The effect of behavioral synchrony with black or white virtual agents on outgroup trust

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ARTICLE INFO

Article history:
Available online 3 February 2018

Keywords:
Behavioral synchrony
Trust
Outgroup members
Virtual environment

ABSTRACT

Trust toward outgroup members is generally lower than it is toward ingroup members. Behavioral synchrony with virtual outgroup characters has been identified as a means of improving attitudes toward racial outgroup members, but this effect has not been tested for outgroup trust. We tested the effect of synchrony with an ingroup/outgroup virtual agent on a behavioral measure of outgroup trust. An experiment used an online economic game to obtain pretest and posttest measures of trust. In between these measures, participants played a dance video game on Xbox Kinect. They were randomly assigned to either an ingroup or outgroup agent (black or white) partner. Game score served as a continuous measure of synchrony with the agent. Regression analysis revealed that agent race moderated synchrony’s effect on change in outgroup trust. Increased synchrony with an outgroup agent led to increased outgroup trust. Conversely, increased synchrony with an ingroup agent led to decreased outgroup trust. Findings are discussed with respect to implications for using virtual interactions to build outgroup trust in the real world.

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Trust in other individuals is essential to human progress, as it facilitates cooperation. Several factors determine cooperative behavior, including the human bias to affiliate with members of one’s ingroup and to distrust outsiders (Seyfarth & Cheney, 2013). An ingroup is a cohesive unit consisting of members who share, for example, similar values, beliefs, or racial backgrounds, while all other groups are referred to as that person’s outgroups. The innate tendency to trust members of one’s ingroup has developed in humans through the course of evolution (Fiske, 2000). When our ancestors did not function as a unit with their ingroup, chances of surviving were diminished (Bateson, 2000). Group members who engaged in joint action stood a better chance of survival than those who did not.

The evolutionary benefits of cooperating with an ingroup are sometimes mirrored by a distrustful bias toward the outgroup (Brewer, 1999; Glaeser, Laibson, Scheinkman, & Souther, 2000). This bias entails negative outcomes like dehumanization (Haslam, 2006), prejudice, and stereotyping behavior (Fiske, 2000) toward outgroup members. Given the need in our society for people to interact and cooperate with those outside their ingroup, overcoming the innate distrust toward outgroup members is an important concern. This study details a potential means for reducing outgroup distrust. Specifically, we present an intervention designed to test whether coordinated interactions with virtual outgroup agents in a video game can facilitate real-world trust in outgroup members.

1. Virtual interventions to improve outgroup trust

Interventions based on commonly used theoretical mechanisms related to outgroup affiliation (such as the contact hypothesis, Allport, 1954) require people to interact with outgroup members face-to-face under specific conditions (e.g., equal status and a common goal). This might be seen as the ideal setting to overcome outgroup bias and prejudice. Practically speaking, however, opportunities for sustained face-to-face interaction with outgroup members can be infrequent, as most people show preference for interacting with ingroup members (Brewer, 1999), and tend to organize in segregated living areas that limit intergroup contact.

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https://doi.org/10.1016/j.chb.2018.01.037
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This lack of interaction minimizes the potential to improve intergroup relationships suggested by contact theories. Therefore, researchers have investigated alternative means of reducing outgroup biases. For example, some researchers have examined how imagined interactions can increase outgroup trust (Vezzali, Capozza, Stathi, & Giovannini, 2012), because real encounters are hard to establish. Other researchers have tried to simulate more realistic encounters by having participants interact with virtual outgroup members (Hasler, Hirschberger, Shani-Sherman, & Friedman, 2014). Virtual platforms such as video games may serve as a convenient alternative to face-to-face intergroup contact due to their accessibility and ease of use. Further, the entertainment value of video games may draw players to situations where they find themselves interacting with outgroup members in virtual environments more so than daily life.

One mechanism that may reduce real-world outgroup bias in this context exploits a player’s movement-based interactions with virtual outgroup characters. This mechanism, which we refer to as behavioral synchrony, is the phenomenon whereby people perform behaviors matched together in time with another entity’s movements (Hove & Risen, 2005). This type of synchrony creates a sense of unity that potentially lays the ground for affiliation outcomes such as trust. In the following sections, we explain the concept of behavioral synchrony and its ability to improve affiliative outcomes (including trust). Then, using a motion-sensing dance game for the Xbox 360 Kinect, we examine whether the effect of behavioral synchrony on racial/ethnic outgroup trust will be further strengthened if one’s interaction partner specifically belongs to an outgroup. Finally, the findings of our study are discussed with respect to implications for using virtual interactions to build outgroup trust.

2. Behavioral synchrony and affiliative outcomes

Foundational research on the connection between shared movements and affiliation stems from LaFrance (1979), who demonstrated that postural mirroring between students and their professors led to improved rapport between the two groups. These researchers measured what is now known as mimicry, the nonconscious mirroring of movements by people in an interaction (Chartrand & Bargh, 1999). While synchrony and mimicry differ in the degree of simultaneity of the interactions (e.g., synchronous actions are closer to simultaneous than mimicked actions), much of the research on these two concepts shows that they have similar prosocial outcomes, such as cooperation (e.g., Wiltermuth & Heath, 2009) and trust (e.g., Maddux, Mullen, & Galinsky, 2008). The present study focuses on trust, which we define as the degree of confidence one party places in another to behave in a way that provides desired outcomes (Kee & Knox, 1970).

Evolutionary logic may be used to explain why synchrony affects trust. Namely, the evolutionary function of synchronized behavior was to identify weak links, or “free riders” in the social group. Those who could not coordinate their behaviors with the group were likely to be liabilities to group goals (Wiltermuth & Heath, 2009). In line with this evolutionary account, such coordination of behaviors among individuals has been referred to as a means of social survival (Chartrand, Maddux, & Lakin, 2005), meaning that synchronized behavior facilitates feelings of similarity and affiliation crucial to thriving in a social environment.

Alternatively, the role of synchrony in facilitating affiliative outcomes may be explained from a neurological perspective. The reduction of the self-other boundary that occurs during behavioral synchrony can be demonstrated by a neurological phenomenon known as the perception-behavior link. This is a mental action whereby people perceive a particular behavior performed by another, and subsequently prepare to perform the same behavior (Chartrand & Bargh, 1999). Perceiving a behavior activates mental representations of that behavior in memory, which then automatically increases our chances of performing that same behavior (Chartrand et al., 2005). The link between one’s perceptions of another’s behavior and that person’s performance of the same behavior is responsible for the feelings of similarity that develop between these individuals. These feelings of similarity ultimately lead to positive outcomes like interpersonal trust (Brewer, 1999).

Besides improving trust towards the person with whom one synchronizes, shared movements can increase affiliative behaviors even toward people not involved in the original synchronized interaction. One study demonstrated that participants who were mimicked by a confederate were more likely to assist individuals with whom they had never interacted (van Baaren, Holland, Kawakami, & van Knippenberg, 2004). Other studies have shown that positive effects of synchrony with an individual can generalize to whole groups (Reddish, Bulbulia, & Fischer, 2013), even if those people are members of an outgroup (Inzlicht, Gutsell, & Legault, 2012). Based on these findings, one can expect behavioral synchrony to improve both ingroup and outgroup trust.

3. Virtual synchrony’s distinct effect on outgroup trust

Recent studies have shown that the effect of behavioral synchrony on attitudes toward outgroup members can be particularly strong if the partner with whom one synchronizes belongs to a racial/ethnic outgroup (Inzlicht et al., 2012). However, as stated above, opportunities for this effect to take place in real world settings are limited, leaving researchers to examine whether interactions with virtual outgroup characters can facilitate trust (Hasler et al., 2014).

Logic from the media equation (Reeves & Nass, 1996) asserts that people interact with virtual entities much in the same way they interact with real humans. Consistent with this logic, synchronizing with virtual agents (characters controlled by a computer) and avatars (characters controlled by the player) can elicit the same prosocial outcomes as synchrony with real people. For example, a recent study (Peck, Seinfeld, Aglioti, & Slater, 2013) showed that embodying a dark-skinned avatar in a virtual world, compared with a light-skinned or purple-skinned avatar, reduced implicit racial bias toward African-Americans. Notably, although this study focused on embodiment, participants’ full-body avatars were synchronized with their body movements, suggesting the potential role of synchrony in this effect.

Behavioral synchrony with an outgroup virtual avatar has also been found to improve empathy toward that outgroup. For example, in a study by Hasler et al. (2014), Israeli college students interacted with a Palestinian virtual avatar who either mimicked or counter-mimicked (i.e., performed the opposite movements of) participant movements. Those in the mimicry condition subsequently showed higher empathy toward Palestinians. In each of these studies, the participant synchronized with an outgroup avatar, which led to positive attitudes toward outgroups. Although these studies made valuable contributions to establishing the role of synchrony in reducing outgroup biases, they were carried out on virtual platforms specially tailored for their studies, thus lacking external validity for testing virtual intervention. The current study uses the Xbox Kinect, a widely used platform, to build a virtual intervention to improve outgroup trust.

Aside from the Kinect’s ease of use and availability, our study design offers other advantages for research in this area. First, whereas prior studies (Hasler et al., 2014; Peck et al., 2013) have featured a virtual avatar that mimics the movement of the player, our study’s use of the Kinect allows us to observe the effects of
synchrony with a virtual agent. Video games involving avatars do not vary synchrony, as the avatar is always in perfect synchrony with the player. The game we used in this study (Dance Central 3) presents synchrony as a goal/challenge to which players aspire. Because some players will be more successful than others, naturally occurring variance in synchrony can be used to detect its effect; other research has been limited to discrete levels of synchrony (e.g., mimicry versus non-mimicry). To capture this variance, the current study incorporates a ratio-level estimate of synchrony in the form of a player’s game score. Although we hid this score from the participant’s view, we recorded this and used it as a continuous measure of behavioral synchrony. Second, whereas the previous virtual mimicry studies tested the effects of an avatar following the player’s movements, we flip this directionality. Instead, we use a motion sensor-based console to test the effect of the player following the agent. If results are in line with our predictions, this would demonstrate that the affiliative effects of leading-following in synchronized interactions extend to both directions of entrainment.

4. Hypotheses

This study examines if behavioral synchrony with a virtual agent—a widely used virtual platform can be used to improve trust towards outgroup members. Literature that suggests that synchrony with outgroup members has a greater potential to reduce outgroup bias than synchronizing with ingroup members (e.g., Inzlicht et al., 2012). This logic is also consistent with previous research demonstrating that synchronizing with an outgroup member in a virtual context can reduce outgroup bias (e.g., Hasler et al., 2014). Based on this past work, we predict that the effect of synchrony on outgroup trust will be greater for participants who dance with an outgroup agent than for those who dance with an agent from an ingroup comparison group (H1).

5. Method

5.1. Participants

Participants included 205 students (M_{age} = 20.27, SD_{age} = 1.62; N_{female} = 147, N_{Caucasian} = 182, N_{African-American} = 23) from a large university in the Midwestern United States. Students were given course credit for participating. We used data from Caucasian and African-American participants. For Caucasian participants, white virtual agents were coded as ingroup, and black virtual agents were coded as outgroup. This pattern was reversed for African-American participants. Data from participants who identified as other races were not included in analyses.

5.2. Procedure

Our experiment featured a single-factor (in/outgroup) between-subjects design, while also including a naturally varying synchrony score predicted to moderate the relationship of group on outgroup trust. Upon arrival, each participant completed a consent form and was led by a research assistant to a room with a computer, a 70-inch television, and an Xbox 360 Kinect system. Participants began by completing an online survey, which served as a pretest measure of trust. To disguise the true nature of this study, they were told that the survey was long, and thus it was being split into two parts by the unrelated task. To ensure diligence, participants were told that their chances to win an Amazon gift card would be based on their performance in the trust game. In actuality, all participants were entered in a random drawing to win this prize. After completing the pretest, the survey instructed them to get the research assistant.

At this time, the research assistant set up Dance Central 3 on the Xbox 360 Kinect and randomly assigned participants to one of two conditions: dancing with a black agent or dancing with a white agent. The research assistant instructed each participant that at the start of the game, “a song will start playing and you can just start dancing by mirroring the onscreen character.” Participants danced for three songs, which the researcher selected from a separate room that was hidden from participants. We used black cardboard to cover the corner of the screen showing participants their score, so they could not assess their own performance. The research assistant recorded the score for each of the three songs from a separate monitor linked to the participant’s screen. All participants danced to the same three songs, which were pre-tested by another study to be perceived as neither stereotypically “white” nor “black.” Participants in both conditions were assured that their performance in the game was not being judged. Once the game was finished, participants went back to the computer to finish the posttest trust measure and additional measures included as potential control variables. After completing these measures, participants were thanked and released. A follow-up email was sent out after all data collection had been completed to debrief participants and award the Amazon gift card. The university’s institutional review board approved all methods and materials.

5.3. Stimulus materials

5.3.1. Dance video game

Dance Central 3 for the Xbox 360 Kinect system served as the stimulus. In this game, players imitate the onscreen movements of a virtual dancer to earn points. The game’s difficulty was set to Easy for all participants, and all participants were matched to dancers of the same gender. Assignment of agent race (ingroup/outgroup) served as our first independent variable. The agents used in the game were white and black characters who were pretested for their typicality to one race (i.e., the ‘most’ black or ‘most’ white characters available in the game; see Staker & Ratan, 2015). The songs to which participants danced were pre-tested to determine which were considered hip hop (on a Likert-type scale from 1 (definitely hip hop) to 7 (definitely not hip hop). Those selected for this study had neutral scores along this scale, so musical stereotypes could not strengthen the effects of agent race.

Based on the assigned ingroup/outgroup condition, the researcher selected agents for each participant that were black/white and female/male to represent one of the four agent combinations (i.e., white males, white females, black males, black females). The backup dancers were the same race and gender as the
main agent. The game provided bonus points for the players’ ability to match certain movements of the game (e.g., “freestyle mode”), which could potentially skew the extent to which game score reflected actual synchrony. Therefore, the bonus feature of the game was disabled in the settings menu.

5.3.2. Trust game faces

Forty-two virtual avatar faces (20 Caucasian, 22 African American) were drawn from a database generated by prior research (Bente, Dratsch, Rehbach, Rey, & Lushaj, 2014). To match facial features across races, each Caucasian face was rendered African-American and each African-American face was rendered Caucasian, for a second total of 84 faces. In a pilot test, participants rated the trustworthiness of the faces on a 7-point Likert scale item. Only those means within one standard deviation of the grand mean were retained in order to reduce the potential that any particularly trustworthy/untrustworthy face(s) would skew purchase behavior. There were 40 faces that remained.

Lastly, in another pilot test, participants rated each of these 40 faces on two items: The first was a 5-point Likert scale item indicating realism of the virtual faces, ranging from 1 (very unrealistic) to 5 (very realistic): No face was dropped for being too unrealistic. The second item indicated whether the face was perceived as Caucasian-American, African-American, or other. For this scale, 32 faces (16 black, 16 white) that were correctly identified by at least 85% of the pilot-test respondents were retained for inclusion in the study. These were randomly divided into two groups of 16 faces (eight faces of each race) for use in the pretest and posttest trust games. All faces used in the trust game, as well as images of the agents used in the dance game, are available upon request from the corresponding author.

5.4. Measures

5.4.1. Synchrony

The game score was used as an indicator of behavioral synchrony, as it is determined by the extent to which participants could imitate the exact movements of the virtual agent. Specifically, each participant’s behavioral synchrony score was created by averaging their game scores on the three songs to which they danced. Naturally occurring variance in scores across participants served as the measure of synchrony, which is our second independent variable.

Game scores are calculated based on the Xbox Kinect’s motion sensor. This sensor operates by inferring motion from players’ silhouettes, which are converted to the Kinect’s inbuilt skeletal template (Asteriadis, Chatzitofis, Zarpalas, Alexiadis, & Daras, 2013.) Although it has been criticized for its ability to capture small movements of the extremities (such as hand and foot), the Kinect motion sensor has been found by biomechanics researchers to validly and reliably capture over 90% of the variability in full-body movements in exergames (van Diest et al., 2014).

5.4.2. Trust

An extended version of a previously validated economic trust game (Bolton, Katok, and Ockenfels, 2004) served as our apparatus to measure trust. The extended version introduced by Bente, Baptist, and Leuschner (2012), includes specific seller information, such as statistics about previous shipping behavior, seller photos, or avatar representations into the game which can be experimentally controlled (Bente, Dratsch, Kaspar, Häfler, Bungard, & Al-Issa, 2014; Bente et al., 2014). In our game setup, participants were presented with a series of the African-American and Caucasian male avatar faces (16 faces in the pretest, and 16 different faces in the posttest) and were told that these avatars represented real-life eBay textbook sellers. Participants acted as the “buyer” in this scenario, and began each turn with 35 tokens. The seller’s textbook also had a value of 35 tokens. During each turn (i.e., an interaction with one avatar), players used an economic decision tree to decide whether or not to buy from the seller.

The buyer’s job was to decide if the seller would be likely to honor the transaction by shipping the item, or if they would cheat the buyer. Three outcomes were possible for each turn. In the first scenario, participants choose to buy and the seller ships. In this case the player gets the 35-token value of the textbook, plus 15 additional tokens due to a “successful transaction bonus,” for a participant total of 50 tokens for that turn. In the second scenario, participants choose to buy but the seller does not ship. In this case, the player loses his/her 35 tokens and receives no textbook, for a total of 0 tokens for that turn. In the third scenario, participants choose not to buy, so the seller does nothing. The player retains his/her 35 tokens for that turn. Outgroup trust was measured as the number of times a participant chose to buy from an outgroup member, and was calculated as a change score between time one and time two. This measure of trust has been reliably used in previous research (e.g., Bente et al. 2014a,b).

The only information available to participants for making a purchasing decision were (a) the black/white face of each male avatar and (b) four bogus ratings of seller reputation based on past selling behavior. The reputation ratings were balanced across race such that the average reputation scores for black/white seller faces were equal. These ratings were included to disguise the intent to measure trust based on avatar race (i.e., to make participants think we were testing the effect of reputation on purchasing behavior). Participants were motivated to correctly identify honest sellers by the potential to win the prize mentioned in the procedure. They received no feedback on whether they made correct decisions during the pretest or posttest. They were told that their performance was saved by the computer for access during the prize giveaway.

We calculated separate averages for white and black faces in order to measure trust. A decision to buy was coded as 1 and the decision not to buy was coded as 0. Averages ranged from 0 to 1. After calculating averages for black and white faces, categories were renamed to ingroup trust and outgroup trust, such that for Caucasian participants, the average for white faces was coded as ‘ingroup trust,’ and the average for black faces was coded as ‘outgroup trust.’ For African-American participants, this pattern was reversed. Though we measured ingroup trust, our analyses only focus on outgroup trust due to its central importance in our hypotheses.

5.4.3. Control variables

Our posttest survey included Likert-type scale items measuring demographics, enjoyment (“How much did you enjoy the dance game?”), competence (“How good do you think you were at this game?”), and experience (“How often have you played this game or one like it before?”). We also controlled for gender and race of participants in our regression analysis for H1. None of these measures correlated with our measure of outgroup trust. As such, they were not included in further analyses.

6. Results

6.1. Preliminary analyses

First, to ensure that participants perceived our ingroup and outgroup agents as intended, we conducted a t-test comparing the ingroup and outgroup conditions’ means for the control item
either race) on outgroup trust. No main effect was found for this.

Examined the direct effect of synchrony (e.g., with an agent of

would increase outgroup trust regardless of agent race, we

showed no significant relationship between this variable and synchrony

The relationship was found between this variable and synchrony

The second regression, which used pretest ingroup trust as a predictor,

The interaction term for synchrony and agent group was a significant

predictor of outgroup trust change ($b = .07, p = .02$).

The regression analysis for H1 produced a significant interaction term showing that agent group moderated synchrony's effect on change in outgroup trust ($b = .07, SE = .03, p = .02$). The regression coefficient of the interaction term was positive indicating that the effect of synchrony on outgroup trust change was significantly stronger and more positive for participants who danced with an outgroup agent than those who danced with an ingroup agent. An examination of the individual effects of the predictors showed that the effect of agent group on outgroup trust approached significance ($b = -.05, SE = .03, p = .06$), though synchrony was unexpectedly a negative predictor of outgroup trust change. This result can be understood more clearly when examining the effect of synchrony on change in outgroup trust separately for the ingroup and outgroup conditions. A linear regression procedure with outgroup trust change as the dependent variable, and synchrony and pre-test outgroup trust as independent variables was carried out separately for subjects who danced with an ingroup agent or an outgroup agent. The results revealed a non-significant but negative effect of synchrony ($b = -.04, SE = .02, p = .09$) for subjects in the ingroup condition, and a non-significant but positive tendency for synchrony on outgroup trust in the outgroup condition ($b = .03, SE = .02, p = .16$). Though these are both non-significant findings, the significant interaction effect between groups indicates that the effect of synchrony on outgroup trust depends on whether one dances with an ingroup or an outgroup member (See Table 1 and Fig. 1). For participants who danced with an outgroup agent (see solid line in Fig. 1), the direction of the relationship between synchrony and outgroup trust was positive. Conversely, for participants who danced with an ingroup agent (see dashed line in Fig. 1), the direction was negative.

6.2. Hypothesis tests

Before our hypothesis was tested, we conducted three preliminary linear regressions to rule out pretest trust variables’ potential effects on the independent variable (synchrony). The first regression, which used pretest outgroup trust as a predictor, indicated no significant effect on synchrony ($b = .06, p = .44$). The second regression, which used pretest ingroup trust as a predictor, showed no significant relationship ($b = .00, p = .98$). Finally, the third regression used pretest between-groups trust (i.e., pretest ingroup trust minus pretest outgroup trust) as a predictor. No relationship was found between this variable and synchrony ($b = -.05, p = .50$). Also, to rule out the possibility that synchrony would increase outgroup trust regardless of agent race, we examined the direct effect of synchrony (e.g., with an agent of either race) on outgroup trust. No main effect was found for this relationship ($b = -.03, p = .64$).

To test H1, we conducted a stepwise linear regression with logarithmized and mean-centered synchrony and agent group (coded as a dummy variable: ingroup = 0) as predictors in the first step. The interaction term of these two variables was added in the second step. Pretest outgroup trust was added as a covariate in both steps. The outcome variable was the change score of outgroup trust (time 2 − time 1). Results of these tests are presented in Table 1.

Our hypothesis (H1) predicted that the effect of synchrony on outgroup trust would be stronger for participants in the outgroup agent condition compared to those in the ingroup agent condition.2 The interaction term for synchrony and agent group was a significant predictor of outgroup trust change ($b = .07, p = .02$).

The regression analysis for H1 produced a significant interaction term showing that agent group moderated synchrony’s effect on change in outgroup trust ($b = .07, SE = .03, p = .02$). The regression coefficient of the interaction term was positive indicating that the effect of synchrony on outgroup trust change was significantly stronger and more positive for participants who danced with an outgroup agent than those who danced with an ingroup agent. An examination of the individual effects of the predictors showed that the effect of agent group on outgroup trust approached significance ($b = -.05, SE = .03, p = .06$), though synchrony was unexpectedly a negative predictor of outgroup trust change. This result can be understood more clearly when examining the effect of synchrony on change in outgroup trust separately for the ingroup and outgroup conditions.

A linear regression procedure with outgroup trust change as the dependent variable, and synchrony and pre-test outgroup trust as independent variables was carried out separately for subjects who danced with an ingroup agent or an outgroup agent. The results revealed a non-significant but negative effect of synchrony ($b = -.04, SE = .02, p = .09$) for subjects in the ingroup condition, and a non-significant but positive tendency for synchrony on outgroup trust in the outgroup condition ($b = .03, SE = .02, p = .16$). Though these are both non-significant findings, the significant interaction effect between groups indicates that the effect of synchrony on outgroup trust depends on whether one dances with an ingroup or an outgroup member (See Table 1 and Fig. 1). For participants who danced with an outgroup agent (see solid line in Fig. 1), the direction of the relationship between synchrony and outgroup trust was positive. Conversely, for participants who danced with an ingroup agent (see dashed line in Fig. 1), the direction was negative.

6.3. Control variables

We correlated agent group, synchrony, and outgroup trust with our potential control variables (see Table 2). Analyses revealed that our agent-group manipulation correlated only with perceived-similarity-of-player-to-agent-race ($r = -.50, p < .01$), which was a manipulation check item. Synchrony correlated with perceived-synchrony (another manipulation check item), $r = .60, p < .01$, enjoyment, $r = .47, p < .01$; game-competence, $r = .56, p < .01$; body-ownership, $r = .18, p = .09$; general-similarity-to-agent, $r = .26, p < .01$, and game-experience, $r = -.26, p < .01$. None of the control variables correlated significantly with outgroup trust. As such, they were excluded from further analyses.

Note. * indicates significant change in $R^2$.

Table 1

Regression predicting change in outgroup trust.

<table>
<thead>
<tr>
<th>Variables</th>
<th>$b$</th>
<th>SE</th>
<th>t</th>
<th>p</th>
<th>$\Delta R^2$</th>
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<tr>
<td>Step 1 Mean Centered log Synchrony</td>
<td>.00</td>
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<td>.64</td>
<td>.40</td>
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<td>Agent Group (0 = ingroup)</td>
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<td>.03</td>
<td>-1.73</td>
<td>.09</td>
<td>.05</td>
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<td>Pretest Outgroup Trust</td>
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<td>.06</td>
<td>-11.36</td>
<td>.00</td>
<td>.11</td>
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<tr>
<td>Step 2 Mean Centered log Synchrony</td>
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<td>.02</td>
<td>-1.93</td>
<td>.06</td>
<td>.02*</td>
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<tr>
<td>Agent Group (0 = ingroup)</td>
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<td>.03</td>
<td>-1.87</td>
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<td>.05</td>
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<tr>
<td>Pretest Synchrony</td>
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<td>.03</td>
<td>2.29</td>
<td>.02</td>
<td>.01*</td>
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</tbody>
</table>

**Table 1.** Variables

- **Step 1**
  - Mean Centered log Synchrony
  - Agent Group (0 = ingroup)
  - Pretest Outgroup Trust

- **Step 2**
  - Mean Centered log Synchrony
  - Agent Group (0 = ingroup)
  - Pretest Synchrony

Note. * indicates significant change in $R^2$.

2 Mean-centering to account for regression to the mean effects has been critici-
cized by previous literature as introducing spurious correlations (e.g., Glymour, Weuve, Berkman, Kawachi, & Robins, 2005). In order to account for this potential threat, we ran our analysis for H2 with synchrony scores that were only logarith-
mized and not mean-centered. Regressing agent group, logarithmized synchrony, and their associated interaction term onto outgroup trust once again produced a significant interaction effect, $\beta = 2.75, p = .07$, thus eliminating this concern.

3 Although no hypotheses were offered for ingroup trust, we ran a linear regression with synchrony, pretest ingroup trust, and agent group as predictors, and change score of ingroup trust as the outcome variable. No significance was found for sync, agent group, or the interaction term. Among other things, this analysis examines whether the patterns associated with a change in trust toward ingroup members is reversed for the pattern we have observed for trust toward outgroup members. As such, the patterns for ingroup trust were not the same as the patterns for outgroup trust, showing that synchrony with ingroup/outgroup agents has a unique effect on outgroup trust.
7. Discussion

When examining participants who danced with either an ingroup or outgroup agent (i.e., all 205 participants), the interaction between synchrony and agent race on outgroup trust predicted by H1 was significant. Notably, however, the patterns observed in the interaction differed somewhat from our expectations. In the following sections, we discuss how synchronizing with a virtual agent of similar or different race can affect outgroup trust and examine the contributions of our study to research on synchrony in virtual environments.

7.1. The influence of synchrony and agent race on outgroup trust

Hypothesis 1 predicted that the effect of synchrony on outgroup trust would be greater for participants who danced with an outgroup agent than for those who danced with an ingroup agent. We intended for participants dancing with an ingroup agent to serve as a control group, because we did not expect these participants to focus on their agent’s race. Hence for this group, we expected the general effect of behavioral synchrony to cause a small increase in outgroup trust. In comparison, we expected a much stronger positive relationship between synchrony and outgroup trust for participants who danced with an outgroup agent, because we expected participants in this group to be more strongly aware of their agent’s outgroup race.

Our results showed a slightly different pattern than expected. The anticipated positive relationship between dancing with an outgroup agent and outgroup trust failed to reach significance. Also, we expected a weak positive relationship between synchrony with an ingroup member and outgroup trust, but instead found a non-significant negative effect here. Though each group’s individual effects were non-significant, the interaction between group and synchrony on outgroup trust was significant. This indicates that as synchrony increases, the effect of agent race on outgroup trust went in opposite directions. For those who danced with an ingroup agent, the direction of this relationship was negative, whereas for those who danced with an outgroup agent, the direction was positive.

Another notable finding was that for participants who danced with an outgroup agent, low synchrony was associated with lower trust toward outgroup members. Initially we might have expected that merely interacting with an outgroup agent (regardless of synchrony level) would slightly increase trust toward outgroup members, or at the very least maintain it. However, having low synchrony with an outgroup member may have reduced trust due to the awkwardness and dissimilarity created by the interaction.

This pattern might suggest that if people are out of sync with an outgroup agent, they may not be open to trusting the outgroup, and as such outgroup trust is low; however, as synchrony with outgroup agents increases, this pattern disappears. Additional research is needed to determine whether people become more open to trusting the outgroup as synchrony with outgroup agents increases.

The resulting crossover interaction suggests the potential for synchrony with a virtual outgroup agent to diminish outgroup bias. This was observed here, particularly when compared to bias expressed by people who were highly in sync with ingroup agents. Less central to our paper, but still noteworthy, was the fact that we did not find a statistically significant main effect for agent race on synchrony. We made no predictions regarding this relationship because previous literature has not shown a consistent direction of effect. Specifically, some research has indicated that people are more likely to synchronize with an outgroup member than an ingroup member (e.g., Miles, Lumsden, Richardson, & Macrae, 2011), whereas other research has shown the opposite (Yabar, Johnston, Miles, & Peace, 2006). The null finding in our study may not indicate the absence of an effect here, but it warrants further examination of boundary conditions related to this relationship.

Table 2
Correlation matrix of all analyzed variables.

<table>
<thead>
<tr>
<th></th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
<th>8.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Synchrony</td>
<td></td>
<td>-06</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Outgroup Trust</td>
<td>-06</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Enjoyment</td>
<td>.47**</td>
<td>-07</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Game Competence</td>
<td>.57**</td>
<td>-08</td>
<td>.52**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Game Experience</td>
<td>-.24**</td>
<td>.03</td>
<td>-.23**</td>
<td>-33**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Perceived Synchrony</td>
<td>.60**</td>
<td>-.13</td>
<td>.54**</td>
<td>-.27**</td>
<td>.79**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Player/Agent Similarity</td>
<td>.26**</td>
<td>-.09</td>
<td>.26**</td>
<td>.46**</td>
<td>-.03</td>
<td>.48**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Player/Agent Race Similarity</td>
<td>-.05</td>
<td>.11</td>
<td>-.08</td>
<td>.13</td>
<td>-.01</td>
<td>.04</td>
<td>.11</td>
<td></td>
</tr>
<tr>
<td>9. Agent Group</td>
<td>.03</td>
<td>-.13</td>
<td>.03</td>
<td>-08</td>
<td>-.07</td>
<td>-.06</td>
<td>.04</td>
<td>-.50**</td>
</tr>
</tbody>
</table>

Note. ** indicates significance at p < .01.
7.2. Contributions to research on synchrony in virtual environments

Our study adds to previous literature on synchrony in virtual environments in several ways: First, our findings suggest that interactions with virtual agents have the potential to not only improve affiliative outcomes, like positive attitudes toward outgroups, but to make people slightly more open to trusting outgroups. This outcome is arguably most central to intergroup cooperation. Although the simple effect of synchrony with an outgroup agent on outgroup trust failed to reach significance, the pattern demonstrated in the interaction indicates that synchrony with an outgroup agent is associated with less outgroup bias than synchrony with an ingroup agent.

In addition, we further established the real-world applicability of our findings by using a behavioral (rather than attitudinal) measure of trust, which involved participants making decisions on whom to trust or not. Second, while other studies have used categorical or ordinal indicators of synchrony, our study illustrates the potential of using virtual technology to generate a continuous measure of synchrony, which can be useful to detect the gradual effect of improving synchrony on outgroup trust. Third, our study incorporated a widely used game console (Xbox 360 Kinect) as its stimulus source; prior studies on synchrony and virtual environments have used custom-built VR (e.g., Peck et al., 2013) or computer-animated characters (e.g., Hasler et al., 2014). Our use of common game system adds to the generalizability and mundane realism of our study’s results. Lastly, previous research on outgroup bias in virtual environments has not explored whether low synchrony can intensify outgroup bias. Because these studies used avatars that directly mimicked participants, synchrony was always perfect in these conditions. Our use of agents rather than avatars allowed us to (a) examine how variations in degrees of synchrony (from high to low) affected outgroup bias, and (b) observe the effects of synchrony when the player follows the virtual character rather than vice versa.

7.3. Implications for future virtual environment interventions

Our findings provide suggestions for the future development of virtual interventions that can be used as tools to improve outgroup trust. The most obvious suggestion is to develop games that facilitate synchrony with outgroup agents. These games should have to the potential to reduce outgroup bias. However, though speculative, our findings suggest that if synchronization with an outgroup member is hindered, the experience could have the counterproductive effect of increasing outgroup bias. Similarly, our findings may also be taken to suggest that outgroup bias can be decreased by creating games in which synchronizing with ingroup agents is impeded. While this type of game may not affect trust in ingroup members, it could make participants more open to trusting outgroup members. Applied to video game design, the strongest effect on reduced outgroup bias should result from a game that simultaneously facilitates easy synchronization with an outgroup agent and hinders synchronization with an ingroup agent. While these suggestions need to be further examined through future research, their potential social impact makes this an area of research worth pursuing.

7.4. Limitations

One limitation of our study is the use of a video game featuring music. This is a concern because people may have focused on synchronizing to the beat of the music rather than to the on-screen agent’s movements themselves. If this was the case, then our measure of behavioral synchrony would be confounded with synchronizing to music. Future synchrony studies that eliminate musical rhythm as a confounding factor are needed.

A second limitation is that our sample was highly skewed in terms of participant race. Of the 205 participants we included in analyses, 182 were Caucasian, and 23 were African-American. In future research on virtual synchrony and race, a greater balance between participant races would be preferable in order to allow effects across races to be compared more precisely.

Third, although we matched participants gender with the gender of the agents used in our dance game stimulus, we did not match participants’ gender with the gender of the sellers in the trust game used for our dependent measure. The decision to use only one gender was based on the difficulty of obtaining multiple faces that met the requirements for inclusion for both male and female faces. This was particularly problematic for female faces given that all seller images were bald. Notably, the correlation between gender and outgroup trust ($r = .02, p = .73$) was negligible, which minimized this concern.

Lastly, our decision to let synchrony vary naturally rather than to manipulate it was not without drawbacks. This decision places limits on our control of synchrony, thereby reducing our ability to make causal claims. However, we believed that this limitation was less severe than its alternative. We knew that if we manipulated synchrony (i.e., induced either synchrony or non-synchrony), extraneous variables would be introduced. For example, non-synchronous conditions would produce frustration and hostility from the inherent impossibility of the task. As such, we made a research design decision that is open to discussion, and stand by it in lieu of our knowledge of its deficits.

7.5. Future directions

The findings of the current study open several avenues for continued research. First, our study found that even a single synchronized interaction with an outgroup agent could have a slight impact on improving outgroup trust. Future researchers should examine this effect in a longitudinal design. Perhaps frequent synchronous encounters with outgroup agents could lead to a strong and lasting effect on outgroup trust.

Second, synchrony is a complex process involving many motor actions, and as such, is difficult to measure accurately. To address this imprecision, a paradigm known as the mirror game was recently developed to study the emergence of synchrony in one dimension (i.e., just lateral movements; see Noy, Dekel, & Alon, 2011). This allows for the more accurate measurement of simultaneous movements in time and space. The mirror game offers promise for researchers studying synchrony in a virtual context.

Third, we referred to the dance score in this study as synchrony, as it involved relatively simultaneous movements between participants and agents, and involved predicting patterns of movement, which has been associated with synchrony in previous literature (see Noy et al., 2011). Still, we are aware that our interpretation of synchrony may be more akin to mimicry than truly spontaneous synchrony, or emergent synchrony. In such synchrony, there is no leader nor follower, rather an emergent pattern whereby each interactant’s movements affect the other’s to an equal degree (Knoblich, Butterfill, & Sebanz, 2011). We therefore encourage future researchers to examine the effects of emergent synchrony in virtual settings on outcomes such as trust.

Finally, researchers should continue to explore behavioral outcomes that can be affected by synchrony with virtual characters. We examined the effect of synchrony on one affiliative outcome (trust). Given the already extensive list of such outcomes toward which synchrony has shown an effect (e.g., similarity, rapport,
cooperation), it seems that synchrony in virtual environments has the potential to affect a wide-range of social behaviors.

8. Conclusion

The goal of the current study was to investigate whether behavioral synchrony with an outgroup virtual agent could increase trust toward outgroup members. We found an interaction effect such that as synchrony increases from low to high, people interacting with an ingroup agent trust outgroup members less, whereas people interacting with an outgroup agent trust outgroup members slightly more.

Whether evolutionarily beneficial or detrimental, it is a reality that people do not trust outgroup members as much as ingroup members (Brewer, 1999). Although this early evolutionary tendency is instilled in people’s minds to this day, it is promising that research has uncovered means to diminish such intergroup biases. Social scientific researchers behind frameworks such as the contact hypothesis (Allport, 1954) and the common in-group identity model (Gaertner, Dovidio, Anastasio, Bachman, & Rust, 1993) have been dedicated to identifying behaviors that can reduce racial tensions. These perspectives assert that sustained, positive contact with outgroup members can dissipate group boundaries.

Though these approaches demonstrate the positive effects of real-life contact, another possibility is that for many people, interaction with outgroup members is limited. As such, research has investigated other means to improving intergroup relations, such as the use of virtual environments to facilitate outgroup interactions (Hasler et al., 2014; Peck et al., 2013; Slaker & Ratan, 2015). The current study adds to this body of literature by showing a behavior toward outgroup members (trust) can be affected by synchronizing with a virtual outagent agent.

Acknowledgements

No external funding sources were involved in this research.

References