If you Cheat, I Cheat: Cheating on a Collaborative Task with a Social Robot

Ali Ayub, Huiqing Hu, Guangwei Zhou, Carter Fendley, Crystal Ramsay, Kathy Lou Jackson and Alan R. Wagner

Abstract—Robots may soon play a role in higher education by augmenting learning environments and managing interactions between instructors and learners. Little, however, is known about how the presence of robots in the learning environment will influence academic integrity. This study therefore investigates if and how college students cheat while engaged in a collaborative sorting task with a robot. We employed a 2x2 factorial design to examine the effects of cheating exposure (exposure to cheating or no exposure) and task clarity (clear or vague rules) on college student cheating behaviors while interacting with a robot. Our study finds that prior exposure to cheating on the task significantly increases the likelihood of cheating. Yet, the tendency to cheat was not impacted by the clarity of the task rules. These results suggest that normative behavior by classmates may strongly influence the decision to cheat while engaged in an instructional experience with a robot.

I. INTRODUCTION

Robots may soon play a role in higher education by augmenting learning environments and managing interactions between instructors and learners. Yet, very little is known about how the presence and use of robots in higher education will impact academic integrity. There are reasons to be concerned. McCabe, Butterfield, and Travisino note that cheating is widespread and increasing [1]. Davis, Drinan, and Gallant suggest that methods for cheating have evolved with technology [2]. Given the prevalence of cheating and the possibility that technology makes it easier to cheat, we set out to investigate how a new and not yet common technology in academic settings may influence ethical behavior [9]. Forlizzi contexts is in its infancy. Research has examined how the presence of a robot influences ethical behavior [9]. Forlizzi...
et al. [9] employed a controlled field study in which unsuspecting subjects passed by food labeled ‘reserved’ with no observer, a human, or a robot watching the food. They found that people behave more dishonestly when the food is being monitored by the robot than the human. Relatedly, Petisca et al. investigate whether or not people are more likely to cheat at a game while in the presence of a robot. They find that the presence of the robot does not inhibit cheating, and find that, in fact, the person cheats at the same rate as if they were alone [10], [11]. Both of these works considered cheating scenarios in which the robot was merely an observer and did not take part in the task.

This work investigates a gap in our understanding related to how student academic integrity could be impacted during an instructional experience with a robot. To the best of our knowledge, this is the first paper to examine the factors that influence students to cheat while collaborating with a robot.

### III. Method

#### A. Participants

We recruited 78 college students (18-22 years old) from three introductory educational psychology courses at The Pennsylvania State University. Most participants were female (78%), freshman (62%), and self-reported their GPA for the current semester as between 3.6-4.0 (36%). The experimental conditions did not differ significantly by gender, \( \chi^2(3) = 1.21, p = 0.75 \), or self-reported GPA, \( \chi^2(6) = 8.02, p = 0.24 \). Our study was IRB approved by the Penn State office of research.

#### B. The Collaborative Task

We adapted the Wisconsin Card Sorting Task (WCST) to serve as the collaborative task for this study [12]. In the original WCST, each card is characterized by a shape (stars, circles, triangles, squares), color for the shapes (yellow, green, blue, or red), the number of shapes (1 - 4). Four baseline WCST cards are present in front of the participant: a card with one red triangle, a card with two green stars, a card with three yellow crosses, and a card with four blue circles (see Figure 2). During each turn, the participant sorts a card by placing it in front of a baseline card based on one of the three characteristics, known as the sorting criterion. After the sort, the participant receives a feedback sound indicating whether or not the sort was correct based on the current sorting criterion. The participant is not told the sorting criteria during the task, rather he/she has to use the feedback after the sort to deduce the sorting criteria. After a small number of sorts, the sorting criterion changes randomly and the participant has to learn the new criterion.

For this study, we converted the original WCST into a collaborative task, where the human participant and the Baxter robot took turns sorting the Wisconsin cards, instead of sorting individually. The robot was situated on one side of the experiment table; the participants sat on the other side of the table upon arrival. The task environment included four baseline WCST cards which were placed on the table, along with a timer, a speaker, and two decks of additional cards. See Figure 1 for the experimental layout.

Before the task began, participants were told to choose any of three criteria to begin sorting (e.g., color), and the robot would sort next. They were also told the correct sorting criterion would change throughout the task, but that participants would not be given the criterion ahead of time. They were told to pay attention to the feedback, a sound from the an external speaker after each sort, to deduce the criterion. A “ding” sound indicated that a card was sorted correctly, and a “buzz” sound indicated that the card was not sorted correctly. The researcher controlled the speaker and played feedback sounds after each sort made by the participant or the robot. The researcher predetermined the pattern of the sorting criteria (e.g., started with color, then changed to number, then a shape). The criteria switch after 5–7 sorts. On average, the sorting criteria changed 3–6 times
for each participant over the course of the experiment.

Participants were instructed to take turns with the robot. Participants were also instructed that if they sorted 10 cards correctly within the 7 minutes allotted, and if Baxter also sorted 10 cards correctly, they would receive extra credit (course points) toward their course grade. Otherwise, if they and/or Baxter fell short of these goals then they would not receive extra credit. However, this instruction was only used as a motivation. All the participants were awarded extra credit regardless of whether or not they sorted the required number of cards.

Across all conditions, the robot sorted 8-9 cards at a slow, steady pace. The robot always sorted below the threshold needed to succeed at the task (i.e., 10 cards). In addition, some cards were purposefully sorted incorrectly in order to represent a poor performing partner. The robot’s behavior was designed to put the extra credit in jeopardy motivating the participants to consider cheating on the task.

C. The Baxter Robot

The Baxter robot, manufactured by Rethink Robotics, was used for this experiment (see Figure 3). The suction gripper on the robot’s right arm was used to pick up and move cards on a flat table. Baxter has three cameras, one on its head and two cameras near its hands. The hand cameras were used to take images and record videos while performing tasks. The robot was controlled remotely by the researcher although human participants believed that the robot was acting autonomously. The robot was programmed to pick up cards from a pre-defined location on the table and to move cards to one of four pre-defined locations on the table. The robot’s right arm was used to move the cards. Its arm hovered over the table when not moving allowing the hand camera to capture video of the table surface. The camera output was sent to a remote desktop allowing the researcher to monitor the table and the cards. The robot’s left arm remained stationary with its camera pointing towards the table as well (Figure 1). The camera output from the left arm was also sent to the remote desktop providing a second view of the table.

During the robot’s turn to sort a card, the researcher first commanded the robot to pick up a card by pressing a button on the keyboard. After the robot picked up the card using its suction gripper, the arm moved back to the default position over the table. Next, the researcher chose one of the four places (for four base cards) on the table by typing a number between (1-4) on the keyboard. The robot then placed the card at the specified location.

D. Confederates

Two confederates were hired for this experiment to act as a participant and to demonstrate cheating behaviors in the confederate cheating condition (explained in Section III-E). The first confederate was a male undergraduate student, 21 years old, Caucasian, a junior, and majoring in computer science. The second confederate was also a male undergraduate student, 21 years old, Asian, a junior, and majoring in mechanical engineering.

E. Experimental Conditions

Participants were randomly assigned to one of the four conditions: confederate cheating, vague rules (CV); confederate cheating, clear rules (CC); no confederate cheating, vague rules (NV); and no confederate cheating, clear rules (NC).

In the cheating exposure conditions (CV & CC), a confederate used three different cheating behaviors: looked ahead, did not wait for the robot’s turn, and sorted for the robot. See Table 2 for descriptions of each cheating behavior. Both confederates demonstrated approximately the same number of cheating behaviors. They also expressed frustration before and after they cheated by sighing, shaking their head, and/or showing anxious facial expressions. In the non-cheating conditions (i.e., NV & NC), confederates did not display any cheating behaviors or express frustration. Instead, confederates followed all of the rules for the task.

In the clear rule conditions (i.e., CC & NC), the researcher verbally explained the rules and provided a list of the rules for the sorting task that was displayed on the table throughout the experiment. The participants in this condition were informed that the list of the rules on the table were the same as the ones explained to them, and they could review the rules at any time during the experiment. In the vague rule conditions (i.e., CV & NV), the researcher verbally explained the rules of the sorting task to each participant before the start of the experiment but the list of rules were not displayed on the table. Participants were also not given time to ask questions.
TABLE I: Descriptions of the types of cheating behaviors occurring in the study.

| Type of Cheating Behavior | Description | Demonstrated by |
|---------------------------|-------------|-----------------|
| Look Ahead                | After the robot’s turn, the confederate flipped the next card over and looked at it to prepare for the next turn. | Confederate and participant |
| Did not wait for the robot’s turn | Before the robot starts to move for its next turn, the confederate sorted another card into one of his sorted card slots with either one of his or Baxter’s card. | Confederate and participant |
| Sorted for the robot      | The confederate put a card in one of the robot’s sorted cards slots with either the robot’s or his own card. | Confederate and participant |
| Sort the same card again  | Immediately after the participant gets feedback on a sort, they sort the same card again in another one of their sorted card slots. | Participant |
| Sort for the robot if it fails to pick up | The participant sorts for the robot when the robot fails to pick up the card due to a suction gripper failure. | Participant |

F. Procedures

The experiment was conducted in a robotics laboratory. For each session, one of the confederates arrived at the lab at approximately the same time as the participant and pretended to be a participant for the same experiment. When both the participant and the confederate arrived, the researcher greeted them, asked for their names, explained that there was only one set up for the study so the two participants (the participant and the confederate) would have to take turns completing the experiment. The confederate was asked to go first, followed by the real participant. The confederate was directed to complete a pre-experiment Qualtrics survey that was loaded on a laptop placed next to the experiment table, and the participant was asked to wait for their turn. Once the survey was complete, the confederate was asked to sit in front of the experiment table and the participant was instructed to complete the survey. Once the participant completed the survey, the experiment began with the researcher verbally explaining the instructions for the sorting task to both individuals.

The confederate and the participant were then introduced to the Baxter robot. They were shown each part of the task and the researcher explained the rules of the sorting task. The participant was told that the first “participant” (i.e., the confederate) would complete the sorting task with Baxter first, then it would be the participant’s turn. Once the instructions were given, the researcher started the timer remotely for the confederate to begin his turn. The participant was able to clearly observe the confederate, their sorting behavior, and the whole experiment table while waiting for his or her turn. The researcher did not stay in the experiment area when the confederate or the participant were completing the task.

After the confederate’s turn, the researcher stopped the timer, and told the confederate “Congratulations, you will be getting the extra credit, because you got more than 10 of your cards sorted correctly and Baxter got more than 10 of his cards sorted correctly. This statement was made in all conditions regardless of how many correct cards they sorted. The confederate was then asked to switch seats with the participant. The participant completed the same sorting task while the confederate completed the post-experiment survey. Figure 4 shows an example of a participant completing the WCST task. Immediately after the participant completed the sorting task, they were instructed to complete the post-experiment survey.

At the end of the experiment, participants were fully debriefed. They were told that they would receive the extra credit regardless of how many cards they and the robot sorted correctly, and that the first “participant” was a confederate. They were then offered an opportunity to ask the researcher questions about the nature of the experiment. All the sessions were video recorded for data analysis purposes and all the participants provided permission to use their video data.

G. Measures

Several different metrics were recorded in order to capture the participant’s cheating behaviors and opinions about the task.

1) Type and Frequency of Cheating Behaviors: The type and frequency of participants’ cheating behaviors were coded using the video recordings of each participant. We used a qualitative research tool, MAXQDA 2018\(^1\) for the video analysis. To establish the codes, two coders applied a general inductive approach to examine the types of cheating behaviors displayed by the participants, without imposing a pre-existing framework for the behaviors that were expected to be observed [13]. Specifically, the two coders independently

\(^1\)Software available from maxqda.com
watched video recordings of the cheating conditions and each created an initial list of distinct cheating behaviors. The two coders then combined their lists of initial cheating behaviors, further refined the combined list through discussion, and came to consensus on a final list of five unique cheating behaviors. As indicated in Table I, the five types of cheating behaviors included: (1) look ahead, (2) does not wait for the robot’s turn, (3) sort for the robot, (4) sort the same card again and (5) sort for the robot if it misses. The first three behaviors were demonstrated by the confederate and imitated by the participants, the latter two were new cheating behaviors demonstrated by the participants during the study. Based on the final coding scheme, the two coders independently analyzed the video data for the cheating conditions and coded the frequencies of each cheating behavior. Intra-class correlation using a two-way mixed model with absolute agreement was conducted on the two raters’ coded frequencies of each cheating behavior, and interrater reliability was lowest for “sort for the robot if it misses” [ICC (3,2) = .444] and highest for “sort for the robot” [ICC (3,2) = .968]. Thereafter, the two raters revisited the coding scheme and resolved all the frequency discrepancies in the cheating conditions and reached perfect agreement. Finally, each rater coded the remainder of the videos, reconciled, and resolved all of the remaining frequency disagreements. The two coders agreed on all the coded behaviors in the final version of the data set.

2) Pretest and Posttest Measures: Participants’ existing perception of robots was measured at the beginning of the experiment using the anthropomorphism (5-items), likeability (5-items), and perceived intelligence (5-items) subscales on the Godspeed questionnaire [14], [15]. Each item had a unique 5-point semantic differential scale with bipolar anchors (e.g. 1=Fake, 5=Natural; 1=Machinelike, 5=human-like), and participants were asked to rate their impressions of robots on a total of 15 items across the three subscales. These subscales have been shown to have strong reliability with Cronbach’s $\alpha$ over .70 [16]. Likewise, the current study also found high internal consistency among all three dimensions: anthropomorphism (Cronbach’s $\alpha$=0.7), likeability (Cronbach’s $\alpha$=0.85), and perceived intelligence (Cronbach’s $\alpha$=0.77).

On the posttest, two items were used to measure participants’ prior experiences with robots. Participants were asked if they had ever interacted with a robot (yes/no) prior to the experiment. If they selected yes, they were then asked to describe their prior interactions with a robot in an open-ended format. Next, two more items were used to measure participants’ prior experiences with the Wisconsin Card Sorting Task (WCST). Participants were asked if they had heard of the WCST (yes/no). If they responded yes, they were then asked if they had experience completing the WCST prior to the experiment (yes/no). The 9-item Academic Dishonesty Scale [17] was given to measure self-reported cheating behaviors in academic settings. On a 5-point Likert scale (1 = never, 5 = many times), participants were asked to rate the frequency with which they had engaged in nine common academically dishonest behaviors (e.g. “Copying a few sentences of material without footnoting in a paper”). Prior studies have reported the scores on this scale with high reliability (Cronbach’s $\alpha$=0.79) [17]. Consistent with prior reporting, scores on the scale in the present study were also found to be internally reliable (Cronbach’s $\alpha$=0.81). Finally, participants’ perception of their own cheating behaviors was measured with a yes/no question asking if they thought they had cheated during the collaborative task with the robot. If they selected yes, they were then asked in an open-ended format, how they cheated and why they cheated.

## IV. Results

A. Preliminary Analysis

A preliminary analysis was conducted to examine whether the experimental conditions were balanced based on participants’ prior exposure to robots and the WCST. Descriptive analysis is shown in Table II. Three one-way ANOVAs on each of the Godspeed subscales showed that there were no statistically significant differences across the conditions on participants’ impressions of robots in terms of anthropomorphism, $F(1,74) = .09, p = .97$; likeability, $F(1,74) = .38, p = .80$; or perceived intelligence, $F(1,74) = 1.82, p = .15$. Few participants (10% in CC & NC, 19% in CV, 29% in NV) reported that they had interacted with a robot such as Baxter robot prior to the experiment. A chi-square test indicated that there were no statistically significant differences across the conditions in the proportion of participants who had this experience, $\chi^2(3) = 3.35, p = .34$. Among the participants who had experiences with robots, none indicated that they engaged in a sorting task with a robot or had collaborated with the Baxter robot, in particular, before. Moreover, very few participants indicated that they had heard of the WSCT.
cheating. Overall, these findings indicate college students of students that cheated did not report their behavior as broke the rules. These results suggest that a large portion of the five participants who cheated self-reported that they cheated. In the NC condition, only one out those who cheated in CC reported that they cheated, and who cheated reported that they cheated, 56% (9 people) of In the CV condition, 65% of participants (13 individuals) participants self-reported that they followed the task rules. Overall, approximately half of the participants who cheated during the sorting task with the robot were a poor partner. Table IV presents the number of participants who cheated on a collaborative task with a robot, based on the observations of the researchers and the number of participants who self-reported that they cheated in the four conditions. Total number of participants in each condition are also reported.

TABLE IV: The number and percentage of participants who were observed cheating and who self-reported that they cheated in the four conditions. Total number of participants in each condition are also reported.

(5% in CV & NC, 6% in NV, 10% in CC) or had completed the task (0 in CV, 5% in NC, 6% in CC and NV) prior to the study. Separate chi-square tests showed there were no statistically significant differences across the conditions among those who had heard about the WSCT, \( \chi^2(3) = .60, p = .90 \), or had completed the task, \( \chi^2(3) = 1.18, p = .76 \). In sum, the four experimental conditions were not statistically different with respect to participants’ impressions of robots, prior interactions with robots, and prior exposure to the WCST.

B. Do students cheat when teamed with a robot?

As stated in Section II, one unique aspect of our experimental setup was that the robot acted as a peer collaborator with a participant rather than an observer or an invigilator. The first question we hoped to answer was whether college students would cheat on a collaborative task with a robot if their reward was contingent on completing the task and the robot was a poor partner. Table IV presents the number of participants who cheated during the sorting task with the robot, based on the observations of the researchers and the number of participants who self-reported that they had cheated on the task. In our study, we found that instances of cheating ranged from a minimum of two people (12%) in the NV condition to a maximum of 20 people (95%) in the CV condition. Interestingly, not all students who cheated believed that they had cheated. Overall, approximately half of the participants self-reported that they followed the task rules. In the CV condition, 65% of participants (13 individuals) who cheated reported that they cheated, 56% (9 people) of those who cheated in CC reported that they cheated, and 50% (1 person) of those who cheated in the NV condition reported that they cheated. In the NC condition, only one out of the five participants who cheated self-reported that they broke the rules. These results suggest that a large portion of students that cheated did not report their behavior as cheating. Overall, these findings indicate college students cheated on the sorting task while collaborating with the robot and that they were sufficiently motivated by the extra credit offered to do so.

C. Do students cheat more after being exposed to a peer’s cheating? Do students cheat more when given vague rules?

Table III presents the means and standard deviations of the average occurrences of cheating behaviors by cheating exposure and clarity of rules. A two-way ANOVA was conducted on the number of cheating behaviors, with cheating exposure (exposed or not exposed to confederate cheating) and rule clarity (vague or clear rules) serving as the between-subject factor. The analysis indicated that there was a statistically significant main effect for cheating exposure, \( F(1,78) = 57.03, p < .001, \) partial \( \eta^2 = 0.44 \), but not rule clarity, \( F(1,78) = 1.12, p = .29 \). Pairwise comparisons with Bonferroni adjustments showed that participants who were exposed to the confederate cheating performed significantly more cheating behaviors (estimated marginal mean= 13.34) than those who did not observe the confederate cheat (estimated marginal mean= 9.19; \( M_{difference} = 12.49 \)), regardless of the clarity of the rules. No statistically significant interaction effect between the two factors was found, \( F(1,78) = 1.51, p = .22 \).

These results show that college students who observed a peer cheating on a task when collaborating with a robot were significantly more likely to cheat on the task themselves. Further, students’ cheating behaviors were not influenced by the vagueness of the task rules and the effects of cheating exposure on cheating behaviors were not dependent on rule clarity.

V. CONCLUSION

This research has taken a novel and important approach to investigating how the presence of robots in the learning environment could influence academic integrity. We have shown that, when tasked with collaborating with a poorly performing robot and motivated to meet the task demands, students will cheat to complete the task only if they have witnessed a peer cheat. This is an important result that sheds light both on the conditions that underpin academic dishonesty and a possible prelude to the issues generated by placing robots in educational environments. Broadly construed, these results suggest that normative behavior by classmates may strongly influence the decision to cheat while engaged in an instructional experience with a robot.

Our experiment did not compare collaboration with a robot to collaboration with a person. We felt that the participant would have encouraged and impelled a poor performing human partner to do better. Using the robot allowed us to

| Participants | CV  | CC  | NV  | NC  |
|--------------|-----|-----|-----|-----|
| who were observed cheating | 20  | 16  | 2   | 5   |
| (95%) | (80%) | (12%) | (25%) |
| who reported that they cheated | 13  | 9   | 1   | 1   |
| (62%) | (45%) | (6%) | (5%) |
| Total | 21  | 20  | 17  | 20  |

TABLE III: Means and standard deviations of the average occurrences of cheating behaviors by condition and the total number of participants.
generate a situation in which the person had to either accept the poor performance or cheat. Our data shows that for most, cheating only became an option once they witnessed the confederate cheating.

The results from this research may extend beyond educational environments. Although the research was experimentally framed as an educational task, we conjecture that these results may apply to other applications such as healthcare. For example, it may be the case that when a patient is tasked with collaborating with a robot to complete rehabilitative exercises the patient is more inclined to cheat on those exercises. Whether or not this is the case remains to be seen.

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REFERENCES

[1] D. L. McCabe, K. D. Butterfield, and L. K. Trevino, Cheating in college: Why students do it and what educators can do about it. JHU Press, 2012.
[2] S. F. Davis, P. F. Drinan, and T. B. Gallant, Cheating in School: What We Know and What We Can Do. John Wiley &amp; Sons, 2011.
[3] T. Belpaeme, J. Kennedy, A. Ramachandran, B. Scassellati, and F. Tanaka, “Social robots for education: A review,” Science robotics, vol. 3, no. 21, 2018.
[4] H. Köse, P. Uluer, N. Akalin, R. Yorgancı, A. Özkul, and G. Ince, “The effect of embodiment in sign language tutoring with assistive humanoid robots,” International Journal of Social Robotics, vol. 7, no. 4, pp. 537–548, 2015.
[5] M. Obaid, W. Barendregt, P. Alves-Oliveira, A. Paiva, and M. Fjeld, “Designing robotic teaching assistants: interaction design students’ and children’s views,” in International conference on social robotics. Springer, 2015, pp. 502–511.
[6] D. Hood, S. Lemaignan, and P. Dillenbourg, “When children teach a robot to write: An autonomous teachable humanoid which uses simulated handwriting,” in Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction, 2015, pp. 83–90.
[7] S. F. Davis, P. F. Drinan, and T. B. Gallant, “Cheating in school,” UK: Wiley-Blackwell, 2009.
[8] S. E. Carrell, F. V. Malmstrom, and J. E. West, “Peer effects in academic cheating,” Journal of Human Resources, vol. 43, no. 1, p. 173–207, 2008.
[9] J. Forlizzi, T. Saenzsukopa, N. Salaets, M. Shomin, T. Mericli, and G. Hoffman, “Let’s be honest: A controlled field study of ethical behavior in the presence of a robot,” in 2016 25th IEEE international symposium on robot and human interactive communication (RO-MAN). IEEE, 2016, pp. 769–774.
[10] S. Petisca, F. Esteves, and A. Paiva, “Cheating with robots: how at ease do they make us feel?” in IROS, 2019, pp. 2102–2107.
[11] S. Petisca, A. Paiva, and F. Esteves, “The effect of a robotic agent on dishonest behavior,” in Proceedings of the 20th ACM International Conference on Intelligent Virtual Agents. New York, NY, USA: Association for Computing Machinery, 2020.
[12] B. Kopp, F. Lange, and A. Steinke, “Cheating in college: Why students do it and what educators can do about it,” Assessment, 2019.
[13] D. R. Thomas, “A general inductive approach for analyzing qualitative evaluation data,” American Journal of Evaluation, vol. 27, no. 2, p. 237–246, 2006.
[14] C. Bartneck, D. Kulić, E. Croft, and S. Zoghbi, “Measurement instruments for the anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety of robots,” International Journal of Social Robotics, vol. 1, no. 1, p. 71–81, 2008.
[15] A. Weiss and C. Bartneck, “Meta analysis of the usage of the godspeed questionnaire series,” 2015 24th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN), 2015.
[16] C.-C. Ho and K. F. MacDorman, “Revisiting the uncanny valley theory: Developing and validating an alternative to the godspeed indices,” Computers in Human Behavior, vol. 26, no. 6, p. 1508–1518, 2010.
[17] D. L. McCabe and L. K. Trevino, “Academic dishonesty: Honor codes and other contextual influences.” The journal of higher education, vol. 64, no. 5, pp. 522–538, 1993.