Category Width and New Household Technology Adoption: Developments of the Measures

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ABSTRACT

This article reports on preliminary developments related to investigating the role of "category width" in the adoption of new household technology. Category width is a construct originally developed by Pettigrew (1958) and previously shown successful in a marketing context involving the trial of new grocery products. The outcomes of this work include a revised Category Width Scale (C-W-S) and the preliminary development and draft of a new Technology Adoption Scale (T-A-S).

Keywords: Category Width, Household Technology, Technology Adoption, Technology Adopters

INTRODUCTION

Considerable research has focused on the correlates of new household technology adoption (TA) (Brown, 2008; Brown, et. al 2006; Larousa, 1998; Rosen, et. al, 1998), and numerous studies have reported a variety of correlates of new technology adoption (Kralewski, et. al, 2008; Nasco, et. al, 2008; Wee, 2003). While some believe the predisposition toward TA is not a generalized consumer trait, others believe that further research is needed. It is clear that similar to the classic diffusion-of-innovation research, some commonalities among TA's are notable, such as being younger, better educated, had higher incomes, and coming from larger families (Lourosa, 1998). In a recent study (Eckrich, et. al., 2004), the roles of twelve variables used previously in early-adoption research were examined as they related to different levels of new technology ownership.

This study examines *category width*, a cognitive variable seemingly neglected in the marketing literature since 1973 when its potential was first explored (Donnelly and Etzel, 1973). In this early work, *category width* (Pettigrew, 1958) was shown to be generally related to a housewife's willingness to try different types of new products (i.e. artificially, marginally, and genuinely new). Using convenience products, housewives' willingness to accept two different kinds of risk typically involved with new product trial were statistically associated with the new products they reported to have purchased. The alternative types of risk were described by two consumer profiles: one where a consumer is willing to risk purchasing some new products with which he/she may not be satisfied, and the other where a consumer risks avoiding new products that could provide more satisfaction by restricting his/her selection set to those with which he/she is familiar. Since *category width* was originally postulated to "tap" a risk-taking dimension comparable to a subject's willingness to tolerate Type I and II errors, the connection with consumer decision-making and new product trial seemed quite logical. Although Donnelly and Etzel (1973) concluded that a housewife's *category width* and new product trial were related, an extensive recent literature search failed to locate any further evaluation/examination of *category width* in the marketing literature.

THEORETICAL BACKGROUND

Category width, as operationalized by Pettigrew's (1958) Category Width Scale (hereafter C-W-S), is a cognitive variable that purportedly reveals individual differences in categorization strategy. Subjects differ in terms of broadness and narrowness of judgments of *category width.* In theory, "broad categorizers seem to have a tolerance for Type I errors: they risk negative instances in an effort to include maximum positive instances. By contrast, narrow categorizers…exclude many positive instances by restricting their category ranges to minimize the number of negative instances."(p. 532) A broad categorizer, therefore, might be willing to adopt new technology based on its potential to produce heretofore unknown benefits and provide greater utility despite the potential downside risks (e.g. a genuinely new product). On the other hand, a narrow categorizer might disregard upside benefits precisely because of the unknown risks associated with the technology, and the availability of more conventional means of obtaining the same utility (e.g. no need for DVD's when video tapes can do the same thing). C*ategory width* should be related to how subjects behave toward the adoption of new household technologies which pose significant levels of purchase risks. If true, *broad* and *narrow*

categorizers should exhibit different household technology ownership profiles, where broad categorizers are generally more favorably predisposed and own more of the latest household technology products.

DEVELOPMENTS

Pettigrew's C-W-S was built around twenty unique "categories." Each category presented a central location on a distribution of an obscure parameter and the subject's task was to speculate on the likely upper and lower boundaries of the parameter's distribution. Theoretically, a subject's general processing strategy was required in order to choose between plausible boundaries. For instance, one of the original categories asked "What do you think (was) the weight of the heaviest ship registered with the U.S. Maritime Commission in 1946?" Categories were intentionally obscure to ensure that subjects could not intuit or otherwise derive answers from situation-specific knowledge. Instead, subjects would have to reveal their willingness to offer an extended or shortened range of the category boundaries (i.e. the category width). While reports confirm the administration of the original C-W-S to "thousands of subjects" in numerous studies up through the mid-90's (Massaro & Ferguson, 1993; Huang & Chao, 1996), greater than half of the original categories were felt to be significantly out-of-date for a study involving the ownership of 21st-century technology (as noted in the U.S. Maritime 1946 example above). Thus, the first development was to "contemporize" the original scale by creating 13 new category statements.

The second development was related to the need to measure *technology adoption (TA),* a construct previously operationalized through a summated series of technology ownership questions (Eckrich, et al, 2004; Lourosa [Yankee Group Study], 1998). In these instances, a TA score was derived from a list of thirteen widely recognized household technologies (e.g. the latest Pentium PC and video-capable cell phones, etc.). Unable to locate a published adoption instrument for this research, it was necessary to develop a TA scale. Using widely accepted scale-development protocols would also provide a solid foundation for future research.

The third development was simply finding a means of assessing a subject's exposure to new household technologies. An updated list had to be generated to reflect the variety of household technologies available.

METHODOLOGY

Revising Pettigrew's Scale.

The C-W-S is a self-administering, 20-item instrument which takes about 25-30 minutes to complete. Each item consists of two responses, one for the terminus of each end of a parameter's response range, and each scored 0 to 3. Summed across all twenty items (40 termini), the highest score of 120 represents the *broadest* category width possible, while a score of 0 represents the *narrowest* category width. A second form of *category width* measurement called the "Natural Category Width Scale" was used by Massaro & Ferguson (1993, p. 31), and consists of "eight questions each of which listed a common semantic category and four possible members of the category. The questions asked subjects to indicate the instances they considered to be…members of a given category." Unfortunately, the results of the Natural Category Width scale did not correlate with the original Pettigrew scale and the authors suggest that "Another conceptualization of the category width phenomenon might warrant consideration." (Massaro &

Ferguson, 1993, p. 47). Earlier, Lake (1973) reported that no additional research by Pettigrew had been done on the scale since its appearance. Further efforts to locate additional revisions of the C-W-S or other tests of performance were unsuccessful.

The problem with administering the original C-W-S was that thirteen of the original items included references to 20th century dates or phenomenon greatly changed over the past half century (e.g. the speed of trains, the number of lynchings, etc.). These items were considered too dated for any realistic expectation that subjects would find the tasks sufficiently engaging or relevant to encourage them to compete the entire 30-minute exercise. Specifically, statements originally numbered 4-7, 9-12, 15, and 17-20 were judged unusable.

To replace these items, a survey of the World Almanac (2006) was used to create an inventory of 20 potential categories (scenarios). Categories were created from a variety of tables and exhibits in the Almanac arranged to produce obscure scenarios roughly similar to the original ones. The idea was to create more than needed and allow independent judges to gauge their suitability as replacements. Three colleagues were given the list of out-of-date questions and asked to find the "best fit" replacements for each from the new list of 20. Exhibit 1 presents the list of the most often chosen replacements.

Once the replacements had been chosen, Pettigrew's (1958) original method of selection was used. The replacement categories were administered as open-end questions to 213 students in three undergraduate marketing classes. Numerical responses were collected on each category, and fixed-alternatives for the final form were chosen on the basis of response values at the 10th, 35th, 65th, and 90th percentile locations. When inserted in place of original scale categories, the overall format was topically rearranged to ensure the new categories were dispersed among the remaining ones.

Technology Adoption Scale.

The second construct operationalized was predisposition toward the adoption of new household technologies. Assuming that predisposition was a unidimensional construct (gradients of favorable to unfavorable), it was decided to attempt the development of a new scale using Thurstone's method of equally-appearing intervals (Trochim, 2005). When completed, the new scale would consist of relatively few items ranging across multiple statements related to the original construct, and would produce a single-score interpretable as an interval measure of the construct (Trochim, 2005; Thurstone, 1925).

Thurstone's method requires several stages of development beginning with the definition of the construct sufficient to enable a large number of participants to have a clear idea what measurement is being proposed. In this case, 40 students in an undergraduate marketing class were told the construct was a subject's inherent predisposition toward owning the very latest household technology. In other words, if there were a household (imaginary if needed) considered the <u>most technologically advanced</u>, what statements would that household's decision-maker answer differently than the decision–maker in a non-technologically advanced household. In combination, students generated a list of 128 different statements they felt achieved this goal.

The next task presented these statements to judges charged with sorting them into eleven piles, ranging from most favorable in producing the desired outcome to the least favorable. Eight non-student judges participated in the sorting activity. Since various sources describe the final selection of statements using either means or medians and inter-quartile differences, it was decided to use means for this research. Exhibit 2 presents the final selection of 15 statements based on mean scores and the smallest inter-quartile differences within similar groups. Question

16 on the list was included as a separate self-report measure of a subject's predisposition toward owning new household technology.

Household Technology Ownership.

The list of household technology products from the previous research was over three years old and underdeveloped. Students who participated in generating the scale statements above, were at the same time asked to brainstorm a list of items they felt would characterize a household as being technologically advanced. In response, they successfully brainstormed a list of 48 unduplicated technology products displayed in Exhibit 3.

RESULTS

The revised instrument was administered to 194 undergraduates (69 males, 125 females), from two universities; a large public school in Florida and a medium-sized private school in New York. As shown in Exhibit 3, the initial data (2006[a]) compares favorably with the performance of Pettigrew's original data. Males produced a mean C-W score of 64.3 (broader) compared with females with a mean of 58.2 (narrower). A t-test of the means produced a t-value of 3.05, significant at $p < .003$, consistent with Pettigrew's finding. Second, although the sample did not exhibit as great an upper-range in scores as Pettigrew's (90 to 117 for males; 91 to 99 for females), differences in sample size and composition may explain some of the reduced variability and the trend is nevertheless similar.

In order to compare the performance of the revisions, Cronbach's coefficient alpha was calculated. Where Pettigrew had run a Spearman-Brown coefficient on an odd-even item split half form of the instrument given to 97 students (S-B=.72), the sampling done for this study did not permit retesting. SPSS allows for coefficient alpha comparisons item-by-item, and thus provides a measure of potential improvement in overall internal consistency associated with the removal of any one item from the scale. As a result, three items were highlighted for removal: two from the newest revisions and one from the original scale. The item from the original scale referenced the average speed of sailing ships (a time/speed dimension), and the others referenced the more general, direct judgment dimensions, namely the highest number of births to unmarried mothers in New Hampshire and the longest Atlantic Coast shoreline of any state. In both cases, only half of the original item was detrimental to internal consistency. It is not yet clear what the operational impact will be for respondents if these items were to be removed permanently.

Once removed, scores were recomputed and produced the highest available coefficient alpha of .829. In view of the improved internal consistency, the same analysis as referenced earlier was performed and is shown in the bottom portion of Table 1. It shows that the mean C-W scores for both males and females increased and that the removal of the three items resulted in the loss of low-end participants (the two visible scores that dropped were C-W=8 for males, and C-W=7 for females). The impact on the t-test was to boost the mean difference and statistical significance bringing the limits of the distribution's thirds closer to Pettigrew's original data. The profiles for males were especially close.

At this point, our first attempt to revise Pettigrew's C-W-S has been shown successful in its capacity to replicate the performance of Pettigrew's 1958 scale. Work remains in-progress to identify and further develop additional items for an expanded inventory of replacement items and to finalize the instrument for field applications. Nevertheless, proposed revisions to the C-W-S and the development of a new household technology scale help pave the way toward additional research into household technology adoption and investigating the role of category width.

Exhibit 1. Thirteen Newly Developed C-W-S Categories

1. Over the past 50 years, the daily temperature in Washington, D.C. has averaged *58 degrees Fahrenheit*. What do you think:
    a. …was the highest-ever recorded temperature in Washington, D.C.
        1. 97° 2. 101° 3. 105° 4. 112°
    b. ...was the lowest-ever recorded temperature in Washington, D.C.
        1. -12° 2. -21° 3. 5° 4. 10°
2. According to the 2004 Computer Industry Almanac, the top 15 nations in the world with the most personal computers in use average *41.1 million computers* each. What do you think:
    a. is the highest number of personal computers in use by the #1 ranked nation?
        1. 49 million 2. 70 million 3. 258 million 4. 104 million
    b. is the fewest number of personal computers in use by the #15 ranked nation?
        1. 15 million 2. 10 million 3. 2 million 4. 30 million
3. Over the last four years, tornado activity in the U.S. has been heaviest in the month of May with an average of *242 tornadoes per year*. What do you think:
    a. was the greatest number of tornadoes in May during this period.
        1. 200 2. 410 3. 500 4. 600
    b. was the fewest number of tornadoes in May during the period.
        1. 204 2. 102 3. 30 4. 295
4. The National Aeronautics and Space Administration has reported that the U.S. has launched an average of *2932 successful space launches* per decade since 1960. What do you think:
    a. is the largest number of successful U.S. space launches in any decade since 1960.
        1. 400 2. 520 3. 297 4. 350
    b. is the smallest number of successful U.S. space launches in any decade since 1960.
        1. 250 2. 175 3. 10 4. 100
5. According to the 2000 U.S. Census, between 1990 and 2000, the total U.S. labor force accounted for by immigrants increased an average of *18% per year*. What do you think:
    a. was the highest percentage of growth in the U.S. labor market accounted for by immigrants in any year since 1960?
        1. 26% 2. 45% 3. 23% 4. 32%
    b. was the lowest percentage of growth in the U.S. labor market accounted for by the immigrants in any year since 1960?
        1. 13% 2. 8% 3. 10% 4. 5%
6. During the period 1990-2004, an average of *101 fatalities* occurred annually in accidents of U.S. regularly scheduled commercial airlines. What do you think:
    a. was the single highest number of fatalities in any one of these years.
        1. 338 2. 200 3. 139 4. 840
    b. was the single fewest number of fatalities in any one of these years.
        1. 70 2. 0 3. 17 4. 49

7. The average number of births to unmarried mothers reported by the Department of Health & Human Services of the State of New Hampshire between 1995 and 2003, was *3,439 per year*. What do you think:
    a. was the highest number of births annually to unmarried mothers in New Hampshire during this period.
        1. 3600 2. 5000 3. 4500 4. 6550
    b. was the lowest number of births annually to unmarried mothers in New Hampshire during this period.
        1. 1500 2. 500 3. 3005 4. 2000
8. Thirteen U.S. states border the Atlantic Ocean with an average coastline per state of *159 miles*. What do you think:
    a. is the longest Atlantic Ocean shoreline of any state?
        1. 400 2. 300 3. 700 4. 200
    b. is the shortest Atlantic Ocean shoreline of any state?
        1. 30 2. 51 3. 10 4. 94
9. The 2004 Computer Industry Almanac reports that the top ten nations in the world with the most Internet users average *58.4 million* users each. What do you think:
    a. is the highest number of Internet users in the top ranked country.
        1. 130 million 2. 90 million 3. 350 million 4. 70 million
    b. is the fewest number of Internet users in the 10th ranked country.
        1. 7 million 2. 1 million 3. 40 million 4. 20 million
10. The EPA has documented that an *average of 25* separate hazardous waste sites per state currently exist in the U.S. What do you think:
    a. is the largest number of hazardous wastes sites in any state?
        1. 33 2. 45 3. 54 4. 95
    b. Was the fewest number of visits to the #10 ranked news and information site?
        1. 18 2. 5 3. 11 4. 2
11. A study of life expectancies of mean and women in 226 countries concluded the average per country to be *66.9 years*. What do you think:
    a. was the highest average life expectancy of all the countries.
        1. 94 2. 79 3. 74 4. 85
    b. was the lowest average life expectancy of all the countries.
        1. 38 2. 57 3. 27 4. 49
12. The National Safety Council has reported that during the fifteen years from 1990 to 2004, an average of *1,090 accidental* deaths have occurred from firearms during this time?
    a. is the highest annual averages of accidental firearms deaths during this time.
        1. 2200 2. 1790 3. 3000 4. 1300
    b. is the lowest annual average of accidental firearms death during this time.
        1. 500 2. 800 3. 920 4. 150
13. Over the past 40 years, the average total number of oceangoing U.S. merchant ships larger than 1,000 metric tons was *1,031 per year*. What do you think:
    a. was the highest total number of these ships in any year since 1963?
        1. 1700 2. 1200 3. 4600 4. 2500
    b. was the smallest total number of these ships in any year since 1963?
        1. 138 2. 900 3. 500 4. 752

Exhibit 2. Technology Adoption Scale

	Statement	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
1.	My mother goes on the Internet almost every night.	☐	☐	☐	☐	☐
2.	I shop on-line.	☐	☐	☐	☐	☐
3.	I own several electronic devices that cost more than $200 each.	☐	☐	☐	☐	☐
4.	I like to do as little physical work as possible at home.	☐	☐	☐	☐	☐
5.	Friends and family often come to see me (my family) when they have questions regarding technology.	☐	☐	☐	☐	☐
6.	We were allowed to play with computers and other technology at a young age at my house.	☐	☐	☐	☐	☐
7.	My household is up-to-date with the newest technological trends.	☐	☐	☐	☐	☐
8.	We have several CD players, I-Pods and other technology in our house.	☐	☐	☐	☐	☐
9.	Our household is often considered the most advanced technologically of any house in the neighborhood.	☐	☐	☐	☐	☐
10.	My family buys new technology as soon as it comes on the market.	☐	☐	☐	☐	☐
11.	Our house is totally wireless in terms of computer accessibility.	☐	☐	☐	☐	☐
12.	We frequently visit technology showcases, computer fairs, and exhibitions.	☐	☐	☐	☐	☐
13.	My family does extensive research on a technology product before purchasing it.	☐	☐	☐	☐	☐
14.	Many appliances in our house work through remote controls.	☐	☐	☐	☐	☐
15.	We have a technologically-advanced product in each room of our house.	☐	☐	☐	☐	☐
16.	All in all, I think I am in the top 5% of consumers interested and willing to buy the latest home technology products.	☐	☐	☐	☐	☐

Exhibit 3.
Comparing Pettigrew's Original C-W-S Performance with Revised C-W-S Performance

Limits of Distribution's Thirds										
Year	**Sex**	**N**	**C-W Mean**	**Range**	**Std Dev**	**t-value**	**p < __**	**Narrows**	**Mediums**	**Broads**
1958	**Male**	**218**	**71.9**	**23-117**	**17.3**	**4.55**	**<.001**	**0-66**	**67-78**	**79-120**
	Female	**116**	**64.5**	**34-99**	**12.0**			**0-58**	**59-70**	**71-120**

Limits of Distribution's Thirds										
2006[a]	**Male**	**69**	**64.3**	**8-90**	**13.4**	**3.05**	**<.003**	**0-62**	**63-70**	**71-120**
	Female	**125**	**58.2**	**7-91**	**13.2**			**0-55**	**56-63**	**64-120**

Limits of Distribution's Thirds										
2006[b]	**Male**	**69**	**66.71**	**14-91**	**12.8**	**3.18**	**<.002**	**0-65**	**66-72**	**73-120**
	Female	**125**	**60.7**	**13-91**	**12.34**			**0-54**	**55-62**	**63-120**

[a] Prior to scale reduction resulting from Cronbach's Coefficient Alpha analysis
[b] Following scale reduction resulting from Cronbach's Coefficient Alpha analysis

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