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by

John K. Horowitz, K. E. McConnell, and John Quiggin

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(first two authors)

Department of Agricultural and Resource Economics

University of Maryland

College Park MD 20742-5535

(third author)

Department of Economics

James Cook University

Townsville, Queensland 4812, Australia

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Send correspondence to:

John K. Horowitz

Department of Agricultural and Resource Economics

University of Maryland

College Park MD 20742-5535

(301) 405-1273; fax: 301-314-9091; horowitz@arec.umd.edu

A Test of Competing Explanations of Compensation Demanded

The disparity between willingness-to-pay and willingness-to-accept, also known as compensation demanded, is a robust experimental finding. Two types of explanations been proposed. The first invokes psychological effects, broadly categorized as reference dependence and loss aversion. The second explanation is that there are large substitution effects but that underlying behavior is neoclassically utility-theoretic. The key observation motivating the present study is that loss aversion implies concavity of willingness to accept, whereas the utility-theoretic explanation implies convexity.

We report experiments in which subjects were endowed with 3 items and asked the minimum payments they required to be willing to relinquish 1, 2, or 3 of them. We examine whether the compensation demanded is convex, concave, neither, or both in the number of items being relinquished.

1. Introduction

The disparity between willingness to pay and willingness to accept, also known as compensation demanded, is one of the most widely studied and robust experimental findings. A typical experiment consists of the following: A person is given an ordinary flashlight and then offered money to return it to the experimenter. The dollar amount the subject asks for is his compensation demanded (CD). Another person is not given a flashlight and instead is asked to pay for one. The dollar amount the subject offers is his willingness-to-pay (WTP). CD is usually substantially higher than WTP, by a factor of two to six times, and this disparity has been shown to occur in a variety of settings and for a wide variety of goods, including public goods. (See reviews in Fisher, McClelland, and Schulze; Horowitz and McConnell; Kahneman, Knetsch, and Thaler.)

Two types of explanations have been proposed for this disparity. The first invokes psychological effects of the valuation process, broadly categorized as reference dependence and loss aversion. The second explanation is that the phenomenon arises from neoclassical utility-theoretic behavior. Analysts such as Shogren *et al.* have interpreted the disparity as evidence of large substitution effects, based on results from Hanemann.

The key observation motivating the present study is that the psychological explanation implies concavity of compensation demanded, whereas the utility-theoretic explanation implies convexity. This permits a test of the competing hypotheses. Note that experiments to look at the curvature of WTP cannot distinguish between loss aversion and utility-theoretic explanations since both theories predict WTP will be concave.

The prediction of convexity of CD from standard consumer theory follows from quasi-concavity of preferences and is a manifestation of an increasing marginal rate of substitution between money and the good. The prediction from the psychological model is more difficult to derive because the behavioral implications are less sharply specified. The general idea is that individuals are most sensitive to whether they are to receive a gain or a loss of some good and relatively insensitive to the amount of gain or loss, contingent on facing one or the other. Such behavior will result in CD being concave.

The two models have very different implications for welfare economics, especially for contingent valuation and environmental policy. Concavity in the loss domain has an especially compelling implication for environmental policy. Sharp concavity suggests that if it were certain that at least some level of environmental deterioration was going to take place, then people would be relatively indifferent to how drastic this deterioration was; people may no longer care much about the environment at all. This contrasts with the neoclassical view, which predicts that people will be increasingly concerned as any predicted environmental deterioration rises.

This paper tests the competing hypotheses using multiple-item, private-good experiments. In a typical experiment, each subject was endowed with 3 units of a good and asked the minimum payments he required to be willing to relinquish 1, 2, or 3 of them. We examine whether the compensation demanded is convex, concave, neither, or both in the number of goods relinquished. The multiple-item experiments also allow us to vary the endowment. We test whether compensation demanded is increasing in the endowment.

Only a few previous studies have measured CD and even fewer have used the multiple goods that are needed to observe its curvature and test the competing explanations. Those studies are reviewed in Section 6. Because the WTP-CD disparity has been thoroughly and, we feel, convincingly established, the current paper does not elicit WTP.

2. Two Behavioral Models

A. Utility-Theoretic

Utility is defined over a good q, whose quantity is controlled by the experimenter, and a vector of other goods, x, available at price p. Write utility as u(q,x). Define u^q = as the maximum of u(q,x) over x subject to $p \cdot x = M$ where M is the individual's income; we suppress the arguments p and M. Let the corresponding expenditure function be m(q,u). Compensation demanded for a change in q from *a*, the endowed point, to *b* is $m(b,u^a) - m(a,u^a)$. If $a > b$ then $m(b,u^a) - m(a,u^a) > 0$. Strict convexity of the expenditure function in q is implied by strict quasi-concavity of utility (Maler).

Consider an individual endowed with three identical flashlights who is asked the minimum payments he requires to relinquish 1, 2, or 3 of them. His utility at the start of the experiment is u^3. The compensation demanded for 1 flashlight is $m(2,u^3) - m(3,u^3)$. More generally, let $CD^{ik} = m(k-i,u^k) - m(k,u^k)$ be the compensation demanded to surrender *i* units of a good when *k* is the endowment; the first superscript represents the amount of the good the individual is asked to surrender, not the amount he will have after the transaction. Thus, the compensation demanded for 2 and 3 flashlights is $CD^{23} = m(1,u^3) - m(3,u^3)$ and $CD^{33} = m(0,u^3) - m(3,u^3)$. Because the expenditure function is strictly convex in q, compensation demanded will also be strictly convex in *i*. In words, the compensation demanded to give up the second flashlight exceeds the compensation demanded to give up the first one.

Strict convexity and $CD^{0k} = 0$ imply the following four inequalities:

(i) $CD^{2k} - 2CD^{1k} > 0$

(ii) $CD^{3k} - 3CD^{1k} > 0$

(iii) $2CD^{3k} - 3CD^{2k} > 0$

(iv) $CD^{1k} + CD^{3k} - 2CD^{2k} > 0$

Economists may also be interested in how compensation demanded changes with the endowment. The relevant derivative is dCD^{ik}/dk and it obeys $\text{sign}(dCD^{ik}/dk) = -\text{sign}[m_{11} - m_{12}(m_1/m_2)]$, so long as this expression is everywhere uniformly signed. Subscripts represent partial derivatives. In words, the endowment effect depends on how having more of the rationed good changes both the marginal value of the good, represented by m_{11}, and the marginal utility of money (*i.e.*, $1/m_2$), represented by m_{12}. Convexity of the expenditure function implies $m_{11} > 0$ and a positive CD-WTP difference implies $m_{12} < 0$. Note that $m_1 < 0$ and $m_2 > 0$.

Thus, the neoclassical model provides no prediction of how compensation demanded changes with the endowment. Our experiments appear to yield m_{11} □ 0, which, in conjunction with CD greater than WTP, implies $dCD^{ik}/dk > 0$. This implies that the compensation demanded for giving up *i* flashlights will be higher when the endowment is 3 than when the endowment is 2.

The general expectation among economists, however, is that the value of any given number of flashlight will fall as the individual has more flashlights. In this case, compensation demanded for giving up *i* flashlights will fall as the endowment increases, or $dCD^{ik}/dk < 0$. This expectation, it may be interesting to note, is consistent with a small CD-WTP difference (m_{12} □ 0) and strictly convex compensation demanded ($m_{11} > 0$). The predicted inequality is:

(v) $CD^{ij} - CD^{ik} > 0,\ k > j$.

B. Psychological Model

The prevailing psychological model of economic decision-making is a value function which is: (a) defined on deviations from a reference point; (b) convex for losses and concave for gains; and (c) steeper for losses than gains (Kahneman and Tversky). The principle underlying convexity in losses is that the individual cares about losing *per se* and further that, conditional on knowing that he faces a loss, the individual is relatively insensitive to the magnitude of that loss. Convexity of the loss value function implies concavity of CD^{ik} in i for $i > 0$. If concavity is strict, the psychological model implies the following four inequalities:

(i□) $CD^{2k} - 2CD^{1k} < 0$

(ii□) $CD^{3k} - 3CD^{1k} < 0$

(iii□) $2CD^{3k} - 3CD^{2k} < 0$

(iv□) $CD^{1k} + CD^{3k} - 2CD^{2k} < 0$

The literature's support for strict convexity of the loss value function is not unequivocal. Kahneman and Tversky claim only that the value function is "commonly" convex for losses (p. 279). The evidence for strict convexity appears to come exclusively from experiments involving risky choice, which show that a majority of subjects are risk-seeking in gambles involving only losses. (See Kahneman and Tversky and their references).

Concavity of CD and the "steeper for losses than gains" property are logically distinct but neither is well defined if property (a) is not satisfied. Evidence for loss aversion has therefore been interpreted in the literature as evidence of reference dependence. However, distinctions between the two models based either on loss aversion or reference dependence are difficult to make, since there have not been clear testable hypotheses based on these principles.

There have therefore also been no clear hypotheses about how compensation demanded changes with the endowment. The following interpretation seems consistent with the psychological model. If consumption bundles are evaluated only as gains or losses, then changes in the endowment should have no effect on the value of any given loss. This implies the equality:

(v□) $CD^{ij} - CD^{ik} = 0$ j, k.

3. Research Method

Thirteen experiments were conducted in-person with small subject groups. The difference between our experiments and previous experiments is that respondents were endowed with multiple items. The items were mugs, flashlights, and binoculars (Table 1).

For example, in Experiment 8 each subject started out with one ceramic mug, three flashlights, and a complete copy of the survey. We first asked subjects to value the mug. Each participant was asked to write down the minimum payment he or she would require to be willing to sell the mug back to us; this is his compensation demanded. We then repeated the following procedure several times, first for practice and then for real money and a real transaction: The administrator drew an *offer price* randomly out of an envelope. If the subject's compensation demanded was higher than the offer price, the subject kept his mug. If his compensation demanded was less than or equal to the offer price, he returned his mug to us and received a check for the randomly drawn price. All subjects were offered the same offer price. Under this method, subjects will report true compensation demanded if they are expected utility maximizers (Becker, DeGroot, and Marschak).

In the second part of Experiment 8, each subject wrote down three numbers: the minimum payments he or she required to be willing to sell us back one, two, and three flashlights. We then randomly drew a piece of paper that stated the number of flashlights (per person) we would actually be buying back, and a second piece of paper that stated the offer price. For example, we might randomly draw the instruction to buy back two of each subject's three flashlights, and then draw an offer price of $8.00. This is a price for the two flashlights, not a per-flashlight price. All subjects who had offered to sell two flashlights for $8.00 or less then turned in two flashlights and received a check for $8.00. They kept their remaining flashlight. All subjects who had offered to sell two flashlights for more than $8.00 kept all three flashlights and received no money.

Subjects were not told the distribution of offer prices. Once the number of flashlights at stake was chosen, the offer-price mechanism was the same as for the single mug, except that this part of the experiment was conducted only once, for real money and a real transaction. The responses allow us to test whether the compensation demanded was convex, concave, neither, or both in the number of items.

The experiments differed in the number and kind of items the subjects were given as an endowment and how many of those items the subject was asked to consider selling. Experiments 1 through 5 did not have an initial one-item experiment.

Subjects for Experiment 1 were undergraduates. Subjects for Experiments 2 through 13 were members of local civic groups. In return for participation, the sponsoring group was paid $20 per subject. The mugs/flashlight/binoculars and CD payments went directly to the subjects. Using local civic groups allows us to survey at low cost a relatively large number of subjects that is more representative of the U.S. population than other commonly surveyed groups such as students. The cost per response is considerably less than an in-person survey of a more rigorously selected sample. The sacrifice is that the groups are not representative samples of the U.S. population.

4. Results

A. Tests for Convexity and Concavity

The behavioral hypotheses can be applied to both aggregate and individual behavior. For aggregate behavior, we need look only at sample means. For individual behavior, we look at the proportion of subjects who exhibit the predicted patterns.

Table 2 gives means for the flashlights and mugs. The means (standard errors) for binoculars (k=3) were $46.88 (9.71) for i=2 and $72.66 (15.0) for i=3. For aggregate behavior, there are thirteen tests of conditions (i) through (iv) (4 at k=3 and 4 at k=4 for mugs; 4 at k=3 for flashlights; 1 for binoculars). Nine of the expressions are positive. None is significantly different from zero at the 95% level for a two-sided test. Thus, aggregate behavior is roughly linear. It is neither demonstrably loss averse nor utility-theoretic.

Closeness to linearity is also true of individual observations. Thirty-three percent of the set of three- and four-mug endowments observations were exactly linear. For binoculars, 50 percent of the responses were exactly linear.

The proportions of individual responses that are strictly convex or concave are shown in Tables 3 through 6 for mugs and flashlights. (For binoculars, 37.5 percent of the responses were convex and 12.5 percent were concave.) Of the eight single condition tests for mugs and flashlights (Tables 3 and 4), six show a higher proportion of concave (loss averse) responses than convex, and two show a higher proportion of convex (utility-theoretic) responses. Tables 5 and 6 show two three-condition tests and two four-condition tests. Three of the four tests demonstrate a higher proportion to be strictly concave than strictly convex. In total, ten of the 12 comparisons show more concavity than convexity.

Next we examine where these proportions are significantly different from zero. Of the 12 comparisons, six have a significantly higher (at the 90% level of confidence) proportion of concave responses, and one significantly higher convex response. Again, concavity appears more prevalent than convexity.

<u>Number of Items</u>. The three proportions which are significantly concave for mugs are i and i-iii. For flashlights the significant proportions of concavity are i, ii, and i-iii. The test for condition iv, comparing the curvature for one, two and three items, is convex for mugs. Both goods show concavity where the value of one and two items is compared (condition i). This test is closest to the origin, and most similar to previous tests in the literature which have found concavity. The one test available for binoculars comparing the value of two versus three (condition iii) shows a larger proportion to be convex.

In summary, concavity (loss aversion) is more prevalent than convexity (utility-theoretic). Behavior becomes more utility-theoretic when more items (2 or 3) are involved.

Table 2

Mean Compensation Demanded for Mugs and Flashlights, by Endowment

	Endowment, *k*				
	Mugs			**Flashlights**	
Number of Items Relinquished, *i*	1	3	4	1	3
1	\$5.07[a] (.30)[b] 188[c]	\$3.61 (.35) 65	\$3.46 (.40) 60	\$6.38 (.67) 38	\$5.40 (.48) 58
2	--	\$8.65 (.82) 128	\$6.82 (.76) 60	--	\$9.38 (.88) 133
3	--	\$13.54 (1.60) 128	\$10.50 (1.15) 60	--	\$14.96 (1.63) 133

[a]The first entry is the mean. [b]The second entry is the standard error. [c]The third entry is the number of observations

Table 3

Single Condition Tests for Convexity

	Mugs		**Flashlights**	
Quantity	**Mean**	**Proportion Positive**	**Mean**	**Proportion Positive**
$CD^{2k} — 2CD^{1k}$	$.47[a] (.81)[b] 125[c]	.22	-$.60 (.34) 58	.14
$CD^{3k} - 3CD^{1k}$	$1.45 (1.61) 125	.30	-$.61 (.72) 58	.26
$2CD^{3k} - 3CD^{2k}$	$.94 (.61) 188	.24	$2.39 (1.05) 124	.33
$CD^{1k} + CD^{3k} - 2CD^{2k}$	$.51 (.21) 125	.36	$.61 (.67) 58	.31

[a]The first entry is the mean. [b]The second entry is the standard error. [c]The third entry is the number of observations pertaining to that cell and the reported proportions.

Table 4

Single Condition Tests for Concavity

	Proportion Negative[a]	
Quantity	**Mugs**	**Flashlights**
$CD^{2k} — 2CD^{1k}$	.38 125[b]	.45 58
$CD^{3k} — 3CD^{1k}$	.37 125	.46 58
$2CD^{3k} - 3CD^{2k}$	.31 188	.28 124
$CD^{1k} + CD^{3k} - 2CD^{2k}$	.22 125	.29 58

[a]The means are the same as Table 3. [b]The second entry is the number of observations.

Table 5

Joint Tests for Convexity

Proportion of cases where the following relations hold with strict inequality	Mugs	Flashlights
(i), (ii) and (iii) hold	.12 125[a]	.07 58
(i),(ii), (iii), and (iv) hold	.10 125	.07 58

[a]The second entry is the number of observations pertaining to the test.

Table 6 Joint Tests for Concavity		
Proportion of cases where the following relations hold with strict inequality.	**Mugs**	**Flashlights**
(i□), (ii□), and (iii□) hold	0.22 128[a]	0.31 58
(i□), (ii□), (iii□), and (iv□) hold	0.08 128	0.16 58

[a]The second entry is the number of observations pertaining to the test.

Item Value. Neither model predicts unequivocally how concavity will change as the value of the individual items increases. For the utility-theoretic model, consider the indirect utility function V(q,M) = $e^{\alpha q}M$. A higher-value item is represented by a higher □ . Compensation demanded is CD^{ik} = (e□ ^{i}-1)M, which becomes more convex in i as □ rises. The difference $2CD^{3k} - 3CD^{2k}$ is equal to (2e$^{3□}$ -3e$^{2□}$ +1)M. Thus, this utility-theoretic model predicts $2CD^{3k} - 3CD^{2k}$ will be increasing in item value. The psychological model does not have a prediction to our knowledge.

Experiments were conducted with mugs (which cost us $4), flashlights ($6) and binoculars ($25). In Experiment 12, 50 subjects each received 3 pairs of binoculars; thus, each began the experiment with an endowment that cost us $75. This is a much larger endowment than any that has been previously used in valuation experiments.

For the binoculars, values for CD^{i3} were elicited for i = 2 and 3. Ten observations were dropped because either CD^{i3} was decreasing in i or was excessively high (greater than $500). Of the 40 remaining observations, 15 were utility-theoretic, 5 were loss-averse, and 20 were exactly linear. (When i takes only two values, behavior falls in exactly one category.) Thus, subjects were three times as likely to exhibit utility-theoretic behavior as loss-averse. The mean of $2CD^{3k} - 3CD^{2k}$ was $9.37 with standard error of 6.62, excluding linear responses. The positive value shows that aggregate behavior was also utility-theoretic.

Results for all items are in Table 7. The magnitudes and the proportion of positive values are increasing as item value increases. The proportion of negative values is decreasing. Thus, behavior becomes less loss averse and more utility-theoretic as the item value increases.

Table 7 Convexity and Concavity as Item Value Increases			
Commodity	$2CD^{3k} - 3CD^{2k}$		
	Proportion negative	Proportion positive	Mean[b]

Mugs	0.31 188[a]	0.24	\$1.30 (0.74)[c]
Flashlights	0.28 124	0.33	\$3.59 (1.60)
Binoculars	0.13 40	0.38	\$9.37 (6.62)
[a]Number of observations [b]Linear responses excluded [c]Standard error			

B. Changes in Endowment

The effects of the endowment can be observed from Table 2. Unlike the previous tests, these are between-sample. There are six tests of condition (v), five of which are independent. All six of the aggregate differences $CD^{ij} - CD^{ik}$ are positive for $k > j$. Four of these are statistically significant for a one-sided test at the 90% level. Three of the five independent differences are significant. We reject (v□).

The results show that when subjects start with more items, the value of any individual item goes down. This finding, which is perfectly in line with economists' expectations for economic behavior, implies that compensation demanded will be moderately convex (utility-theoretic), a result not readily observed in the within-sample tests.

5. Previous Studies

Only a few previous valuation studies provide information on the concavity or convexity of CD. Two studies of environmental goods found CD to be convex, as in the utility-theoretic model. A third study of a private good found CD to be concave.

Brookshire and Coursey elicited WTP and CD for trees a public park in Colorado. Two increases in tree numbers (200 trees to 225 or 250) and two decreases (175 and 150) were used for WTP and CD, respectively. Mansfield used these data to estimate WTP and CD functions and found the following results: (a) The intercept for the CD regression was significantly different from zero under one specification and insignificant under a second. (b) CD was convex. (c) The hypothesis that WTP and CD were generated from the same underlying CES utility function was rejected. Note that the Brookshire and Coursey data included only two changes in the quantity of the good and the good was public, not private. The latter distinction required the surveys to include a collective choice mechanism.

Rowe, d'Arge, and Brookshire elicited CD and WTP for improved visibility in the Grand Canyon. CD was convex in the miles of improved visibility. Mean CD was $24.46 for a 25 mile decrement, from 75 to 50 miles, and $71.42 for a 50 mile decrement, from 75 to 25 miles. WTP was concave ($3.53 for a 25 mile increment, from 25 to 50 miles, and $6.54 for a 50 mile increment, from 25 to 75 miles.)

Loewenstein studied the value of postponing or speeding up the receipt of a $7 gift certificate for a local record shop. Compensation Demanded and WTP were both concave in the number of weeks of delay and speed-up, respectively. Mean CD to delay receipt for 3 extra weeks was $1.09. Mean CD to delay for 7 extra weeks was $1.76.

Other studies have attempted to derive different testable hypotheses for the loss aversion and utility-theoretic models. Shogren *et al.* elicited WTP and CD from students for chocolate bars and sandwiches that had a possibility of bacterial contamination. They found a small CD-WTP disparity for the former items and a much larger disparity for the latter. They attributed the difference between the goods to a utility-theoretic effect arising from the lack of close substitutes for risk of food-borne pathogens. Differences in the availability of substitutes is a maintained assumption that cannot be tested separately utility-theoretic behavior. The psychological model suffers from not being well specified for such choices because it does not specify how loss aversion should vary across goods.

Bateman *et al*. elicited WTP and CD for chocolate, soft drinks, and money and showed that the purported reference point affects the elicited values. Again, the psychological model suffers from not being well specified; in their case, about what the reference point will be.

6. Summary

Our results show behavior that is not clearly loss averse or utility-theoretic. Utility-theoretic behavior is evinced in three ways: (1) As the item value increases, behavior is more utility-theoretic. (2) As more units are surrendered from a given endowment, behavior is more utility-theoretic. In other words, as one moves "farther from the origin," behavior is more utility-theoretic. (3) In the between-sample comparison of different endowments, behavior is clearly utility-theoretic.

We see this study as weakly favoring the utility model over the psychological model. We have four reasons. First, in-sample tests of concavity/convexity are consistent with both models and the edge for loss aversion is only slight. Second, between-sample tests of changing endowments are clearly utility-theoretic. Third, findings (1) and (2) from above show that as greater changes are at stake, behavior conforms more closely to the utility model. They suggest that neoclassical behavior would likely be observed in the multiple-item, high-stakes real world.

Fourth, the utility model did not fail. Previous studies have led to the impression that utility models will suffer miserably in comparison to psychological models whenever behavior on such a small scale is being investigated. For example, KKT conclude that "the evidence reported [in their paper] offers no support for the contention that observations of loss aversion and the consequential evaluation disparities are artifacts… Instead the findings support an alternative view of endowment effects and loss aversion as fundamental characteristics of preferences" (p. 1346). In this context, the fact that the utility model did not dramatically fail for us must be seen as a victory.

Further tests would be aided by having more concrete predictions from the two models. Consider the interpretation of changes in the endowment. In our between-sample tests of endowment changes, behavior conforms closely to economists' expectations. This appears to be particularly strong evidence against the psychological model since it contradicts the reference point effect (as we have interpreted it), and the reference point effect is essential to the psychological model in a way that loss function concavity is not. Nevertheless, this test must take a back seat to the concavity/convexity tests, since the psychological model has been rather silent on the effects of changing endowments and any prediction must be inferred from the literature rather than read directly.

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Table 1. List of Experiments

Expt.	Subject Group	N	Endowment	CD Elicited for:
1	Undergraduate students	37	3 mugs	1, 2, 3 mugs
2	PTA	10	3 mugs	1, 2, 3 mugs
3	PTA	25	3 mugs	1, 2, 3 mugs
4	Parents of Swim Club	52	4 mugs	1, 2, 3 mugs
5	PTA	20	4 mugs	1, 2, 3 mugs
6	"Mothers of Multiples"	18	1 flashlight	1 flashlight

3 different mugs 1, 2, 3 mugs

7 Parents of Cub Scouts 30 1 mug 1 mug

3 flashlights 1, 2, 3 flashlights

8 Lions' Club 42 1 mug 1 mug

3 flashlights 1, 2, 3 flashlights

9 PTA 40 1 mug 1 mug

3 mugs 2, 3 mugs

10 PTA 27 1 mug 1 mug

3 flashlights 2, 3 flashlights

11 PTA 27 1 flashlight 1 flashlight

3 mugs 2, 3 mugs

12 PTA 58 1 mug 1 mug

3 binoculars* 2, 3 binoculars*

(*Eight subjects received flashlights instead of binocs.)

13 PTA 50 1 mug 1 mug

3 flashlights 2, 3 flashlights