now, or you can contact Jerry Timbrook
(jtimbrook1@notes.udayton.edu) using the information provided on this sheet and we
will remove your responses from the overall data set.

The purpose of the study was to compare a commonly used ranking system (the
Modified Traditional Format; MTF) to a new ranking system (the BINS format, a drag-
and-drop system). The BINS ranking format differs from current commonly used ranking
systems in that respondents can indicate that two or more items are ranked equally (by
stacking them in the same bins); when using traditional ranking formats, ties between
items to be ranked are not permitted. Additionally, this ranking system allows
respondents to indicate the relative distance between items to be ranked; traditional
ranking formats do not provide information on the relative distance between items to be
ranked.

Our hypotheses are that the BINS format will outperform the MTF on measures of:
completion time, preference, usability (the ease of use of the tool) and number of rank
repositions. After using each ranking format, your opinion of the ranking system was
assessed using a battery of usability questions from a modified version of the System
Usability Scale (SUS). The items related to UD that you were asked to rank were
provided by the Office of Admissions.

Please do not discuss this study with anyone else so as not to bias future participants.

Assurance of Privacy
Your results will only be seen by the investigators. Your name will not be
revealed in any documents resulting from this study.

References
For more information on this topic, you may wish to consult the following sources:


Contact Information
You may contact Jerry Timbrook, (jtimbrook1@notes.udayton.edu, 937-229-
5032) or Dr. William F. Moroney (william.moroney@notes.udayton.edu, 937-229-2767)
if you have any questions or concerns regarding your participation in this research. If
you have any questions regarding participants’ rights in psychological studies as outlined
by the APA Code of Ethics you may also contact the Chair of the Psychology
Department’s Research Review and Ethics Committee at the University of Dayton, Dr. Greg Elvers in SJ 312 (greg.elvers@notes.udayton.edu; 937-229-2171).
Thank you for participating in this study.
APPENDIX M

NUMBER OF RECORDED REPOSITIONINGS BY RANKING FORMAT

<table>
<thead>
<tr>
<th>Number of Repositionings</th>
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<th>BINS</th>
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<td>30</td>
</tr>
<tr>
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<tr>
<td>18</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Mean (SD)</td>
<td>.96 (1.6)</td>
<td>1.8 (3.1)</td>
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<tr>
<td>Mode</td>
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</table>

**APPENDIX N**

**PRELIMINARY STUDY BINS FORMAT, PAPER VERSION, EXPLICIT CONTINUUM**
<table>
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<th>Import</th>
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</thead>
<tbody>
<tr>
<td>Data</td>
<td>Data</td>
</tr>
<tr>
<td>Formats</td>
<td>Formats</td>
</tr>
<tr>
<td>IMPLICIT CONTINUUM</td>
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</tr>
</tbody>
</table>

APPENDIX O
PRELIMINARY STUDY BINS FORMAT, PAPER VERSION.
APPENDIX P

PRELIMINARY STUDY ALTERNATIVES FOR EXPERIMENTAL TASK

<table>
<thead>
<tr>
<th>Availability of recreational facilities on campus</th>
<th>Campus Surroundings (Neighborhood)</th>
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</thead>
<tbody>
<tr>
<td>Quality of on-campus housing</td>
<td>Cost (after scholarships and grants)</td>
</tr>
<tr>
<td>Personal Attention to Students</td>
<td>Quality of social life</td>
</tr>
<tr>
<td>Campus Attractiveness</td>
<td>Quality of majors of interest to you</td>
</tr>
<tr>
<td></td>
<td>Quality of Academic Facilities (Library, etc.)</td>
</tr>
</tbody>
</table>
APPENDIX Q

PRELIMINARY STUDY RANKING TASK INSTRUCTIONS

Note: These instructions were read aloud to participants. Words in italics represent actions that the researcher took while reading the instructions.

Practice Task Instructions (for use with the “Cookie” practice ranking task)

I am now going to explain a ranking procedure to you. You will use this format to answer the next two questions. The first question is a practice question. For the first question, you will rank five cookies from your most favorite cookie to your least favorite cookie. You will accomplish this ranking by placing each cookie in one of the bins along this continuum. [POINT TO CONTINUUM]. By placing a cookie in a bin close to “Most Favorite,” you are indicating that you like this cookie the most. [SHOW THIS PROCEDURE TO PARTICIPANTS]. By placing a cookie in a bin close to “Least Favorite,” you are indicating that you like this cookie the least. [SHOW THIS TO PARTICIPANTS]. If you like two cookies equally, you can stack them on top of one another within the same bin. [PUT TWO COOKIES IN THE SAME BIN SOMEWHERE BETWEEN THE COOKIE IN THE FAVORITE BIN AND THE COOKIE IN THE LEAST FAVORITE BIN] By placing two cookies in this middle bin, you are indicating that you like both cookies equally, but you like them less than [THE COOKIE IN THE FAVORITE BIN] and more than [THE COOKIES IN THE LEAST FAVORITE BIN].

Cookies can be placed in any bin along the continuum. Each bin can contain as many or as few cookies as you’d like. It is ok if some bins do not have any cookies in them. Do you have any questions about the procedure that I have just explained to you? You may now begin your ranking task. Take as much time as you need. Please turn over your paper to indicate that you have finished your ranking task.
Experimental Task Instructions (for use with the “University Aspects” ranking task)

The next question will ask you to rank various aspects of the University of Dayton. You will complete this ranking task using the same procedure as the first question. You will rank ten aspects of the University of Dayton according to how important they were in your decision to attend. By placing an aspect in a bin close to “Most Important,” you are indicating that this aspect influenced your decision to attend the University of Dayton the most. [SHOW THIS TO PARTICIPANTS]. By placing an aspect in a bin close to “Least Important,” you are indicating that this aspect influenced your decision to attend the University of Dayton the least. [SHOW THIS TO PARTICIPANTS]. If two aspects were equally important in how they affected your decision to attend the University of Dayton, you can stack them on top of one another within the same bin. [PUT TWO ASPECTS IN THE SAME BIN SOMEWHERE BETWEEN THE ASPECT IN THE MOST AND LEAST IMPORTANT BINS]. By placing two aspects in this middle bin, you are indicating that both aspects were equally important, but they were less important than [THE ASPECT IN THE MOST IMPORTANT BIN] and more important than [THE ASPECT IN THE LEAST IMPORTANT BIN]. Aspects can be placed in any bin along the continuum. Each bin can contain as many or as few aspects as you’d like. It is ok if some bins do not have any aspects in them. Do you have any questions about the procedure that I have just explained to you? You may now begin your ranking task. Take as much time as you need. Please turn over your paper to indicate that you have finished your ranking task.
APPENDIX R

PRELIMINARY STUDY DECISION MAKING PROCESS QUESTIONNAIRE

Instructions: For this portion of the experiment, we ask you to describe the strategies you used to rank the various aspects of the University of Dayton. To help us understand your decision making process, we ask you to construct a step-by-step decision making sequence describing your decisions as you completed the ranking processes. To help you construct your decision making sequence, we have provided the following examples:

A person with roughly a size 10 foot, purchasing a pair of shoes, might construct a decision making sequence similar to this:

1. Searched shoe styles at store.
2. Selected a pair of shoes, based on color and style.
3. Requested a size 10.
4. Tried the shoes.
5. Checked for comfort. Decided the shoes were too tight.
6. Requested and tried a size 11.
7. Checked for comfort. Decided the shoes were too loose.
8. Requested and tried a size 10½.
9. Checked for comfort. The shoes fit and were the desired color and style.
10. Decided to purchase the shoes.

There is no right or wrong strategy for how YOU ranked the aspects. So, another person’s decision making sequence for shoe purchasing might look like this:

1. Searched shoe styles at store.
2. Based on style and color, the store had no desirable shoes.
3. Decided to go to a different store, where shoes were organized by size.
4. Found the size 10 section.
5. Searched for a desirable color and style.
6. Selected a pair of shoes, based on style and color.
7. Requested a size 10 and tried the shoes.
8. Checked for comfort and desired appearance.
9. The shoes fit, and were of desirable appearance
10. Decided to purchase the shoes.
On the page that follows, please construct your decision making sequence. There is one set of 15 procedure lines, similar to the examples provided above. You may use as many or as few lines as you need. There are no right or wrong answers.
Describe the **decision making process** you used when ranking aspects of the University of Dayton.

1. ________________________________________________________________________

2. ________________________________________________________________________

3. ________________________________________________________________________

4. ________________________________________________________________________

5. ________________________________________________________________________

6. ________________________________________________________________________

7. ________________________________________________________________________

8. ________________________________________________________________________

9. ________________________________________________________________________

10. _______________________________________________________________________ 

11. _______________________________________________________________________ 

12. _______________________________________________________________________ 

13. _______________________________________________________________________ 

14. _______________________________________________________________________ 

15. _______________________________________________________________________ 

**ONCE YOU HAVE COMPLETED YOUR DECISION MAKING SEQUENCE, RETURN YOUR PACKET TO THE RESEARCHER.**
APPENDIX S

PRELIMINARY STUDY USABILITY SCALE

Instructions:

This questionnaire gives you an opportunity to express your satisfaction with the usability of the ranking format you just used. Your responses will help us understand what aspects of the format you are particularly concerned about and the aspects that satisfy you.

Please read each statement and indicate how strongly you agree or disagree with the statement by circling a number on the scale.

Whenever it is appropriate, please write comments to explain your answers.

Thank you!

1. Overall, I am satisfied with how easy it is to use this ranking format.

<table>
<thead>
<tr>
<th>STRONGLY AGREE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>STRONGLY DISAGREE</th>
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<tbody>
<tr>
<td>COMMENTS:</td>
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</tbody>
</table>

2. It is simple to use this ranking format.

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<tr>
<th>STRONGLY AGREE</th>
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</tr>
</tbody>
</table>
3. This ranking format helped me produce the result that I intended.

<table>
<thead>
<tr>
<th>STRONGLY AGREE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>STRONGLY DISAGREE</th>
</tr>
</thead>
</table>

**COMMENTS:**

4. I am able to complete my ranking task quickly using this format.

<table>
<thead>
<tr>
<th>STRONGLY AGREE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>STRONGLY DISAGREE</th>
</tr>
</thead>
</table>

**COMMENTS:**

5. I feel comfortable using this ranking format.

<table>
<thead>
<tr>
<th>STRONGLY AGREE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>STRONGLY DISAGREE</th>
</tr>
</thead>
</table>

**COMMENTS:**

6. It was easy to learn to use this ranking format.

<table>
<thead>
<tr>
<th>STRONGLY AGREE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>STRONGLY DISAGREE</th>
</tr>
</thead>
</table>

**COMMENTS:**


7. I believe I became productive quickly using this ranking format.

<table>
<thead>
<tr>
<th>STRONGLY AGREE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>STRONGLY DISAGREE</th>
</tr>
</thead>
</table>

COMMENTS:
APPENDIX T

PRELIMINARY STUDY SURVEY COMPLETION QUESTIONS

Note: Diagrams in this Appendix were given to participants in the explicit continuum condition. Participants in the other implicit continuum condition received diagrams with an unnumbered continuum.

Instructions: Please circle the option that most closely corresponds to how you completed the ranking task. Please answer each question in order, and do not go back to any page after you have completed it.

1. While completing the University of Dayton ranking task, I reassigned the rank of at least 1 aspect from its initial rank.

   (For example - Sally initially ranked the “Quality of Social Life” aspect 1 slot away from “Most Important.” However, after ranking several other aspects, Sally moved the “Quality of Social Life” aspect to a slot closer to “Least Important.” Therefore, Sally would answer “Yes” to this question as she has reassigned the rank of an aspect.)

   a. Yes
   b. No (Please go to question #3 below)
   c.

2. I reassigned ______ aspects(s) when using the ranking format:

   a. 1-2
   b. 3-4
   c. 5-6
   d. 7-8
   e. More than 8

3. Did you review your final rankings before submitting them?

   a. Yes
   b. No (Please go to question #5 below)
Instructions: After reading the statement below, please circle the response that most closely describes your review process using the ranking format.

4. I very carefully reviewed my rankings before I indicated to the researcher that I had completed the ranking task.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

Instructions: The next two questions focus on the clarity of the instructions for the ranking format. Please circle the response that most closely corresponds to your opinion.

5. The verbal instructions provided by the researcher were easy to understand.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

6. The written instructions provided on the ranking format were easy to understand.

STRONGLY AGREE 1 2 3 4 5 6 7 STRONGLY DISAGREE

Questions are continued on the next page. Please don’t go back to any other pages.
**Please read the following scenario:** Sally was asked to rank three aspects of the University of Dayton according to how important they were in her decision to attend. Sally was asked to complete this task using the same ranking format that you just used. The diagram below represents the final ranking that Sally submitted to the researcher.

![Diagram](image)

**Instructions:** Examine the diagram and then answer the following question in the space provided. Use as much or as little room as you need.

7. In your own words, explain what Sally is communicating with her ranking. What is the order of importance for these three aspects in her decision to attend the University of Dayton?

*Questions are continued on the next page. Please don’t go back to any other pages.*
8. While completing the ranking task, I stacked at least one aspect on top of another aspect within the same bin.
   a. Yes
   b. No (Please go to question #13 on the next page)

9. It was easy to stack aspects on top of one another.

<table>
<thead>
<tr>
<th>STRONGLY AGREE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>STRONGLY DISAGREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMENTS:</td>
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</tbody>
</table>

10. I would prefer a ranking task that did NOT allow me to stack aspects on top of one another.

<table>
<thead>
<tr>
<th>STRONGLY AGREE</th>
<th>1</th>
<th>2</th>
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<th>4</th>
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</tr>
</tbody>
</table>

11. Stacking aspects on top of one another helped me produce the ranking that I intended.

<table>
<thead>
<tr>
<th>STRONGLY AGREE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</table>

12. Learning to stack aspects on top of one another took a long time.

<table>
<thead>
<tr>
<th>STRONGLY AGREE</th>
<th>1</th>
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<th>4</th>
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<td>COMMENTS:</td>
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</tbody>
</table>

Questions are continued on the next page. Please don’t go back to any other pages.
Please read the following scenario: Sally was asked to rank three aspects of the University of Dayton according to how important they were in her decision to attend. Sally was asked to complete this task using the same ranking format that you just used. The diagram below represents the final ranking that Sally submitted to the researcher.

Instructions: Examine the diagram above then circle the option that best fills in the blank in the following sentences. If none of the answers correctly complete the sentence, circle “None of these are correct”.

13. According to the ranking that Sally provided to the researcher, “Quality of social life” was __________________ “Quality of on-campus housing” in Sally’s decision to attend the University of Dayton.
   a. half as important as
   b. equally important as
   c. twice as important as
   d. None of these are correct

14. According to the ranking that Sally provided to the researcher, “Campus attractiveness” was __________________ “Quality of social life” in Sally’s decision to attend the University of Dayton.
   a. half as important as
   b. equally important as
   c. twice as important as
   d. None of these are correct

Questions are continued on the next page. Please don’t go back to any other pages.
15. According to the ranking that Sally provided to the researcher, “Quality of on-campus housing” was ______________ “Campus attractiveness” in Sally’s decision to attend the University of Dayton.
   a. half as important as
   b. equally important as
   c. twice as important as
   d. None of these are correct

16. Think back to when YOU were completing the “University Aspects” ranking task. When positioning aspects, did you consider the numeric relationship between the bins? For example, did you believe that an aspect in the fourth bin was half as important as an aspect in the second bin? A copy of the ranking format is included below for your reference.
   a. Yes
   b. No

*Questions are continued on the next page. Please don’t go back to any other pages*
17. This ranking format and the ranking procedure were designed by the researchers with a specific metaphor in mind (the format was designed to mirror a physical item). What metaphor do you think the researchers were trying to convey?

*Questions are continued on the next page. Please don’t go back to any other pages.*
18. This ranking format was designed to mirror a rack of test tubes. Do you think that is a valid comparison? Why or why not?

19. Can you think of an item or a process that is a better metaphor for this ranking format? Explain your answer.

*Questions are continued on the next page. Please don’t go back to any other pages.*
Instructions: The ranking format pictured above is different than the format you used to complete your ranking task. This ranking format DOES NOT include numbers along the continuum. Your ranking format DID include numbers along the continuum. Examine the diagram above then circle the option that best corresponds to your opinion.

20. Do you think your ranking task would have been easier if you used the ranking format pictured above?
   a. Yes
   b. No

Questions are continued on the next page. Please don’t go back to any other pages.
21. Did you feel that the ranking task required you to place at least one alternative in the FIRST bin? (The bin closest to “Most Important.”)
   a. Yes
   b. No

22. Did you feel that the ranking task required you to place at least one alternative in the LAST bin? (The bin closest to “Least Important.”)
   a. Yes
   b. No

**Instructions:** Please answer the following questions in the space provided.

23. What is the one thing that you liked best about this ranking format? Why?

   

24. What is the one thing that you liked least about this ranking format? Why?

   

25. If there was one thing that you could change about this ranking format, what would it be? Why?

   