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A COMPARISON OF TWO MEASURES OF REUSE AND RECYCLING BEHAVIOR: SELF-REPORT AND MATERIAL CULTURE

VICTOR CORRAL VERDUGO
Universidad de Sonora, Mexico and
University of Arizona, Tucson

GERARDO BERNACHE
University of Arizona, Tucson

LILIA ENCINAS
Universidad de Sonora, Mexico

LYDIA C. GARIBALDI
Universidad de Sonora, Mexico

ABSTRACT

Reuse and recycling patterns of fifty Mexican families were studied. Such patterns were assessed from 1) the hands-on recording of the presence of reusable and recyclable items in the garbage discarded by a sample of families (their material culture) and 2) the analysis of self-reports given by housewives regarding their reuse or recycling practices. A comparison of the two types of data obtained was made by using regression analyses, which revealed a non-significant correlation between most of the self-reported reuse/recycle activities and the material record of the actual presence of reusable/recyclable products in trash samples. Then, a confirmatory factor analysis of both indicators of reusing and recycling revealed that each method measures a different construct. These two constructs seem to be independent since their statistical correlation is frail and non-significant. A discussion of the nature of such constructs is developed, and the significance of these findings is considered.

Classically, two types of methods have been employed to study refuse behaviors. In one, subjects are asked to report the quantity of products they reuse or recycle as an indication of pro-environmental behavior [1-3]; in the other method,

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behavior is inferred from careful measurements of the material components of garbage. The latter method entails direct hands-on sorting, coding and recording of refuse components, and subsequent analysis of the raw composition data [4, 5].

The use of more than one type of measure in studying any behavior or event has important methodological implications which are especially related to the issue of measurement validity. According to Campbell and Fiske, justifying a claim that a construct is valid (i.e., that the instruments used measure the factor under investigation) is difficult when an investigator relies on a single research method [6]. This has led to the development of research strategies that employ several methods of measurement in order to better understand the variables under study. By using such strategies, the investigator expects that the same or comparable results will be produced by the different methods, since they ostensibly measure the same factor. This circumstance is known as *convergent validity.* The opposite case, *divergent or discriminant validity,* occurs when there is low correspondence among different methods, which suggests that they measure different phenomena [6].

When studying refuse disposal behavior, the convergence among methods above mentioned is not easily found. A sustained program of research on this methodological issue has been carried out by the archaeologists of the "Garbage Project" at the University of Arizona. William Rathje has presented a model of the relationship between verbal responses and material realities [7, 8], according to which what people say is very different from what they do. Rathje has shown that a clear disparity exists between data resulting from material measurements and data reported by individuals with regard to their garbage disposal practices [9]. According to this author, subjects' verbal reports regarding their own behavior are strongly influenced by erroneous beliefs, attitudes, perceptions, and even myths about the behavior in question. Rathje and Murphy demonstrate ". . . the tendency of people to be unreliable sources of quantitative information about their behavior" [8, p. 67].

Cote further tested that hypothesis by investigation the correlation between the report of a group of individuals regarding their food consumption and the record of food traces found in their garbage cans [10]. His results revealed that only two products out of fifteen produced correlations greater than .50. In addition, McGuire used regression analyses to investigate the relationship between verbal reports of aluminum and newspaper recycling and the actual presence of these objects in garbage [11]. With their own data analysis, both Cote and McGuire obtained non-significant regression coefficients; such results support Rathje's hypothesis of a disparity between actual behavior and reported behavior.

More comprehensive studies could be carried out by including a wide range of variables associated with refuse disposal. Cote studied only a pattern of food consumption and did not consider additional products, while McGuire was mainly interested in aluminum and newspaper recycling. Their results are valuable, since they opened an area of useful research. However, it is time to replicate and

confirm these hypotheses on new ground. New research should include more products and a greater variety of refuse practices. The research done by Rathje and his colleges at the Garbage Project has produced key advances in this area, in sharp contrast with the general lack of concern from psychological researchers studying environmental behavior—the combination of these two measures is rarely used. Even when they are combined [12], the testing of correspondence among both measures as an indication of construct validity is not reported.

In addition, no research confirming the hypothesis of two different factors (i.e., behavior and perception of self-behavior) has been produced so far. Although some of the studies mentioned previously have shown that there is a lack of correspondence between self-reports of behaviors and material culture, this has been accomplished by means of comparing reports of single categories of items or actions related to garbage disposal. In order to investigate the assumption that two different entities (actual and perceived behavior) are the causes of the lack of correspondence, it is necessary to demonstrate that the disparity between the two methods is also found when comparing clusters of categories of verbal responses and material realities. This confirmation could be developed by using confirmatory factor analysis on data obtained from self-reports and material measures. If this bi-factorial structure is confirmed, one could be more confident in labeling material measurement results as caused by "actual behavior" and self-report responses as caused by "the perception for behavior." In addition, the correlation (covariance) between these two factors could be estimated.

Finally, such a confirmation would make possible assessing actual proenvironmental behavior (as a construct) with garbage analysis. The potential use of these results is wide-ranging, since a latent variable derived from an objective methodological approach such as the recording of material culture could be used to help test predictive models of responsible environmental behavior.

The present study is part of a larger project wherein households' daily refuse, their consumption patterns, and associated demographic characteristics were investigated. This study was carried out in an urban zone of northwestern Mexico. New variables that included a wide range of products and reuse patterns were included so that we could confirm or reject the hypothesis regarding the disparity between reported behavior and the material traces of such behavior. Recording protocols were an adaptation from those developed by the Garbage Project [5, 13]. In addition, a bifactorial model of actual and perceived behavior was developed and tested using such variables and their corresponding data.

METHOD

Subjects

Fifty randomly-selected families of a representative residential zone of Hermosillo, Mexico, were investigated. The sample was selected following two

steps: first, a representative city's zone was chosen as the area of study to match the parameters of INEGI [14], the Mexican census office, with regard to income, number of family members, and educational level. Then, fifty houses were randomly selected from the representative zone. Responses to self-report instruments were given by housewives who, in Mexico, traditionally have the responsibility for purchasing products and deciding on garbage disposal practices. When analyzing the distribution of population characteristics in this sample, it was found that the age of respondents and household size were normally distributed, while income showed a positive skewness, which indicates that most families of this sample are middle-low and low-class families. This sample corresponds to the general population characteristics of Hermosillo, and is considered as an indicator of representativeness.

Instruments

A self-report questionnaire investigating reusing and recycling practices was used. The first section consisted of questions investigating the amount of reuse of non-packaging paper, packaging paper, cloth/textiles, and corrugated cardboard while the second section included questions about the recycling of glass, aluminum, newspapers, and steel. The structure of this questionnaire was similar to that of the instrument used by DeYoung [1], and it includes four response options: "never," "sometimes," "often," and "always" (see Appendix 1).

The material measurement consisted of an adapted version of recording forms developed by the Garbage Project [5, 13]. Such forms are designed to capture a wide array of data suitable for material component analysis. These forms include columns where type of product, frequency of products and their classification as recyclable and reusable is annotated. In this study a column of "reuse evidence" was added (see Appendix 2).

Procedure

Housewives' consent to participate in this study was obtained and then the investigators proceeded to pick up their garbage bags, which contained the last four days of household refuse. A second pick-up collected the garbage of three additional days, so that a full-week sample of refuse was obtained. The garbage collection was done in November, and care was taken to avoid holidays which would bias the sample of a "normal" week. The garbage bags were transported to a University of Sonora facility converted to a garbage laboratory, and then the contents were analyzed. During the last day of garbage collection, housewives responded to the questionnaire, which included their report of reuse and recycling behaviors. These results were then contrasted with those of the material measurement.

Data Analysis

The information obtained was recorded for analysis. On one hand, the answers to self-report questions were numerically coded: "never" = 4, "sometimes" = 3, "often" = 2, and "always" = 1. On the other hand, garbage data were coded according to the frequency of items found in garbage samples. This coding assigned lower numeric ranks to higher levels of reuse and recycling behaviors.

Bivariate regressions of self-report results (considered here as a dependent variable, DV) on garbage analysis results (the independent variable, IV) were done for each of the variables under study (i.e., reuse of non-package paper, reuse of package paper, reuse of cloth and textiles, reuse of cardboard, recycling of glass, recycling of aluminum, recycling of newspaper, and recycling of steel). If the results of this analysis were to reveal a high correlation between the dependent and the independent variables, then the conclusion would be that a significant agreement exists between the records produced by the self-report and by the garbage analysis methods. Therefore, a significant regression coefficient would be expected as well as a high value of the R^2 statistic (which indicates the amount of the DV variance accounted for by the IV) associated with each model. A $p < 0.05$ associated to T was required in order to accept a regression coefficient as significant. In addition, a minimum value of $R^2 = 0.25$ was expected in order to consider the IV-DV relationship as acceptable.

Moreover, a confirmatory factor analysis (CFA) was used to test the hypothesis of the existence of two separate constructs related to the two measurement methods. One CFA was done on recycling data and another on reuse data. For each set of data a bifactorial structure subjacent to the interrelationships between measures was pre-specified: the material measurement items were assigned to converge on a factor (actual behavior) and the self-report results on the other (perceived behavior). In addition, the covariance among methods was estimated, in order to assess whether or not these constructs were significantly related to each other. These analyses were performed using the EQS statistical package [15], which in addition to reporting factor coefficients (lambda weights) also produces goodness to fit indicators: chi-square (X^2), Bentler-Bonett Normed Fit Index (BNFI), Bentler-Bonett Nonnormed Fit Index (BNNFI) and Comparative Fit Index (CFI). A non-significant X^2 as well as high values—higher than .900 and close to 1.00— of BNFI, BNNFI, and CFI are expected [15] as indications of an adequate correspondence between Rathje's Model and the data.

RESULTS

Table 1 shows the results of regressing the reported indicators of reuse against their corresponding material indicators. In no case was a significant T value obtained, which indicates that the reuse self-report does not predict actual reuse practices. Values of R^2 varied from .002 to .034 (the highest). Since R^2 is the

Table 1. Correspondence among Self-Reports and Material Measurements of Reuse Products (Bivariate Regression)

Variable	*DF*	Effect Size	*T*	Prob>*T*
A) Dependent variable: PAPER REUSE (MATERIAL) $R^2 = 0.002$				
INTERCEPT	1	0.58247	1.58	0.1191
PAPER REUSE[a]	1	0.05154	0.35	0.7231
B) Dependent variable: PACKAGE-PAPER REUSE (MATERIAL) $R^2 = 0.0002$				
INTERCEPT	1	2.01288	2.04	0.0468
PACK-PAPER REUSE[a]	1	0.05154	–0.31	0.7538
C) Dependent variable: CARDBOARD REUSE (MATERIAL) $R^2 = 0.034$				
INTERCEPT	1	0.05246	0.30	0.760
CARDBOARD REUSE[a]	1	0.07206	1.30	0.198
D) Dependent variable: CLOTH AND TEXTILES REUSE (MATERIAL) $R^2 = 0.011$				
INTERCEPT	1	0.96153	1.66	0.102
CLOTH REUSE[a]	1	–0.11538	–0.71	0.471

[a]Independent variables correspond to self-report method.

square of *r*, the coefficient of linear correlation, this means that a correlation higher than .18 was not obtained among any of the VD-VI comparisons of the reuse indicators.

Table 2, on the other hand, exhibits results of regressing the reported indicators of recycling against the corresponding results of the material measurement. This time two significant regression coefficients were obtained: One for newspaper recycling ($T = 2.25$, $p = 0.0149$) and the other one for steel recycling ($T = 2.45$, $p = 0.0177$). One could conclude that a high correspondence between the material measurement and the self-report measurement exists with regard to these two products. However, if the R^2 value for both regression models is observed, it will be noticed that this value is equal to 0.11, which means that the correlation between both methods is about .34, a *statistically significant* but nonetheless *weak* correlation.

Table 2. Correspondence among Self-Report and Material Measurements of Recycling Products (Bivariate Regression)

Variable	*DF*	Effect Size	*T*	Prob>*T*
A) Dependent variable: GLASS RECYCLING (MATERIAL) $R^2 = 0.0208$				
INTERCEPT	1	3.50265	3.77	0.0004
GLASS RECYCLING[a]	1	−0.01272	−0.02	0.9774
B) Dependent variable: ALUMINUM RECYCLING (MATERIAL) $R^2 = 0.029$				
INTERCEPT	1	1.52599	0.98	0.3317
ALUMINUM RECYCLING[a]	1	0.71176	1.21	0.2328
C) Dependent variable: NEWSPAPER RECYCLING (MATERIAL) $R^2 = 0.117$				
INTERCEPT	1	0.08667	0.08	0.9348
NEWSPAPER RECYCLING[a]	1	1.16666	2.52	0.0149
D) Dependent variable: STEEL RECYCLING (MATERIAL) $R^2 = 0.112$				
INTERCEPT	1	1.35643	0.76	0.4653
STEEL RECYCLING[a]	1	2.57920	2.45	0.0177

[a]Independent variables correspond to self-report method.

A final corroboration of the lack of correspondence among the two methods was obtained by using confirmatory factor analysis. This lack of correspondence was—in hypothesis—thought to be explained by the existence of two different constructs measured by each (material, self-report) technique. This hypothesis was tested.

In Figure 1 the set of relationships between the material indicators or reuse and their corresponding construct (actual reuse behavior) is shown. All but one factor loading were significant ($p < 0.05$). Similar results were obtained for the lambda loadings produced among the self-report indicators and their corresponding factor (perceived reuse behavior). In this case all of the factor coefficients were significant. The covariance among both constructs is low (0.166) and nonsignificant. Goodness of fit indicators confirmed the correspondence among this bi-factorial model and the data ($X^2 = 7.28$, [$p = 0.9925$]; BNFI = 0.979, BNNFI = 1.053, CFI = 1.000).

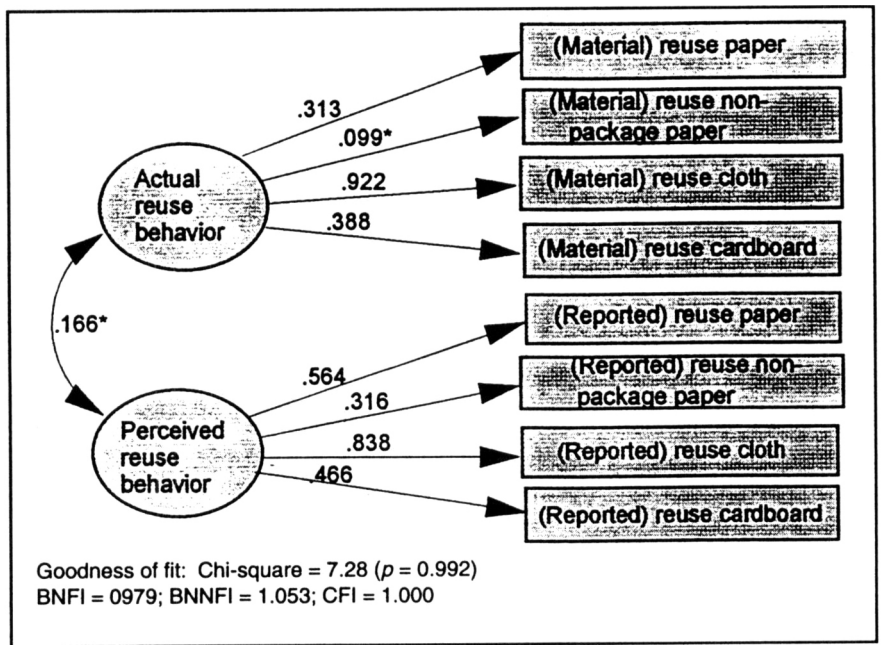

Figure 1. Confirmatory factor analysis of the "Actual reuse" and "Perceived reuse" constructs. Lambda loadings are standardized coefficients. All factor loadings are significant at $p < 0.05$ except those marked with an asterisk (*). The covariance among factors is non-significant. BNFI = Bentler-Bonett Normed Fit Index; BNNFI = Bentler-Bonett Nonnormed Fit Index; CFI = Comparative Fit Index.

Finally, Figure 2 shows the second model of bi-factorial structure obtained for the recycling data using factor analysis. As in the former case, here the convergence of the material indicators on a factor (actual recycling behavior) was tested as a separate construct structure from the self-report indicators convergence on the second factor (perceived recycling behavior). In this case, two additional arrows (factor loadings) were included. These correspond to the material indicator of aluminum recycling, and the self-reported indicator of steel recycling which, as was mentioned before, produced significant correlations with their alternate method. Therefore, a lambda loading from perceived recycling behavior on the material indicator of aluminum recycling, and another lambda loading from actual recycling behavior on the self-reported indicator of steel recycling were included and tested in this model. These lambda loadings were significant. In addition, results showed that two factor loadings from actual recycling behavior on its corresponding (material) indicators were significant, as well as all the lambda

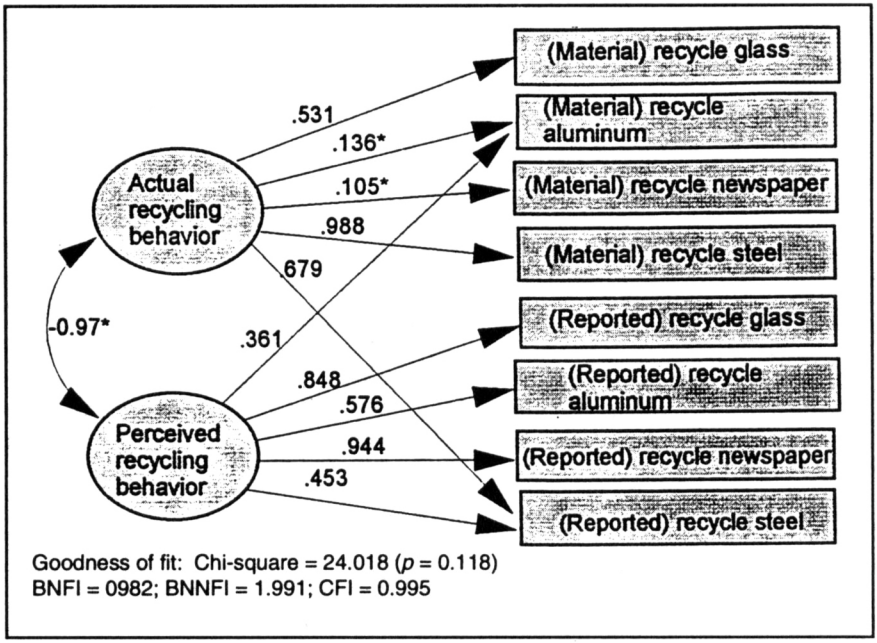

Figure 2. Confirmatory factor analysis of the "Actual recycling" and "Perceived recycling" constructs. Lambda loadings are standardized coefficients. All factor loadings are significant at $p < 0.05$ except those marked with an asterisk (*). The covariance among factors is non-significant. BNFI = Bentler-Bonett Normed Fit Index; BNNFI = Bentler-Bonett Nonnormed Fit Index; CFI = Comparative Fit Index.

weights from the perceived recycling behavior on its indicators. The covariance among the obtained factors was, as in the other case, low (–0.097) and non-significant. Goodness of fit indicators for this statistical model of correspondence between actual and perceived recycling also showed its adequacy ($X^2 = 24.018$ [$p = 0.11895$]; BNFI = 0.982, BNNFI = 0.991, CFI = 0.995), which indicates that this model of interrelationships fits the data.

DISCUSSION AND CONCLUSIONS

The use of a multiplist methodology has been considered as a preferred research strategy when measuring any event. However, this approach sometimes results in additional problems. As our data showed, self-reports and garbage analyses seem to measure different facets of proenvironmental behavior. Yet, some investigators [12] use a combination of these methods to measure the same variable.

The findings of this study revealed that a one-to-one comparison of both measures of reuse and/or recycling behaviors produced a lack of correspondence in almost every case. Although the comparison of recycling aluminum and recycling steel for both methods resulted in a significant correlation, this correlation was low (.34) in practical terms. This direct comparison repeated previous results of other investigators [7, 10, 11].

Results from factor analyses confirmed the presence of two separate constructs resulting from the self-reports and the garbage analysis. Since garbage analysis produces data (traces of behavior) directly linked to individuals' overt actions, it could be considered an indicator of actual behavior. On the other hand, the self-report most likely indicates the perception that individuals have with regard to their actual or a desired behavior. This particular characteristic of the self-report method has been previously pointed out. As Michelson states: "It is a documented fact that all questionnaires and interviews evoke responses significantly affected by the respondent's acquiescence to and perceptions of social desirability" [16, p. 233].

Our findings show a high intercorrelation between self-report responses. In every case a high and significant loading from the "perceived behavior" factor on their corresponding items was found. This is an indication of convergent construct validity but also of a homogeneous perception of being (or not) a recycler or reuser in all situations. In other words, an individual perceives him/herself as being a recycler/reuser of different products, not only of one or two. These results reinforce the idea of a factor influenced by norms or social desirability, since citizens are expected to be consistent reusers and recyclers in every situation.

On the other hand, garbage analysis data were less consistent when factor-analyzed. Although this situation results in a threat to convergent construct validity it also reveals the heterogeneous quality of real behavior. Being an actual reuser of cloth does not necessarily correlate with being a non-package paper reuser. However, in spite of this, our results indicate that it is feasible to produce a "proenvironmental behavior" latent variable, such as reuse or recycling, from garbage data. If these results were to be consistently replicated, the investigator in this area could use an objective measure of actual responsible environmental behavior (e.g., reuse, recycling) as a factor to correlate with other latent variables (like motivation, knowledge, attitudes) and observed variables (socio-demographic characteristics, situational factors) of population groups.

There were also differences resulting from the analysis of reuse and recycling data. In the case of reuse, our (tested) model of indicators-factors convergence only included loadings from each construct to its corresponding indicators, while in the recycling analysis the factor "actual recycling behavior" was influencing not only its corresponding indicators (material measures) but also the self-report of steel recycling. A similar situation is observed when analyzing the loading from "perceived recycling behavior" as it relates to the garbage analysis of aluminum recycling. In other words, our analysis shows that the actual recycling behavior (as

a whole) influences the self-perception of being a recycler of steel, while the perceived recycling behavior influences (the actual) being a recycler of aluminum. Therefore, the slight correspondence among perception and actual behavior could be explained by particular influences from these latent variables to specific individual responses revealed either by material traces or self-reports.

Some limitations of this study should be discussed: The first is a time limitation. The garbage analysis included only a one-week sampling of household refuse. The problem of such a time limitation is that some items and products have a long use-life and consequently are thrown away only after a matter of weeks or even months. Thus, a one-week sample may not be as representative of all decisions and behaviors associated with using and discarding of a wide range of household items and consumer products. We think that the sample of fifty households, as a whole, is designed to capture the general population's behavior in an appropriate way; nevertheless, our main limitation is that the one-week sample period for each household may result in a higher probability of getting more material items with a short use-life than those household items with a longer use-life. Moreover, recyclable items are, in general terms, items of short use-life, the reusables stay in use for longer periods. As a result, in the future we should pay closer attention to the measure of reusable items. This limitation should be faced by increasing the research study's length of duration.

A second limitation has to do with the way in which the self-report data were obtained. There is not only a vagueness implicit in response options such as "Never," "sometimes," "often" and "always" of self-reports, but also this method is intended to "measure" long-term daily behavior, while the garbage analysis recorded traces of a short-term period. It is possible that—at least partially—the lack of correspondence in results between the two methods could be explained by this divergence. Yet, one would expect a consistency in housewives' recycling and reuse behavior.

Another possible limitation is the extent of inference allowed by the material recording of "reuse" or "recycling" behavior. For example, someone could never recycle anything and still have few aluminum cans or newspapers in his/her refuse because there is little aluminum or newspaper brought into the house. This possible limitation should be assessed by using an independent method registering actual reuse or recycling behavior. Therefore, the problem of independent verification, as a need for obtaining construct validity, continues.

Yet, considering the limitations listed above the consistency obtained in the lack of correspondence among the two methods could indicate that an important part of this disagreement results from the fact that these methods indeed measure something different. It is clear that both types of psychological events, instrumental behavior, and perception of self behavior, should be related to each other, as our results indicate (especially in the case of steel and aluminum recycling). However, this relationship is not strong enough to identify both phenomenon as a single one. What people do and what people think they do could be two different aspects of

their psychological functioning. This difference should be considered by investigators when using a multiplist strategy in studying human proenvironmental behavior.

APPENDIX I
Self-Report Questionnaire

House # _____ Houshold Members: Adults _____ Children _____

Income $ _____ Age of Respondent _____ Occupation _____

Respondent's Education: Elementary ____ Secondary ____ Trade School ____
College ____ Other ____

	NEVER	SOMETIMES	OFTEN	ALWAYS
I. REUSE				
1. Reuses sides of writing paper				
2. Reuses clothing items (within household)				
3. Reuses paper grocery bags				
4. Reuses cardboard boxes . . .				
II. RECYCLE				
1. Recycle non-returnable glass bottles/jars				
2. Recycle tin and aluminum cans				
3. Recycle used newspaper . .				
4. Recycle steel/iron				

APPENDIX 2
Garbage Recording Form

House # _____ Sample # _____ Date _____ Recorders _____
Initial Sample Weight _____ Kgs.

	Frequency	Weight	Reduce	Reuse	Recycle
A. Recyclables*					
Non-Recyclables					
B. Material Categories					
METALS					
Ferrous*					
Aluminum*					
Other*					
PAPER					
Corrugated Cardboard* . .					
Packaging Paper*					
Non-Packaging Paper . . .					
Newspaper*					
Glossy Magazine*					
Tissue and Papertowel . .					
Other					
PLASTIC					
Foam					
Other Plastic					
PET Bottles*					
ORGANIC					
Food Related					
Leaves, Twigs*					
Grass					
OTHER					
Glass*					
Textile*					
Wood*					
Diapers					
Rocks					
Other					
Other					
TOTAL					

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Direct reprint requests to:

Professor Victor Corral
Department of Psychology
University of Arizona
Tucson, AZ 85721