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The Effects of Answer Copying on the Ability Level Estimates of Cheater Examinees in Answer Copying Pairs

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Abstract

The purpose of this study was to examine the effects of answer copying on the ability level estimates of cheater examinees in answer copying pairs. The study generated answer copying pairs for each of 1440 conditions, source ability (12) x cheater ability (12) x amount of copying (10). The average difference between the ability level estimates before answer copying and after answer copying was examined. The results indicate that there is no gain on average from answer copying for the cheater examinee when both cheater and source examinees are in the same ability level interval. The gain from answer copying is higher as the source examinee's ability level increases. The results also indicate that the gain and loss from answer copying is not the same when the source and cheater examinee exchange their position in the answer copying pair. The results indicate that answer copying on multiple-choice tests may have an important effect on the observed ability level estimate of a cheater examinee even for the small amount of copying. Answer copying behavior causes invalid test scores when the difference between the ability levels of the source and cheater examinees get larger. Answer copying can invalidate the test scores and high stake decisions based on the standard test scores. The educators should be aware of this problem and they should look for solutions to prevent or decrease the answer copying behavior. One solution might be using analytical methods to detect answer copying pairs by calculating the probability of matching responses between response vectors. The literature has a variety of analytical methods such as the ω index (Wollack, 1996) and the GBT index (Van der Linden & Sotaridona, 2006) to detect answer copying pairs. However, the statistical power of these methods is still questionable to detect a low ability examinee who gains an important amount of benefit by copying answers from a high ability examinee (Zopluoglu & Davenport, 2010). So, the better way is to prevent answer copying before it occurs.

1. INTRODUCTION

Academic dishonesty persists as a serious problem in the educational system. Multiple-choice tests are still one of the most used assessment methods in our schools and answer copying on multiple-choice tests is a type of academic dishonesty that is all too common. Cizek (1999) presents a detailed taxonomy for answer copying behaviors on multiple-choice tests. Answer copying behaviors on tests are divided into the three main areas. The first area is copying answers by "giving, taking, or receiving information from others (GTR)." The second area is copying answers through the "use of forbidden materials (FM)" and the last area is copying answers by "circumventing the process of assessment (TAP)." Cizek (1999) lists 15 different types of GTR observed in the classrooms including "looking at another student's test paper," "sharing an eraser with answers written on it," "coding the options by using four corners of a desk."

Self-reported survey results showed that answer copying on multiple-choice tests is very common. In one study, McCabe (2001) surveyed 2,294 high school juniors at 25 schools (14 public and 11 private) across the US and reported answer copying rates for 12 specific behaviors. Three of these behaviors were specifically about answer copying on exams: copying from another on a test/exam, using crib notes on a test/exam, and helping someone cheat on a test/exam. Sixty-six percent of the students in public schools and 57% of the students in private schools reported that they had copied from another on a test/exam.

In another study, the prevalence of answer copying among business college students in the US was investigated by using an online survey. Students were asked to report whether or not they engaged in 15 different answer copying behaviors. After receiving 1,255 survey results, it was reported that 17.4% of the students copied from another's exam with his/her knowledge and 16.5% of the students copied without his/her knowledge. Also 1.8% of the students reported that they engaged in "answer copying during exams" more than five times. Similarly, 23.8% of the students reported that they allowed someone to copy their exam, and 2.9% of the students engaged in this behavior more than five times (Rakovski & Levy, 2007).

Lin and Wen (2007) similarly investigated answer copying rates in Taiwan with 2,068 college students. They asked students to rate engagements in 17 different answer copying behaviors from one (never) to five (almost every time). The behavior "copying from other

students in a test" ranked 5th with a mean rating of 2.44 and "passing answers to other students in a test" ranked 4th with a mean rating of 2.46 among 17 different answer copying behaviors. They also reported that 2.6% of the students copied answers and 2.1% of the students passed answers almost every time they took a test.

Bernardi et al. (2008) compared college business students from Australia (54 students), China (88 students), Ireland (101 students) and the United States (174 students). They asked students whether or not they had engaged in 10 different answer copying behaviors. Twenty-two percent of the students in Australia, 50% of the students in Ireland, 51% of the students in United States, and 56% of the students in China reported that they had cheated on exams by "looking at/copying another's exam."

The literature has many other studies that provide self-reported cheating rates. Copying answers by "giving, taking, or receiving information from others" is one of the most commonly observed behaviors in these studies (Diekhoff et al., 1999; Bopp et al., 2001; Jensen et al., 2002; Lupton and Chapman, 2002; Brimble and Clarke, 2005; Josephson Institute of Ethics, 2006; Hughes and McCabe, 2006; Vandehey et al., 2007; Josephson Institute of Ethics, 2008). Validity is the most important concern in any testing situation and answer copying behavior is an important threat for the test score validity by causing inaccurate inferences about the test takers' ability. Most school districts make their decisions based on test scores and inaccurate ability estimates of the students may invalidate high stake decisions.

Item response theory is becoming a common method to measure a student's ability by estimating a standardized ability level from the student's response vector. IRT assumes a true ability level of the student symbolized by θ. However, the estimation process never recovers the true ability level of the student and we always observe an estimate of true ability level symbolized by $\hat{\theta}_{\text{pre}}$ in this paper. If we assume that a student does not copy answers, the difference between θ and $\hat{\theta}_{\text{pre}}$ should be minimum and the magnitude of difference depends on the estimation problems related to factors other than answer copying (sample size, number of items, etc.). $\hat{\theta}_{\text{pre}}$ refers to the estimated level of the student's true ability if no answer copying occurs on the student's response vector. If answer copying occurs and the student changes responses by taking information from another student, the ability level, symbolized by $\hat{\theta}_{\text{post}}$ in this paper, is estimated based on a different response vector after answer copying,

If a student copy the answers by looking at another student's paper, three different ability levels can be hypothesized for the student. The first one is the true ability level of the student (θ), the second one is the estimated ability level if no answer copying occurs ($\hat{\theta}_{\text{pre}}$, estimated ability before cheating), and the last one is the estimated ability level if answer copying occurs ($\hat{\theta}_{\text{post}}$, estimated ability after cheating). The difference between $\hat{\theta}_{\text{pre}}$ and $\hat{\theta}_{\text{post}}$ is the effect of answer copying on the ability level estimate of a cheater examinee. Decisions based on $\hat{\theta}_{\text{post}}$ are not valid and should not be used in the practice. Observing answer copying behavior is not always possible in practice so it's not easy to predict the difference between $\hat{\theta}_{\text{pre}}$ and $\hat{\theta}_{\text{post}}$ for a cheater examinee and what factors affect the magnitude of this difference. The simulation method used for this study provides a flexible environment to examine this difference and to manipulate different variables to examine the magnitude of difference between $\hat{\theta}_{\text{pre}}$ and $\hat{\theta}_{\text{post}}$.

The purpose of this study is to investigate the effects of answer copying behavior on the ability level estimates of cheater examinees in answer copying pairs by using the simulation as a technique. Three independent variables are used as control variables and the magnitude of the difference between $\hat{\theta}_{\text{pre}}$ and $\hat{\theta}_{\text{post}}$ is investigated under different conditions.

2. METHOD

a. Independent and Dependent Variables

The independent variables manipulated in this study were the amount of copying and the ability levels of the source and cheater examinees' in the answer copying pairs. This study manipulated the amount of copying in ten different levels from 10% to 100% in increments of 10%. The study used a hypothetical 40-item multiple-choice test with five options per item. For instance, the level of 10% indicates copying four items from a source examinee. The study also manipulated the ability levels of the examinees in answer copying pairs. All possible combinations of the source and cheater examinees' ability levels were examined in this research. The IRT scale was divided into 12 equal intervals between -3 and +3. The intervals were from [-3, -2.5) to [2.5, 3) in increments of 0.5. The number of possible combinations between the source ability level and the cheater ability level intervals was 144 (12 x 12). Ability levels of the sources and cheaters were generated by using a uniform distribution within each interval. Each level of

amount of copying is fully crossed with 144 combinations of the source and cheater ability levels, yielding a total of 1440 conditions (12 x 12 x 10).

The dependent variable was the difference between the estimated ability level before answer copying and the estimated ability level after answer copying for a cheater examinee, $\Delta(\theta) = \hat{\theta}_{post} - \hat{\theta}_{pre}$.

b. Data Generation

Generating Honest Pairs

The item response vectors of the hypothetical examinees were generated based on the nominal response model for a hypothetical 40-item test. The nominal response model item parameters were taken from Wollack's study (1996).

First, the IRT ability level scale was divided into 12 equal intervals. These intervals were denoted as C_t (t=1,2,…,12) for the cheater ability level intervals and S_p (p=1,2,…,12) for the source ability level intervals. For instance, C_1 represented the hypothetical cheater examinees whose ability levels were between -3 and -2.5. S_5 represents hypothetical source examinees whose ability levels were between -1 and -0.5. Wingen software (Han, 2007) was used to generate response vectors based on the given hypothetical examinees' ability levels and item parameters.

For a C_t category, the uniform distributed ability levels of 500 hypothetical cheaters within interval t were randomly generated by the software and then the response vectors of these examinees were generated based on the given item parameters. For a S_p category, the uniform distributed ability levels of 500 hypothetical sources within interval p were randomly generated by the software and then the response vectors of these examinees were generated based on the same item parameters. The software produced a 500 x 40 response matrix for each of the C_t and S_p conditions.

After generating response vectors, independent response vectors were matched for each C_tS_p condition. This process was programmed in R (R Core Development Team, 2009). First, a 1,000 x 40 matrix was produced and then 500 response vectors of hypothetical sources in interval p (S_p) were placed on the odd rows of the 1,000 x 40 matrix. After that, the 500 response vectors of hypothetical cheaters in interval t (C_t) were placed on the even rows of the same 1,000 x 40 matrix. So, each consecutive pair of rows included a response vector of a source from interval p

in the odd row and a response vector of a cheater from interval t in the even row. As a result, 500 pairs of independent response vectors (1-2, 3-4, 5-6, 7-8, …, 999-1000) were obtained in a 1,000 x 40 matrix for each C_tS_p condition. The same process was replicated for each of 144 C_tS_p conditions. The source ability level and cheater ability level were manipulated in this step.

The true ability levels of hypothetical examinees used to generate response vectors were saved in this step. But the true ability levels (θ) are not observed in practice and they are not recovered completely. We observe the estimate of true ability levels in practice. Therefore, the estimated ability levels of hypothetical examinees before answer copying (θ_{pre}) were calculated by using MULTILOG 7 (Thissen, 2003) based on generated response vectors and saved for later use.

Generating Answer Copying Pairs

The amount of copying was manipulated in this step. A random copying situation was simulated for an honest pair of examinees. For each consecutive pair of rows in the 1,000 x 40 matrix (1-2, 3-4, 5-6,……, 999-1000), m% of 40 items was randomly selected and the response vector of the odd row (source) was overwritten to the response vector of the even row (cheater) for selected items (m=10,20,……100). This process was also programmed in R (R Core Development Team, 2009).

At the end of Step 2, 500 answer copying pairs of examinees were obtained in the consecutive pair of rows of a 1,000 x 40 matrix for each 1440 source level(12) x cheater level(12) x percentage of copying(10) condition.

In this research, it was assumed that there was a pre-calibrated item bank with the item parameters known. So the ability level of any examinee could be estimated by using known item parameters. The ability levels of the examinees in each 1,000 x 40 matrix were re-estimated after answer copying based on maximum likelihood method by using MULTILOG 7 (Thissen, 2003).

The re-estimated ability levels of hypothetical examinees after answer copying (θ_{post}) were also saved for later use. Figure 1 shows the data generation process step by step.

c. Data Analysis

For each of 1440 conditions, the difference between the estimated ability level after answer copying and the estimated ability level before answer copying was calculated for each of 500 hypothetical cheater examinee, $\Delta(\theta) = \hat{\theta}_{post} - \hat{\theta}_{pre}$. The average difference over 500 cheater

examinees in a condition was taken and reported as a summary statistics to compare across different conditions.

$$\sum_{i=1}^{n=500} \frac{\hat{\theta}_{i(post)} - \hat{\theta}_{i(pre)}}{500}$$

3. RESULTS

Table 1-10 summarize the mean change in ability levels of 500 hypothetical cheater examinees after answer copying for each condition. The ability level intervals for the hypothetical source and cheater examinees are represented by their midpoints in the tables. For instance, when a cheater examinee whose ability level is between -1 and -1.5 copy four items in a 40-item test from a source examinee whose ability level is between 2 and 2.5, we expect on average an increase of .28 in its observed ability level (Table 1).

The diagonal elements give the average change in cheater examinee's ability level when they copy from a source examinee whose ability level is in the same interval. Regardless of the amount of copying, the results indicated that the average change in the ability level estimate after answer copying is almost zero when a cheater examinee copies from a source examinee with the same ability level. When both cheater and source examinees are in the same ability level interval, there is no gain on average from answer copying for the cheater examinee.

The gain from answer copying was higher as the source examinee's ability level increases. It is not surprising since the cheater examinee is more likely to copy more correct responses in the test when the source examinee is more talented. However, the increase in ability level estimate was very close to each other when the source examinees' ability level was between 1.5 and 2, between 2 and 2.5, and between 2.5 and 3. For instance, when the cheater examinee whose ability level is between -.5 and -1 copied eight items in a 40-item test, the increase in its ability level estimate was .36 for the source between 1.5 and 2, .38 for the source between 2 and 2.5, and .39 for the source between 2.5 and 3 (Table 2). In a similar way, the loss from answer copying was getting higher as the source examinee's ability level decrease. For instance, when a cheater examinee whose ability level is between 0 and .5 copy 16 items in a 40-item test, the decrease in its ability level estimate was .64 for the source between -1 and -1.5, .73

for the source between -1.5 and -2, .85 for the source between -2 and -2.5, and -.89 for the source between -2.5 and -3 (Table 4).

The results indicated that the gain and loss from answer copying is not the same when the source and cheater examinee exchange their position in the answer copying pair. This can be easily seen because the tables are not symmetric. For instance, when a cheater examinee whose ability level is between -2 and -2.5 copied 20 items in a 40-item test from a source examinee whose ability level is between 2 and 2.5, the increase in the ability level estimate was 2.01. However, when a cheater examinee whose ability level is between 2 and 2.5 copied 20 items in a 40-item test from a source examinee whose ability level is between -2 and -2.5, the decrease in the ability level estimate was 2.64 (Table 5). This pattern can be seen for each level of amount of copying from 10% to 100%.

Even though the tables cover all possible combinations between the source and cheater examinees' ability levels, it may be more meaningful to look at the left bottom corner of the tables. In practice, it is more likely to have low ability examinees while copying answers from high ability examinees. Even for the least amount of copying (10%), when a cheater examinee whose ability level is between -2.5 and -3 finds the best source and copy four items, the average increase in the ability level estimate can be as much as .92 (Table 1). This means that we observe an ability level estimate of around -1.6 for the cheater examinee while it is actually around -2.75. As the amount of copying increase, the gain can be as much as 2.48 in 50% copying (Table 5) and 3.48 in 80% copying (Table 8) for the same cheater examinee. The gain from answer copying behavior for the different combinations of source and cheater examinees' ability levels can be examined across 10 different levels of amount of copying from Table 1 to Table 10.

4. DISCUSSION AND LIMITATIONS

The results of the study indicated that answer copying on multiple-choice tests may have an important effect on the observed ability level estimate of a cheater examinee even for the small amount of copying. Answer copying behavior causes invalid test scores when the difference between the ability levels of the source and cheater examinees is larger. Especially, the gain from answer copying can be gigantic when a low ability examinee find a good source and copy the answers. When a cheater examinee whose ability level is between -2.5 and -3 copy 20 items in a 40-item test (50% copying) from a source examinee whose ability level is between

2.5 and 3, the increase in the ability level estimate is 2.48 on average. This change moves a student from the very left edge to the middle in a normal distribution. The increase in the ability level estimate may be much higher as the amount of copying increase.

This study revealed that answer copying can invalidate the test scores and high stake decisions based on the standard test scores. The current literature and survey results have enough evidence to believe that many students are engaged in exchanging their responses during the multiple choice tests. So, the educators should be aware of this problem and they should look for solutions to prevent or decrease the answer copying behavior. One solution might be using analytical methods to detect answer copying pairs by calculating the probability of matching responses between response vectors. The literature has a variety of analytical methods such as the ω index (Wollack, 1996) and the GBT index (Van der Linden & Sotaridona, 2006) to detect answer copying pairs. However, the statistical power of these methods is still questionable to detect a low ability examinee who gains an important amount of benefit by copying answers from a high ability examinee (Zopluoglu & Davenport, 2010). So, the better way is to prevent answer copying before it occurs. The literature suggests that the environmental factors are more important to courage students for answer copying (McCabe and Trevino, 1997; Passow et al., 2006; McCabe et al., 2001). The school and class environment should be well prepared to prevent answer copying behavior before it occurs. The educators should develop methods such as increasing the number of proctors or using more than one test form in the exam to reduce the unethical behavior during the exams and discourage students from answer copying behavior.

The result of the study may not be very surprising. It is expected that a cheater gains more when the cheater copies answers from a more talented student or the cheater copies more correct items. However, there is no empirical information how much gain may occur in practice. The current study used the simulation as a technique and estimated the change in ability level estimates for a commonly used IRT model for multiple-choice tests in various conditions. The results may be supportive to understand why the power to detect answer copying pairs is too low for the ω index and GBT index when a low ability cheater copies answers from a high ability source.

The research has many limitations. First limitation is using known item parameters when estimating the ability levels. In most cases, it is not expected to have a pre-calibrated item bank so the item parameters of the nominal response model have to be estimated and these estimations may not be very accurate in small sample sizes. The second limitation was using model based response vectors generated by the computer. In practice, the responses of the real examinees may not follow the nominal response model or the items may not fit the model. Another point about the items used in this study and previous studies is the number of alternatives in multiple-choice items. This study used the same five option multiple-choice items as previous research. So, the results are also limited with the number of alternatives in the items used to generate the data. A fourth limitation is the type of copying simulated in this study. It was assumed that cheaters were copying answers randomly from sources. This assumption may not be correct in real life and the results may differ for different types of copying such as difficulty weighted copying.

REFERENCES

Bernardi,R.A., Baca, A.V., Landers, K.S., & Witek, M.B. (2008). Methods of Cheating and Deterrents to Classroom Cheating:An International Study. *Ethics & Behavior , 18* (4), 373-391.

Bopp, M., Gleason, P., & Misicka, S. (2001). *Reducing Incidents of Cheating in Adolescence.* Saint Xavier University (Master Project).

Brimble,M., Clarke, P.S. (2005). Perceptions of the Prevalence and Seriousness of Academic Dishonesty in Australian Universities. *Australian Educational Researcher , 32* (3), 19-44.

Cizek, G. J. (1999). *Cheating on Tests.* New Jersey: Lawrence Erlbaum Associates.

Diekhoff,G.M., LaBeff, E.E., Shinohara, K., & Yasukawa,H. (1999). College Cheating in Japan and the United States. *Research in Higher Education , 40* (3), 343-353.

Han, K. (2007). WinGen: Windows software that generates IRT parameters and item responses. *Applied Psychological Measurement , 31* (5), 457-459.

Hughes, J.M.C. & McCabe, D L. (2006). Academic Misconduct within Higher Education in Canada. *Canadian Journal of Higher Education , 36* (2), 1-21.

Jensen,A. L., Arnett, J.J., Feldman, S. S., Cauffman, E. (2002). It's Wrong, But Everybody Does It: Academic Dishonesty among High School and College Students. *Contemporary Educational Psychology , 27*, 209-228.

Josephson Institute of Ethics. (2008). *The Ethics of American Youth*. Retrieved 04 27, 2009, from http://charactercounts.org/pdf/reportcard/2008/Q_all.pdf

Josephson Institute of Ethics. (2006). *Ethics of American Youth*. Retrieved 04 27, 2009, from http://charactercounts.org/pdf/reportcard/2006/reportcard-all.pdf

Lin, C.S. & Wen, L.M. (2007). Academic Dishonesty in Higher Education - A Nationwide Study in Taiwan. *Higher Education , 54*, 85-97.

Lupton, R.A & Chapman, K.J. (2002). Russian and American College Students' Attitudes, Perceptions, and Tendencies Towards Cheating. *Educational Research , 44* (1), 17-27.

McCabe, D. (2001). Why Students Do It and How We Can Help Them Stop. *American Educator , 25* (4), 38-43

McCabe, D.L. & Trevino, L.K. (1997). Individual and Contextual Influences on Academic Dishonesty: A Multicampus Investigation. *Research in Higher Education , 38* (3), 379-396.

McCabe, D.L., Trevino, L.K., & Butterfield K.D. (2001). Cheating in Academic Institutions: A Decade of Research. *Ethics and Behavior , 11* (3), 219-232.

Passow, H.J., Mayhew, M.J., Finelli, C.J., Harding, T.S., & Donald D.C. (2006). Factors Influencing Engineering Students' Decisions to Cheat by Type of Assessment. *Research in Higher Education , 47* (6), 643-684.

Rakovski, C.C. & Levy, E.S. (2007). Academic Dishonesty: Perceptions of Business Students. *College Student Journal , 41* (2), 466-481.

R Development Core Team (2009). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.

Thissen,D. (2003). Multiple categorical item analysis and test scoring using item response theory [Computer Software]. Chicago:Scientific Software.

Vandehey, M.A., Diekhoff, G.M., LaBeff, E.E. (2007). College Cheating: A Twenty-Year Follow Up and the Addition of an Honor Code. *Journal of College Student Development , 48* (4), 468-480.

Van der Linden, W. J. & Sotaridona, L.S. (2006). Detecting Answer Copying When the Regular Response Process Follows a Known Response Model, *Journal of Educational and Behavioral Statistics, 31 (3), 283–304*

Wollack, J.A. (1996). Detection of Answer Copying Using Item Response Theory. *Dissertation Abstracts International, 57/05, 2015*.

Zopluoglu, C. & Davenport, E. (2010). The Effects of Ability Levels of the Examinees in Answer Copying Pairs on the Empirical Power and Type I Error Rates of The GBT and ω Indexes Used to Detect Answer Copying on Multiple-Choice Tests. Unpublished manuscript, University of Minnesota, Minneapolis, MN.

TABLES AND FIGURES

Figure 1. The Main Steps in the Research Design To Generate The Data

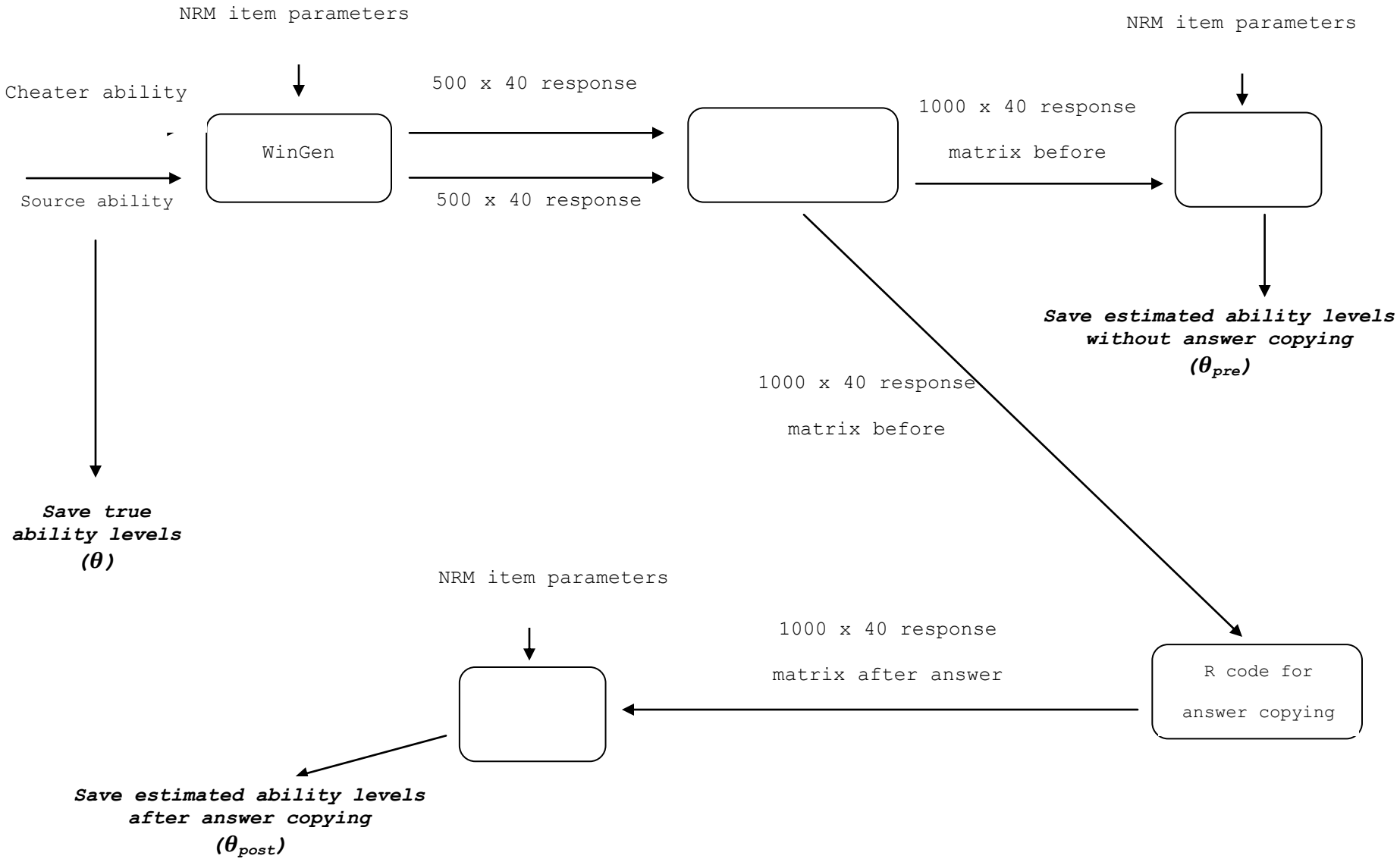

Table 1. The difference between θ_{post} and θ_{pre} - %10 copying

		Cheater Ability Level											
		-2.75	-2.25	-1.75	-1.25	-.75	-.25	.25	.75	1.25	1.75	2.25	2.75
Source Ability Level	-2.75	0.00	-0.03	-0.07	-0.10	-0.13	-0.17	-0.25	-0.38	-0.59	-0.88	-1.25	-1.48
	-2.25	0.07	0.00	-0.05	-0.09	-0.10	-0.15	-0.22	-0.36	-0.57	-0.86	-1.20	-1.47
	-1.75	0.16	0.07	0.01	-0.04	-0.08	-0.13	-0.21	-0.34	-0.54	-0.80	-1.12	-1.41
	-1.25	0.29	0.15	0.07	0.00	-0.05	-0.10	-0.17	-0.28	-0.45	-0.72	-1.02	-1.26
	-.75	0.45	0.25	0.14	0.06	0.00	-0.05	-0.11	-0.23	-0.41	-0.60	-0.86	-1.20
	-.25	0.58	0.39	0.23	0.11	0.06	-0.01	-0.06	-0.13	-0.28	-0.46	-0.67	-0.96
	.25	**0.72**	**0.47**	**0.30**	**0.18**	**0.11**	0.04	0.00	-0.07	-0.16	-0.35	-0.50	-0.67
	.75	**0.82**	**0.55**	**0.35**	**0.22**	**0.14**	0.08	0.03	-0.01	-0.07	-0.18	-0.32	-0.48
	1.25	**0.86**	**0.59**	**0.39**	**0.26**	**0.16**	0.11	0.07	0.04	0.00	-0.08	-0.16	-0.22
	1.75	**0.88**	**0.62**	**0.42**	**0.29**	**0.18**	0.12	0.09	0.07	0.03	-0.03	-0.07	-0.12
	2.25	**0.94**	**0.65**	**0.43**	**0.28**	**0.20**	0.13	0.11	0.08	0.06	0.05	-0.01	-0.07
	2.75	**0.92**	**0.64**	**0.45**	**0.29**	**0.20**	0.13	0.11	0.10	0.08	0.08	0.04	-0.01

* The cell means are calculated over 500 cheater examinees, $\Delta(\theta) = \hat{\theta}_{post} - \hat{\theta}_{pre}$

* SE for cell means are between .003 and .026

Table 2. The difference between θ_{post} and θ_{pre} - %20 copying

		Cheater Ability Level											
		-2.75	-2.25	-1.75	-1.25	-.75	-.25	.25	.75	1.25	1.75	2.25	2.75
Source Ability Level	-2.75	0.00	-0.06	-0.16	-0.19	-0.24	-0.32	-0.46	-0.66	-0.98	-1.36	-1.77	-2.03
	-2.25	0.14	0.00	-0.07	-0.15	-0.21	-0.30	-0.44	-0.63	-0.94	-1.32	-1.73	-2.01
	-1.75	0.34	0.14	-0.01	-0.08	-0.17	-0.25	-0.38	-0.59	-0.89	-1.24	-1.64	-1.93
	-1.25	0.53	0.28	0.13	0.00	-0.08	-0.19	-0.31	-0.51	-0.78	-1.16	-1.52	-1.83
	-.75	0.77	0.47	0.27	0.12	0.01	-0.10	-0.23	-0.40	-0.65	-1.02	-1.35	-1.62
	-.25	0.98	0.65	0.41	0.23	0.11	0.00	-0.13	-0.27	-0.50	-0.81	-1.12	-1.39
	.25	**1.17**	**0.83**	**0.55**	**0.35**	**0.20**	**0.09**	0.00	-0.13	-0.31	-0.53	-0.86	-1.01
	.75	**1.28**	**0.93**	**0.64**	**0.44**	**0.27**	**0.17**	0.09	0.00	-0.12	-0.36	-0.56	-0.76
	1.25	**1.36**	**1.00**	**0.71**	**0.49**	**0.34**	**0.22**	0.15	0.10	0.00	-0.14	-0.33	-0.51
	1.75	**1.42**	**1.06**	**0.74**	**0.52**	**0.36**	**0.25**	0.20	0.15	0.09	-0.01	-0.13	-0.26
	2.25	**1.45**	**1.06**	**0.76**	**0.54**	**0.38**	**0.28**	0.21	0.18	0.16	0.11	-0.01	-0.11
	2.75	**1.42**	**1.07**	**0.79**	**0.56**	**0.39**	**0.29**	0.23	0.20	0.18	0.17	0.08	-0.03

* The cell means are calculated over 500 cheater examinees, $\Delta(\theta) = \hat{\theta}_{post} - \hat{\theta}_{pre}$
* SE for cell means are between .004 and .028

Table 3. The difference between θ_{post} and θ_{pre} - %30 copying

		Cheater Ability Level											
		-2.75	-2.25	-1.75	-1.25	-.75	-.25	.25	.75	1.25	1.75	2.25	2.75
Source Ability Level	-2.75	-0.03	-0.14	-0.22	-0.31	-0.39	-0.50	-0.67	-0.94	-1.28	-1.74	-2.09	-2.49
	-2.25	0.19	0.00	-0.12	-0.23	-0.33	-0.46	-0.63	-0.90	-1.27	-1.68	-2.09	-2.41
	-1.75	0.43	0.18	0.00	-0.13	-0.25	-0.40	-0.56	-0.83	-1.18	-1.57	-2.01	-2.31
	-1.25	0.70	0.41	0.18	0.01	-0.15	-0.28	-0.48	-0.72	-1.07	-1.49	-1.87	-2.17
	-.75	1.00	0.66	0.37	0.16	0.01	-0.16	-0.33	-0.56	-0.89	-1.27	-1.65	-1.97
	-.25	1.24	0.93	0.61	0.34	0.16	0.01	-0.15	-0.37	-0.67	-1.05	-1.43	-1.70
	.25	**1.52**	**1.08**	**0.77**	**0.51**	**0.30**	**0.16**	0.00	-0.19	-0.45	-0.77	-1.08	-1.34
	.75	**1.61**	**1.26**	**0.89**	**0.63**	**0.42**	**0.25**	0.13	-0.02	-0.20	-0.44	-0.75	-1.01
	1.25	**1.73**	**1.36**	**0.99**	**0.69**	**0.50**	**0.34**	0.24	0.13	0.01	-0.21	-0.43	-0.66
	1.75	**1.82**	**1.37**	**1.03**	**0.75**	**0.54**	**0.38**	0.30	0.22	0.14	0.01	-0.18	-0.34
	2.25	**1.83**	**1.38**	**1.04**	**0.77**	**0.56**	**0.42**	0.34	0.25	0.23	0.14	0.04	-0.18
	2.75	**1.82**	**1.43**	**1.07**	**0.79**	**0.57**	**0.44**	0.36	0.32	0.27	0.25	0.10	0.05

* The cell means are calculated over 500 cheater examinees, $\Delta(\theta) = \hat{\theta}_{post} - \hat{\theta}_{pre}$
* SE for cell means are between .006 and .031

Table 4. The difference between θ_{post} and θ_{pre} - %40 copying

		Cheater Ability Level											
		-2.75	-2.25	-1.75	-1.25	-.75	-.25	.25	.75	1.25	1.75	2.25	2.75
Source Ability Level	-2.75	-0.01	-0.15	-0.30	-0.43	-0.54	-0.69	-0.89	-1.17	-1.58	-2.01	-2.44	-2.73
	-2.25	0.21	-0.01	-0.17	-0.34	-0.46	-0.62	-0.85	-1.13	-1.51	-1.97	-2.37	-2.72
	-1.75	0.52	0.23	0.00	-0.18	-0.34	-0.50	-0.73	-1.04	-1.42	-1.85	-2.30	-2.60
	-1.25	0.85	0.53	0.23	0.02	-0.19	-0.36	-0.64	-0.91	-1.30	-1.73	-2.13	-2.51
	-.75	1.24	0.85	0.49	0.20	-0.01	-0.19	-0.41	-0.73	-1.09	-1.53	-1.95	-2.21
	-.25	1.50	1.08	0.73	0.42	0.22	0.02	-0.22	-0.48	-0.83	-1.17	-1.67	-1.94
	.25	**1.73**	**1.35**	**0.94**	**0.64**	**0.40**	**0.20**	0.00	-0.25	-0.57	-0.94	-1.34	-1.63
	.75	**1.93**	**1.54**	**1.13**	**0.79**	**0.56**	**0.36**	0.19	0.00	-0.27	-0.61	-0.90	-1.18
	1.25	**2.08**	**1.63**	**1.22**	**0.89**	**0.65**	**0.48**	0.32	0.20	0.02	-0.24	-0.54	-0.79
	1.75	**2.10**	**1.68**	**1.27**	**0.95**	**0.72**	**0.53**	0.44	0.32	0.16	-0.03	-0.22	-0.48
	2.25	**2.14**	**1.72**	**1.33**	**0.99**	**0.75**	**0.58**	0.48	0.40	0.33	0.21	-0.04	-0.19
	2.75	**2.16**	**1.75**	**1.36**	**1.02**	**0.77**	**0.59**	0.49	0.45	0.38	0.26	0.15	0.02

* The cell means are calculated over 500 cheater examinees, $\Delta(\theta) = \hat{\theta}_{post} - \hat{\theta}_{pre}$
* SE for cell means are between .007 and .031

Table 5. The difference between θ_{post} and θ_{pre} - %50 copying

		Cheater Ability Level											
		-2.75	-2.25	-1.75	-1.25	-.75	-.25	.25	.75	1.25	1.75	2.25	2.75
Source Ability Level	-2.75	0.04	-0.21	-0.43	-0.55	-0.72	-0.87	-1.12	-1.44	-1.86	-2.29	-2.78	-3.09
	-2.25	0.32	0.00	-0.21	-0.44	-0.61	-0.77	-1.04	-1.35	-1.76	-2.26	-2.64	-3.03
	-1.75	0.61	0.29	-0.02	-0.24	-0.43	-0.65	-0.92	-1.27	-1.69	-2.13	-2.54	-2.87
	-1.25	1.02	0.63	0.29	-0.01	-0.25	-0.48	-0.74	-1.09	-1.50	-1.94	-2.43	-2.67
	-.75	1.39	0.95	0.59	0.26	-0.02	-0.27	-0.55	-0.87	-1.28	-1.73	-2.18	-2.53
	-.25	1.72	1.31	0.88	0.53	0.26	0.01	-0.28	-0.58	-0.97	-1.40	-1.86	-2.17
	.25	**2.02**	**1.58**	**1.15**	**0.80**	**0.49**	**0.24**	0.01	-0.31	-0.64	-1.06	-1.53	-1.82
	.75	**2.18**	**1.74**	**1.33**	**0.98**	**0.69**	**0.47**	0.22	0.00	-0.27	-0.65	-1.05	-1.33
	1.25	**2.33**	**1.88**	**1.48**	**1.09**	**0.82**	**0.58**	0.42	0.24	0.00	-0.32	-0.63	-0.90
	1.75	**2.41**	**1.96**	**1.55**	**1.20**	**0.91**	**0.69**	0.55	0.41	0.22	0.04	-0.29	-0.50
	2.25	**2.45**	**2.01**	**1.58**	**1.23**	**0.93**	**0.75**	0.62	0.51	0.40	0.25	0.01	-0.22
	2.75	**2.48**	**2.02**	**1.61**	**1.25**	**0.99**	**0.79**	0.68	0.61	0.53	0.39	0.20	0.00

* The cell means are calculated over 500 cheater examinees, $\Delta(\theta) = \hat{\theta}_{post} - \hat{\theta}_{pre}$
* SE for cell means are between .008 and .033

Table 6. The difference between θ_{post} and θ_{pre} - %60 copying

		Cheater Ability Level											
		-2.75	-2.25	-1.75	-1.25	-.75	-.25	.25	.75	1.25	1.75	2.25	2.75
Source Ability Level	-2.75	0.01	-0.29	-0.52	-0.71	-0.87	-1.10	-1.36	-1.67	-2.10	-2.67	-3.06	-3.39
	-2.25	0.30	-0.01	-0.27	-0.52	-0.74	-0.97	-1.25	-1.60	-2.02	-2.54	-2.94	-3.31
	-1.75	0.74	0.35	0.00	-0.26	-0.55	-0.83	-1.09	-1.48	-1.86	-2.33	-2.84	-3.15
	-1.25	1.14	0.69	0.35	0.00	-0.29	-0.58	-0.91	-1.26	-1.68	-2.14	-2.61	-2.97
	-.75	1.55	1.07	0.69	0.33	0.01	-0.29	-0.65	-1.02	-1.44	-1.92	-2.36	-2.72
	-.25	1.92	1.47	1.03	0.65	0.34	-0.01	-0.32	-0.69	-1.11	-1.55	-2.03	-2.36
	.25	**2.25**	**1.75**	**1.29**	**0.92**	**0.59**	**0.28**	-0.01	-0.35	-0.74	-1.14	-1.63	-1.97
	.75	**2.47**	**1.99**	**1.52**	**1.17**	**0.83**	**0.55**	0.27	-0.01	-0.38	-0.78	-1.23	-1.51
	1.25	**2.59**	**2.10**	**1.70**	**1.33**	**1.00**	**0.75**	0.52	0.28	0.04	-0.34	-0.74	-1.01
	1.75	**2.72**	**2.23**	**1.79**	**1.42**	**1.12**	**0.85**	0.67	0.51	0.30	0.00	-0.35	-0.54
	2.25	**2.76**	**2.27**	**1.84**	**1.48**	**1.17**	**0.96**	0.80	0.66	0.50	0.27	0.00	-0.26
	2.75	**2.77**	**2.33**	**1.89**	**1.52**	**1.22**	**1.03**	0.88	0.77	0.65	0.52	0.19	0.02

* The cell means are calculated over 500 cheater examinees, $\Delta(\theta) = \hat{\theta}_{post} - \hat{\theta}_{pre}$

* SE for cell means are between .009 and .035

Table 7. The difference between θ_{post} and θ_{pre} - %70 copying

		Cheater Ability Level											
		-2.75	-2.25	-1.75	-1.25	-.75	-.25	.25	.75	1.25	1.75	2.25	2.75
Source Ability Level	-2.75	0.02	-0.30	-0.67	-0.85	-1.11	-1.33	-1.63	-1.99	-2.40	-2.94	-3.35	-3.70
	-2.25	0.35	0.00	-0.38	-0.62	-0.92	-1.21	-1.47	-1.85	-2.34	-2.81	-3.29	-3.59
	-1.75	0.81	0.41	0.02	-0.35	-0.65	-0.97	-1.29	-1.68	-2.16	-2.65	-3.07	-3.45
	-1.25	1.24	0.81	0.40	0.00	-0.33	-0.68	-1.02	-1.45	-1.92	-2.44	-2.84	-3.25
	-.75	1.69	1.20	0.75	0.39	0.00	-0.35	-0.73	-1.13	-1.62	-2.11	-2.55	-2.88
	-.25	2.12	1.64	1.16	0.74	0.33	0.00	-0.35	-0.76	-1.22	-1.73	-2.21	-2.48
	.25	**2.42**	**1.96**	**1.52**	**1.07**	**0.69**	**0.35**	-0.03	-0.40	-0.83	-1.28	-1.74	-2.12
	.75	**2.70**	**2.18**	**1.76**	**1.37**	**0.98**	**0.67**	0.34	0.00	-0.40	-0.83	-1.25	-1.63
	1.25	**2.87**	**2.40**	**1.94**	**1.55**	**1.18**	**0.91**	0.66	0.34	-0.02	-0.43	-0.81	-1.08
	1.75	**2.99**	**2.53**	**2.07**	**1.68**	**1.36**	**1.08**	0.86	0.64	0.38	0.00	-0.36	-0.62
	2.25	**3.06**	**2.60**	**2.16**	**1.75**	**1.44**	**1.19**	1.02	0.85	0.62	0.29	0.01	-0.27
	2.75	**3.11**	**2.62**	**2.18**	**1.80**	**1.49**	**1.29**	1.10	1.01	0.78	0.59	0.32	-0.05

* The cell means are calculated over 500 cheater examinees, $\Delta(\theta) = \hat{\theta}_{post} - \hat{\theta}_{pre}$
* SE for cell means are between .010 and .039

Table 8. The difference between θ_{post} and θ_{pre} - %80 copying

		Cheater Ability Level											
		-2.75	-2.25	-1.75	-1.25	-.75	-.25	.25	.75	1.25	1.75	2.25	2.75
Source Ability Level	-2.75	-0.01	-0.40	-0.75	-1.08	-1.36	-1.61	-1.96	-2.34	-2.80	-3.25	-3.76	-4.15
	-2.25	0.46	-0.03	-0.40	-0.76	-1.10	-1.40	-1.74	-2.18	-2.62	-3.17	-3.59	-3.93
	-1.75	0.97	0.45	0.01	-0.41	-0.75	-1.12	-1.51	-1.95	-2.42	-2.92	-3.37	-3.71
	-1.25	1.38	0.88	0.41	-0.03	-0.39	-0.78	-1.20	-1.62	-2.13	-2.58	-3.05	-3.40
	-.75	1.86	1.30	0.87	0.43	-0.02	-0.43	-0.81	-1.25	-1.78	-2.26	-2.76	-3.07
	-.25	2.22	1.77	1.31	0.87	0.43	0.01	-0.42	-0.89	-1.33	-1.85	-2.31	-2.68
	.25	**2.67**	**2.15**	**1.66**	**1.22**	**0.79**	**0.37**	0.01	-0.44	-0.92	-1.35	-1.85	-2.17
	.75	**2.98**	**2.47**	**1.99**	**1.54**	**1.16**	**0.77**	0.39	0.01	-0.44	-0.97	-1.41	-1.71
	1.25	**3.24**	**2.71**	**2.23**	**1.80**	**1.40**	**1.09**	0.74	0.37	0.03	-0.48	-0.87	-1.20
	1.75	**3.33**	**2.87**	**2.38**	**1.95**	**1.63**	**1.32**	1.04	0.75	0.40	0.02	-0.42	-0.74
	2.25	**3.49**	**2.98**	**2.48**	**2.07**	**1.76**	**1.49**	1.29	1.04	0.81	0.40	-0.03	-0.32
	2.75	**3.48**	**3.02**	**2.56**	**2.16**	**1.83**	**1.59**	1.40	1.23	0.96	0.65	0.29	0.07

* The cell means are calculated over 500 cheater examinees, $\Delta(\theta) = \hat{\theta}_{post} - \hat{\theta}_{pre}$

* SE for cell means are between .012 and .038

Table 9. The difference between θ_{post} and θ_{pre} - %90 copying

		Cheater Ability Level											
		-2.75	-2.25	-1.75	-1.25	-.75	-.25	.25	.75	1.25	1.75	2.25	2.75
Source Ability Level	-2.75	0.01	-0.45	-0.90	-1.28	-1.68	-2.00	-2.41	-2.80	-3.30	-3.83	-4.25	-4.63
	-2.25	0.49	0.02	-0.45	-0.87	-1.31	-1.69	-2.13	-2.55	-3.03	-3.57	-4.02	-4.38
	-1.75	0.96	0.48	0.00	-0.43	-0.90	-1.32	-1.74	-2.23	-2.74	-3.26	-3.72	-4.01
	-1.25	1.49	0.98	0.45	0.00	-0.45	-0.91	-1.35	-1.84	-2.36	-2.84	-3.34	-3.64
	-.75	1.96	1.46	0.97	0.47	-0.01	-0.44	-0.96	-1.38	-1.88	-2.42	-2.91	-3.24
	-.25	2.37	1.95	1.41	0.96	0.47	0.00	-0.01	-0.94	-1.46	-1.97	-2.42	-2.80
	.25	**2.89**	**2.33**	**1.86**	**1.38**	**0.91**	**0.47**	0.03	-0.49	-0.99	-1.49	-1.98	-2.29
	.75	**3.26**	**2.75**	**2.24**	**1.79**	**1.33**	**0.89**	0.46	-0.02	-0.52	-1.01	-1.41	-1.83
	1.25	**3.59**	**3.07**	**2.59**	**2.16**	**1.71**	**1.31**	0.92	0.46	0.00	-0.50	-0.94	-1.32
	1.75	**3.81**	**3.33**	**2.83**	**2.40**	**1.99**	**1.64**	1.28	0.89	0.50	0.04	-0.43	-0.71
	2.25	**3.96**	**3.49**	**3.02**	**2.63**	**2.24**	**1.91**	1.62	1.29	0.83	0.41	0.01	-0.33
	2.75	**4.12**	**3.62**	**3.16**	**2.74**	**2.41**	**2.09**	1.83	1.48	1.15	0.73	0.38	-0.03

* The cell means are calculated over 500 cheater examinees, $\Delta(\theta) = \hat{\theta}_{post} - \hat{\theta}_{pre}$

* SE for cell means are between .014 and .045

Table 10. The difference between θ_{post} and θ_{pre} - %100 copying

		Cheater Ability Level											
		-2.75	-2.25	-1.75	-1.25	-.75	-.25	.25	.75	1.25	1.75	2.25	2.75
Source Ability Level	-2.75	0.01	-0.51	-1.04	-1.54	-2.08	-2.56	-3.14	-3.61	-4.19	-4.75	-5.23	-5.55
	-2.25	0.53	-0.02	-0.48	-1.05	-1.56	-2.08	-2.60	-3.11	-3.64	-4.20	-4.69	-5.08
	-1.75	1.03	0.53	0.01	-0.54	-1.04	-1.53	-2.07	-2.60	-3.11	-3.66	-4.13	-4.52
	-1.25	1.61	1.06	0.51	0.01	-0.49	-1.04	-1.55	-2.04	-2.63	-3.11	-3.67	-3.99
	-.75	2.13	1.52	1.06	0.51	0.02	-0.51	-1.03	-1.57	-2.06	-2.59	-3.11	-3.49
	-.25	2.62	2.07	1.57	1.04	0.51	0.00	-0.54	-1.03	-1.57	-2.12	-2.50	-2.98
	.25	**3.13**	**2.58**	**2.07**	**1.55**	**1.04**	**0.53**	-0.01	-0.55	-1.06	-1.61	-2.07	-2.39
	.75	**3.63**	**3.12**	**2.61**	**2.04**	**1.51**	**1.03**	0.54	0.00	-0.58	-1.11	-1.57	-1.92
	1.25	**4.17**	**3.68**	**3.12**	**2.63**	**2.09**	**1.55**	1.04	0.58	0.00	-0.57	-1.03	-1.34
	1.75	**4.70**	**4.20**	**3.60**	**3.12**	**2.60**	**2.13**	1.62	1.08	0.53	-0.09	-0.51	-0.86
	2.25	**5.13**	**4.72**	**4.17**	**3.58**	**3.11**	**2.60**	2.07	1.59	1.03	0.52	-0.02	-0.38
	2.75	**5.59**	**5.06**	**4.47**	**4.00**	**3.42**	**2.92**	2.44	1.96	1.33	0.79	0.34	-0.03

* The cell means are calculated over 500 cheater examinees, $\Delta(\theta) = \hat{\theta}_{post} - \hat{\theta}_{pre}$

* SE for cell means are between .016 and .041