Social Working Memory Training Improves Perspective-Taking Accuracy

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Abstract

Despite the importance of perspective taking for navigating the social world, even healthy adults frequently misinterpret what other people think and feel. Yet, to date, no research examines whether perspective-taking accuracy can be improved among healthy adult samples. Building off of work suggesting that social working memory (SWM) capacity (i.e., the ability to maintain and manipulate social cognitive information in mind) predicts perspective-taking skills, we developed a novel SWM training intervention to test the hypothesis that SWM training improves perspective-taking accuracy. Participants were randomly assigned to complete 12 days of either SWM training or nonsocial, "cognitive working memory" (CWM) training (active control condition). Perspective-taking accuracy was assessed pre- and posttraining. SWM training significantly increased perspective-taking accuracy and these improvements significantly surpassed improvements made by participants who underwent CWM training. SWM training therefore may be an efficient route toward improved perspective-taking accuracy.

Keywords

Perspective-taking leads to a variety of prosocial outcomes, such as reduced stereotyping (Galinsky & Mascowitz, 2000), increased empathy (Lamm, Batson, & Decety, 2007), and enhanced helping (Oswald, 1996). Yet, despite the importance of understanding the people around us, people are prone to perspective-taking errors. For example, even healthy adults from nonclinical samples frequently misinterpret what another person is thinking (Apperly, Back, Samson, & France, 2008; Keysar, Barr, Balin, & Brauner, 2000), falsely assume that other people share the same knowledge that they do (Krueger & Clement, 1994), and are biased in their attributions of the mental states driving people's behaviors (Jones & Nisbett, 1971).

That even healthy adults make perspective-taking errors prompts the question of whether and how perspective-taking accuracy can be improved. While a few studies show that practicing perspective-taking exercises (e.g., imagining different characters' perspectives in a story) improves social outcomes in clinical and developing samples (Chalmers & Townsend, 2014; Combs et al., 2007; Fisher & Happé, 2005; Nahum et al., 2014), to our knowledge, no research examines the underlying mechanisms that facilitate improvements to perspective-taking accuracy, nor whether perspective-taking accuracy is plastic among healthy adults.

Social working memory (SWM) capacity, or the ability to maintain and manipulate social cognitive information in mind (Meyer, Spunt, Berkman, Taylor, & Lieberman, 2012; Meyer, Taylor, & Lieberman, 2015; Thornton & Conway, 2013), may be a basic mechanism that if trained, improves adult perspective-taking accuracy. This possibility stems from three

relevant observations. First, research in social psychology finds that perspective-taking requires cognitive resources (Epley, Keysar, Van Boven, & Gilovich, 2004; Epley, Morewedge, & Keysar, 2004), including working memory resources (Lin, Keysar, & Epley, 2009). Second, social neuroscience research finds that the working memory demands afforded by perspective taking rely specifically on SWM neural mechanisms (Meyer et al., 2012; Meyer et al., 2015). For example, SWM neural responses (but not nonsocial or cognitive working memory [CWM] neural responses) predict perspective-taking accuracy on the director's task, in which participants must consider another person's point of view in order to derive a correct answer. Third, training CWM (e.g., the amount of objects that can be maintained in working memory) has been shown to improve performance on related cognitive tasks, such as those assessing reading and math ability (Chein & Morrison, 2010; Holmes, Gathercole, & Dunning, 2009) and even fluid intelligence in adults (Jaeggi, Buschkuehl, Jonides, & Perrig, 2008; Jaeggi, Buschkuehl, Shah, & Jonides, 2014; cf. Melby-Lervåg & Hulme, 2013; Redick et al., 2013). Thus, working memory training may expand the cognitive resources available for

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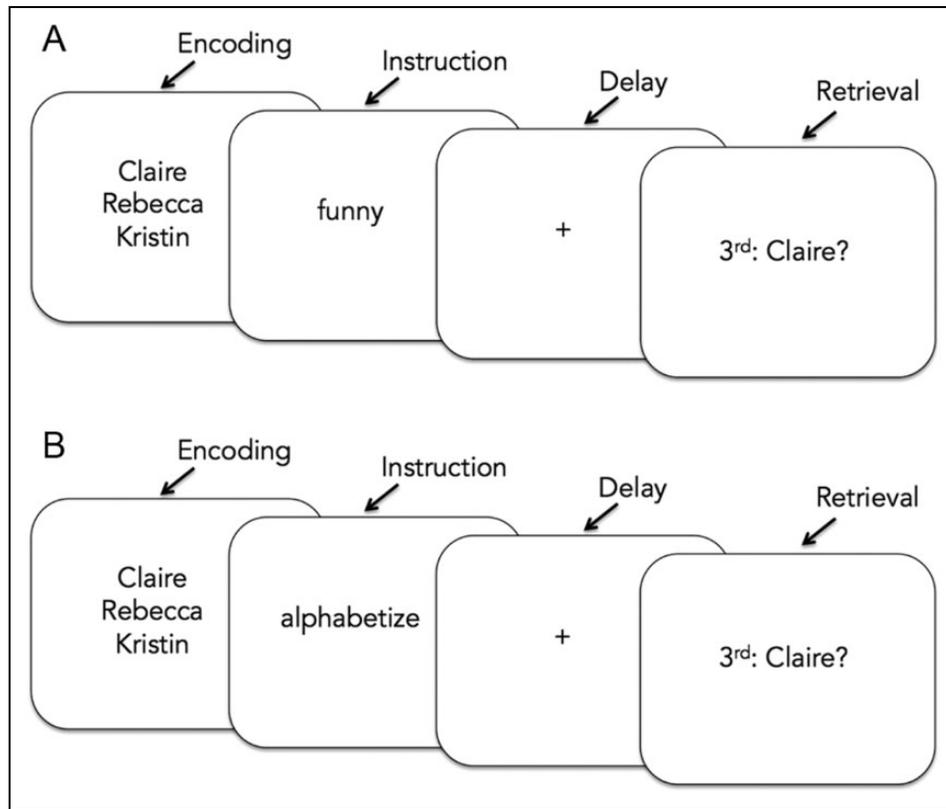Email: m.meyer@princeton.edu

Figure 1. Pictorial display of the (A) social working memory task and (B) cognitive working memory task. Each trial included encoding (4 s), instruction (1.5 s), delay (6 s), and the true/false probe question (4 s).

related tasks (Klingberg, 2010). Taken together, findings from social psychology, social neuroscience, and working memory training suggest that training SWM capacity may improve perspective-taking accuracy.

To examine this possibility, participants were randomly assigned to complete either SWM training or CWM training (active control condition) for 12 days and laboratory measures of SWM, CWM, and perspective taking were assessed pre- and posttraining. Because SWM neural mechanisms, but not CWM neural mechanisms, predict perspective-taking skills, we hypothesized that SWM training (vs. CWM training) improves perspective-taking accuracy.

Method

Participants

Sixty participants from The University of California, Los Angeles (UCLA) community were recruited to participate in this study. Sample size was determined based on past recommendations that for analysis of covariance (ANCOVA) in pre- and postdesigns, a sample size of 24–34 participants per cell yields roughly 80% power (Shan & Ma, 2014). Participants were randomly assigned to complete either the SWM training condition or the CWM training condition. Participant recruitment finished when 60 participants were recruited. Six participants (three per condition) did not complete training, yielding 27 subjects in the SWM training condition (14 females, mean

age = 21.35 SD = 3.54; 52% Caucasian, 26% Asian, 11% Latino/Latina, and 11% Other) and 27 subjects in the CWM training condition (27 subjects, 14 females, mean age = 21.08 SD = 2.08; 48% Caucasian, 41% Asian, 4% Latino/Latina, and 7% Other). Participants were paid US\$20/hr for the entire duration of participation (including the 12 days of training) and provided written informed consent according to the procedures of the UCLA Institutional Review Board.

Two weeks prior to participation, participants completed a questionnaire in which they rated 10 of their close friends on 36 traits. For each trait, participants rated how much each friend possesses the traits on a 1–100 scale (1 being the least and 100 being the most). These ratings were later used to create SWM trials (see Materials section).

Laboratory Tasks

Participants completed two laboratory sessions. In the first laboratory session (Time 1), participants completed a computerized SWM task that comprised 18 SWM trials (henceforth referred to as *test trials*, so as not to be confused with the SWM trials completed during training, which are henceforth referred to as *training trials*) in which participants encoded a list of their own friends' names, observed a trait word, and then ranked the previously encoded friends from most to least in terms of the trait during the delay period (Figure 1A). After the delay period, participants next answered a true/false question about
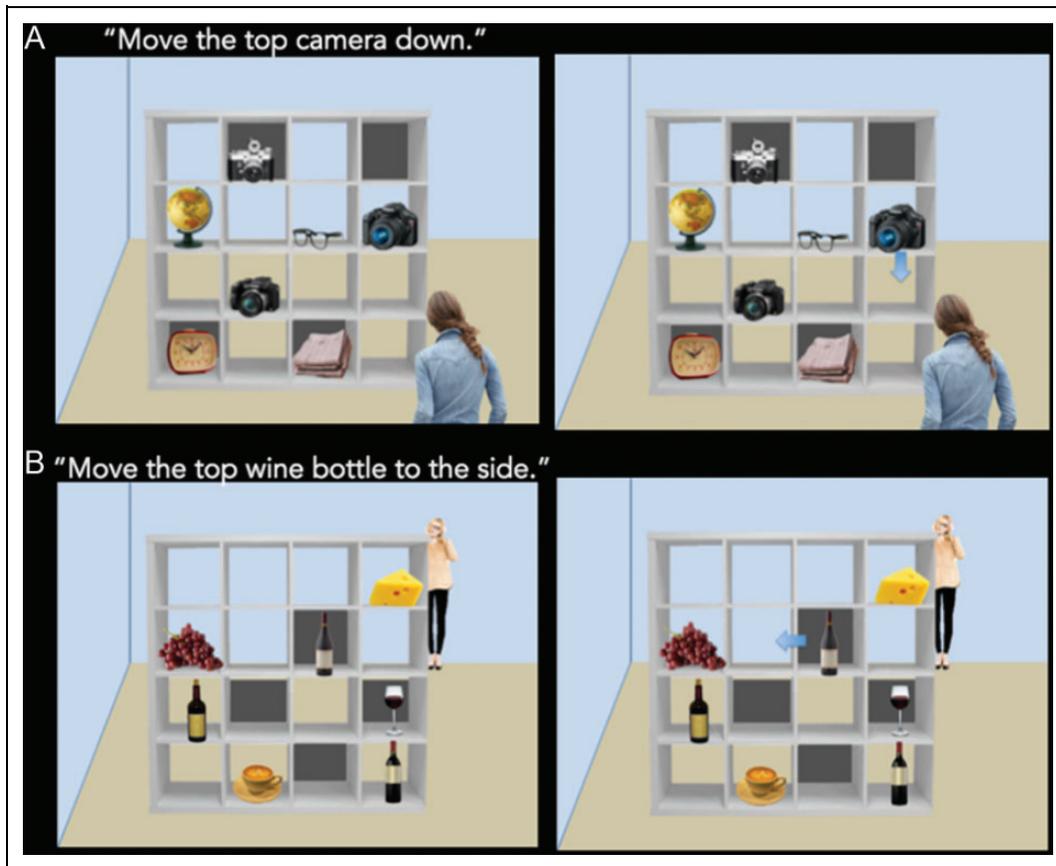
Figure 2. Pictorial display of the director task completed during laboratory sessions. For each trial, the participant viewed the first slide and heard, via audio recording, the director asks for one of the objects on the shelf to be moved (2.5 s). On the next screen, the participant saw an arrow indicating one of the objects to be moved and determined whether the arrow indicated the object that the director had asked to be moved (up to 5 s). The arrow always pointed in the correct direction (up, down, and side). Thus, whether the arrow was referring to the object that the director wanted to be moved was the only factor influencing whether a trial was correct or incorrect. A. Control condition trials that do not require perspective-taking. B. Experimental trials that do require perspective-taking.

their ranking at retrieval. For example, during the delay period shown in Figure 1A, a participant may determine that Claire is the funniest of these three friends, Rebecca is the second funniest of these three friends, and Kristin is the third funniest of these three friends. In response to the probe question at retrieval, where the subject is asked if Claire is the third funniest, the participant would therefore press the keyboard button that indicated that the answer to the probe is "false," based on their ranking. The friends and traits encoded varied from trial to trial. During this task, participants also completed 18 CWM test trials in which they alphabetized friends' names during the delay period (Figure 1B) and answered the true/false probe question at retrieval regarding their alphabetized order. For example, a correct answer to the probe question shown in Figure 1B is false, as the name "Claire" is in the first position when the names Claire, Rebecca, and Kristin are alphabetized. The 18 SWM and CWM test trials each included 6 test trials for each of three difficulty levels based on the number of friends encoded (two friends, three friends, or four friends).

Participants also completed the *director task*, a computerized measure of perspective-taking ability (18 trials). In this task, participants observe a set of objects on a bookshelf.

A woman by the bookshelf (the "director") first asks (via audio recording) the participant to move one of the objects that appears on the shelf (2.5 s). Participants next have up to 5 s to determine whether an arrow suggesting one of the objects to be moved is the object that the director wanted to be moved. Some of the shelves on the bookshelf have a wall behind them and others do not. Additionally, the arrow always pointed in the correct direction (up, down, and side). Thus, whether the arrow was referring to the object that the director wanted to be moved was the only factor influencing whether a trial was correct or incorrect.

Trials in the director task included experimental, control, and catch trials. For experimental and control trials, one of the three objects relevant to the director's request is on a bookshelf blocked by a wall. For experimental trials, the director is on the other side of the bookshelf and therefore has a different perspective than the participant, because she cannot see the objects blocked by the gray shelf walls. This director asks for one of the three objects within one category of objects to be moved (e.g., "move the top wine bottle to the side," see Figure 2B). These trials require perspective-taking because the participant must take into account that what the director means by "top

wine bottle'' may not be the same as what the participant perceives as the top wine bottle.

For control perspective-taking trials, the director faces the front of the bookshelf (and therefore has the same perspective as the participant) and asks for one of three objects within a category of objects to be moved (e.g., "move the top camera down;" see Figure 2A). These are control trials because they have the same elements as the experimental trials except that, because the director has the same perspective as the participant, deriving a correct answer does not require perspective-taking.

During the catch trials (three with the director on the same side of the bookshelf as the participant and three with the director on the other side of the bookshelf), the director asks for one object that is the only object in its class on the bookshelf and is always viewable on both sides of the bookshelf to be moved (e.g., in Figure 2B, the director may say "Move the grapes to the side."). Trial order on all tasks was randomized.

On the 14th day after the participants' first laboratory session, participants completed a second laboratory session (Time 2). In this session, participants again completed SWM and CWM test trials and the director task; however, all trials presented in the posttraining session were unique from those presented in the pretraining session. In both laboratory sessions, participants completed practice trials of each task immediately before completing a given task. Participants completed three SWM trials and three CWM trials before they completed the working memory tasks, and four director task trials before completing the director task. Practice trial sets included each trial type used in each task. Task order was also counterbalanced across participants in both laboratory sessions.

Materials

For each SWM test trial and training trial, participants encoded the names of friends selected from the list of their 10 close friends that they provided 2 weeks before their first laboratory session. Consistent with past SWM research (Meyer et al., 2012; Meyer et al., under review; Tabak et al., under review; Krol & Bartz, under review), to control for rating distance effects on task difficulty, we aimed to select friends that were ranked no more than 25 points apart (on the 100-point scale) and no closer than 5 points apart from one another for each trait word for both SWM training trials and SWM test trials. These distances served as a rule for friend name selection for both the laboratory sessions and training sessions and were adhered to as closely as possible given the distribution of ratings given by the participants (mean distance for friend names on the relevant trait within a trial $= 13.26$; $SD = 4.27$). For both the SWM task and the director task, trials were standardized on brightness, contrast, font, and size.

SWM and CWM Training Paradigms

Training comprised 12 days of SWM or CWM training exercises. Each daily set of exercises included 60 training trials, which collectively yielded a total $\sim$20 min/day of training.
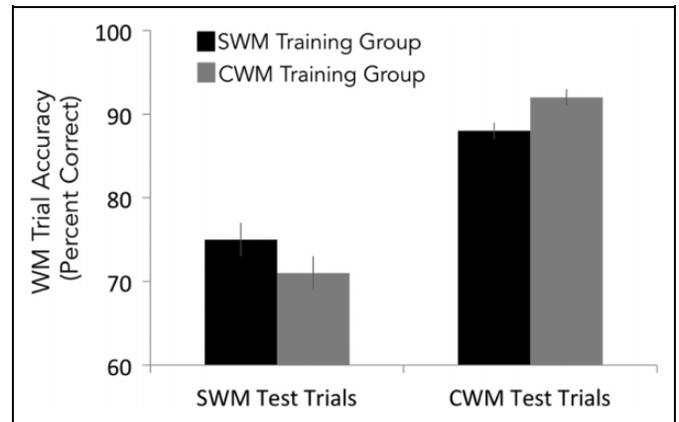

Figure 3. Corrected mean values (estimated marginal means $\pm$ SEM) for Time 2 social working memory (SWM) and cognitive working memory (CWM) test-trial accuracy. Corrected mean values control for Time 1 SWM and CWM test-trial performance.

The format of training trials was identical to the format of working memory test trials completed during the laboratory sessions (i.e., participants first encode friends' names, see a trait [SWM training group] or the instruction to alphabetize [CWM training group] for 1.5 s, followed by a 6-s delay period and up to a 4-s probe question asking about their ranked order (the probe question period is up to 4 s, because the screen advances when the participant makes their keyboard button response). Critically, the SWM and CWM training interventions were identical except for the fact that SWM training trials required participants to rank friends along trait dimensions in working memory, whereas CWM training trials required participants to alphabetize friends' names in working memory. Thus, we were able to examine perspective-taking accuracy gains due specifically to SWM training.

Consistent with past working memory training research (e.g., Jaeggi et al., 2008; Klingberg, 2010; Klingberg et al., 2005), working memory training was computer-adaptive based on the subject's performance (see Figure 3). The 60 training trials completed each day were organized into sets of 5 trials. For each set of five training trials, participants answered working memory trials of the same load level (e.g., two friends, three friends, four friends, etc., with a maximum of six friends). If the participant answered more than three of the five working memory training trials correctly, the following five training trials presented were of a greater load level. If the participant answered less than three training trials correctly, the following set of five training trials showed a lower load level. If the participant answered three training trials correctly, the following set of five training trials showed the same load level as the previous five training trials. SWM training trials were determined accurate if the participant's answer was consistent with their original online trait rankings, a method previously used to determine SWM accuracy (Dumontheil et al., 2014; Meyer et al., 2012; Tabak et al., under review). The number of friends' names that are encoded in a set of five trials is the working memory load manipulation. Thus, as participants perform

Table 1. Social Working Memory (SWM) and Cognitive Working Memory (CWM) Test-Trial Accuracy at Time 1 and Time 2, Shown Separately for Individuals Who Underwent SWM Training and CWM Training.

	SWM Training Group		CWM Training Group		SWM Training Group		CWM Training Group	
Training Session	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Time 1	72.86	10.46	71.76	10.22	86.54	9.32	89.81	4.82
Time 2	74.75	10.45	71.3	10	87.39	8.83	92.59	3.9

Table 2. Test-Trial Processing Speed (reaction time) at Time 1 and Time 2, Shown Separately for Individuals Who Underwent SWM Training and CWM Training.

	SWM Training Group		CWM Training Group		SWM Training Group		CWM Training Group	
Training Session	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Time 1	1.8	0.28	1.91	0.33	1.69	0.28	1.75	0.31
Time 2	1.43	0.32	1.51	0.35	1.4	0.3	1.37	0.31

Note. SWM = social working memory; CWM = cognitive working memory.

better on the task, they receive more challenging working memory trials. This procedure helps ensure that subjects train at their (social or cognitive) working memory capacity.

Participants completed working memory training sessions over the Internet by logging into a website with their subject ID number. On the first day of training, the first five working memory training trials began with three friend load level trials. Each subsequent training session began with five training trials with the same load level of the previous day's maximum load level. To facilitate participant compliance, participants received two e-mails/day (once in the morning and once in the evening) to remind them to complete their online exercises.

Data Analysis

Following suggestions for data analysis of pre- and postdesigns with multiple conditions (Bonate, 2000) and previously reported statistical analyses in working memory training research (e.g., Jaeggi et al., 2008; Klingberg et al., 2005), we used a general linear framework, with Time 2 scores as the dependent variable, Time 1 scores as a covariate, and condition (SWM training group vs. control group) as the fixed factor in ANCOVA (for the director task outcome) or multivariate analysis of covariance (MANCOVA; for the SWM and CWM outcomes) to compare posttraining task performance between groups. Past working memory training research has also found that gains to working memory reaction time (RT) linearly increase with working memory load (e.g., Kirschen et al., 2004), suggesting the greatest processing speed gains to the most demanding trial types. We therefore also examined whether training induced gains in RT on our SWM and CWM test trials varied by load in a four-way repeated measures ANOVA, with working memory type (SWM vs. CWM), load level (two friends vs. three friends and vs. four friends), time (Time 1 and Time 2), and group (SWM training vs. CWM training) factors. One outlier more than 2.5 SD outside of their

group's SWM Time 2 mean accuracy and three outliers more than 2.5 SD outside of their group's CWM Time 2 mean accuracy were first removed from analyses examining improvements in SWM and CWM accuracy posttraining, and follow-up analyses were performed with these outliers to confirm the results. RT data on the baseline working memory tasks was not recorded for one participant and thus they are not included in the working memory RT analyses.

Results

Training Induced Improvements to Working Memory

Each training intervention improved test-trial accuracy on the trained working memory task (e.g., SWM training improved SWM test trial accuracy, whereas CWM training improved CWM test trial accuracy). Specifically, Time 2 SWM and CWM test-trial accuracy, controlling for Time 1 SWM and CWM test-trial accuracy, significantly varied by group, with individuals who underwent SWM training showing greater SWM test-trial accuracy and individuals who underwent CWM training greater CWM test-trial accuracy, $F(2, 45) = 3.48$, $p = .02$, $\eta p = .13$; Figure 3 displays mean Time 2 values corrected for the Time 1 covariate; Table 1 reports Time 1 and Time 2 raw data. Moreover, this result remains significant when outliers were included in the analysis ($p = .05$).

Both working memory training interventions also improved participants' SWM and CWM test-trial processing speed (Table 2 shows raw data; p's < .0001). Although these improvements did not significantly vary by group, MANCOVA $F(2, 48) = 1.84$, $p = .08$, among participants who underwent SWM training, the gain in SWM test-trial RT processing speed remains significant when controlling for Time 2 versus Time 1 gains in CWM test-trial RT, $F(1, 25) = 8.14$, $p = .005$, $\eta p = .25$. In contrast, among individuals who underwent CWM training, the gain in SWM test-trial RT
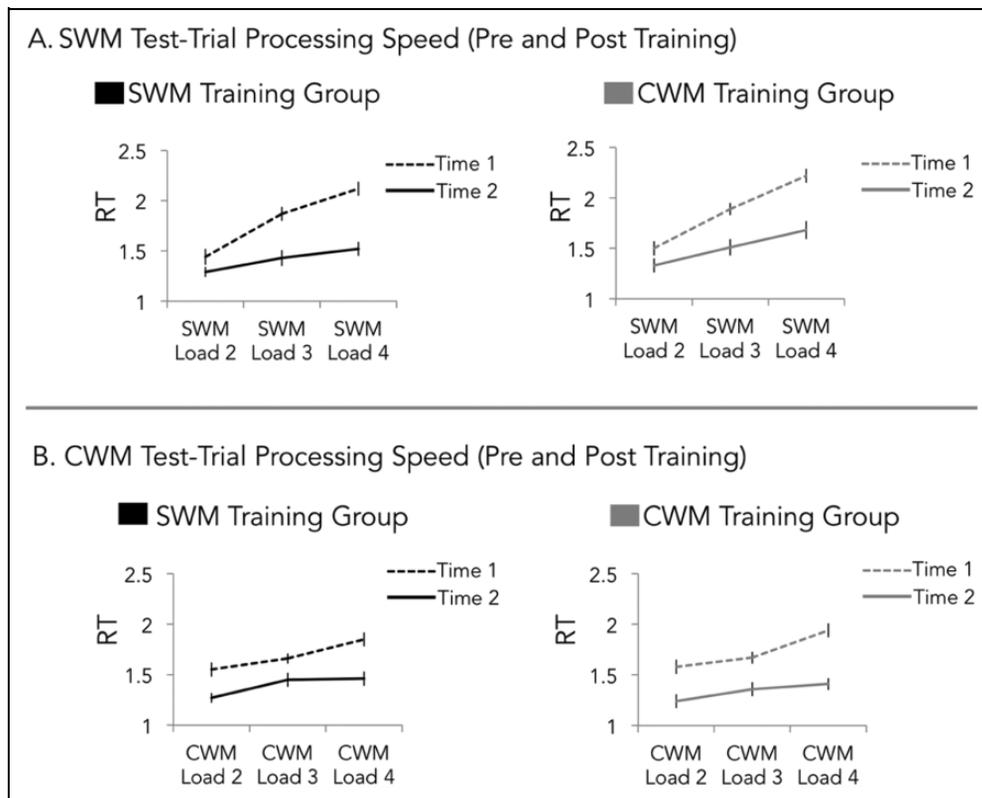
Figure 4. Social working memory (SWM) and Cognitive working memory (CWM) processing speed (reaction time) on SWM and CWM test-trial performance. Raw Time 1 and Time 2 data are plotted ($\pm$ SEM).

processing speed becomes nonsignificant when controlling for gains to CWM test-trial processing speed, $F(1, 24) = 1.55$, $p = .113$. Thus, SWM training may uniquely improve independent components of SWM and CWM processing speed.

Past working memory training research has found that training induced gains in processing speed increase with working memory load level (Kirschen et al., 2005). We therefore additionally examined whether our observed changes in processing speed vary as a function of SWM and CWM test-trial load level. A four-way interaction analysis (WM test trial type [SWM vs. CWM] $\times$ load level [two friends vs. three friends vs. four friends] $\times$ time [pre- vs. posttraining] $\times$ group [SWM training vs. CWM training]) of working memory (WM) processing speed (RT) revealed an interaction between load level and time, such that both training interventions increased test-trial processing speed as a function of working memory test-trial load level (e.g., at Time 2, participants were increasingly faster as a function of WM load; $F(2, 100) = 24.65$, $p < .001$, $\eta p = .45$; Figure 4). In other words, gain to working memory processing speed was larger for load levels that require more working memory resources.

SWM Training Improves Perspective-Taking Accuracy

Our primary interest was to examine whether SWM training improves perspective-taking accuracy. Consistent with this possibility, Time 2, controlling for Time 1, director task
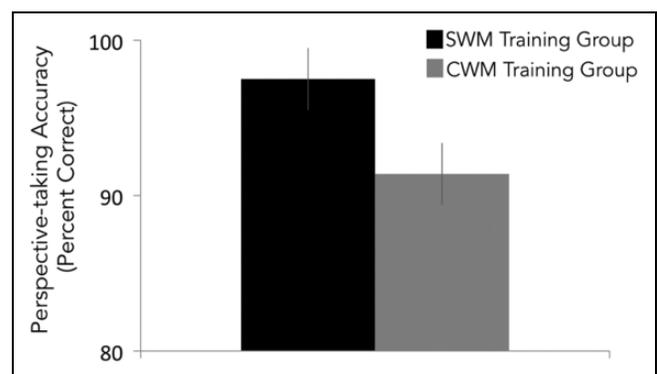

Figure 5. Corrected mean values (estimated marginal means $\pm$ SEM) for Time 2 perspective-taking accuracy. Corrected mean values control for Time 1 perspective-taking accuracy.

accuracy was significantly greater for individuals who underwent SWM versus CWM training; $F(1, 51) = 3.31$, $p = .04$, $\eta p = .06$; Figure 5 displays mean Time 2 values corrected for the Time 1 covariate; Table 3 reports Time 1 and Time 2 raw data). Moreover, this effect persists when controlling for baseline performance on SWM and CWM task accuracy ($p = .041$, $\eta p = .06$) or accuracy gain on control perspective-taking trials ($p = .049$, $\eta p = .05$). Follow-up t-tests revealed that both groups were significantly more accurate in perspective-taking at Time 2 versus Time 1. The improvements in the CWM training condition may reflect practice effects or marginal gains

Table 3. Perspective-Taking Accuracy and Processing Speed (Reaction Time) on the Director Task at Time 1 and Time 2, Shown Separately for Individuals Who Underwent SWM Training and CWM Training.

Training Session	SWM Training Group		CWM Training Group		SWM Training Group		CWM Training Group	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Time 1	86.95	18.72	83.86	22.46	1.42	0.44	1.14	0.45
Time 2	98.15	5.34	90.74	20.33	1.42	0.49	1.01	0.37

Note. SWM = social working memory; CWM = cognitive working memory.

from CWM training, both of which are consistent with past working memory training findings (see Klingberg, 2010, for a review). Nonetheless, participants who underwent SWM training showed significantly greater gains than those who underwent CWM training, suggesting SWM training may enhance perspective-taking accuracy above and beyond any improvements due to practice effects or domain-general working memory training. There was no interaction between training group and perspective-taking trial RTs ($p = .25$; Table 3).

Discussion

We report the first evidence that SWM training improves perspective-taking accuracy. Twelve days of computer-adaptive (i.e., performance based) SWM training (vs. CWM training) significantly improved director task accuracy on trials that require considering another person's perspective during communication. Moreover, this effect persisted when controlling for baseline SWM, CWM, and director task performance, as well as when controlling for accuracy gains on similarly formatted director task trials that did not necessitate perspective-taking. Thus, improvements accrued from training SWM transfer to nontrained perspective-taking tasks.

Building off of research and theory from the working memory training literature (e.g., Klingberg, 2010), we propose SWM training improves perspective-taking accuracy for two reasons. First, SWM and perspective-taking may share similar underlying neurocognitive mechanisms. Despite the surface-level differences between the SWM task used for training and the director Task, both tasks require the momentary maintenance and manipulation of information about others' minds. Indeed, SWM neural responses correspond with self-reported (Meyer et al., 2012) and experimentally measured (Meyer et al., 2015) perspective-taking skills, suggesting SWM and perspective-taking may share underlying neural circuitry. Second, the SWM training intervention developed here may specifically target the development of social cognitive capacity. It has been suggested that computer-adaptive working memory training interventions, which calibrate the amount of information dealt with in working memory based on each participant's performance, facilitates plasticity because participants train at their working memory capacity (Klingberg, 2010). Although practicing the director task could also improve performance on the director task, our observation that computer-adaptive SWM training improves performance may therefore be a more meaningful observation. That is, perspective-taking may have

improved not simply because participants mastered the director task but because their ability to manage social cognitive information in working memory expanded. Thus, training SWM may be a parsimonious way to improve not only performance on the director task but also other social cognitive skills that require the maintenance and manipulation of social cognitive information.

Importantly, despite the appeal of working memory training as an efficient means to enhance cognitive performance, much debate surrounds whether performance gains from working memory training are robust and long lasting (Melby-Lervåg & Hulme, 2013; Redick et al., 2013). The SWM training–induced findings reported here are subject to the same questions, and future research is needed to replicate and extend the present findings.

Future research will be particularly critical in delineating the effectiveness of different types of SWM training. In the present study, we manipulated trait processing in SWM. However, trait processing is unlikely to be the only social cognitive process managed in working memory that relates to social skills, like perspective-taking. For example, social situations can become complicated and pose information-processing demands to working memory as a function of the number and kinds of relationships between people that we must consider in order to behave with social grace. Talking about your recent marital engagement with three close friends may not pose great working memory demands. Talking about your marital engagement with three close friends, two of whom broke off their own engagement with one another, and the third of whom previously dated your new fiancé may tax working memory resources as you try to nicely share your news. Thus, training the capacity to juggle social network relationships in working memory may also be beneficial to social skill development.

Interestingly, in both training groups, participants' perspective-taking scores were significantly higher at Time 2 than at Time 1 (with SWM participants showing the greatest improvement), despite the fact that Time 1 perspective-taking scores were relatively high. Thus, one possibility is that training interventions, like the one employed in this study, are only effective in improving perspective-taking when participants are already performing fairly well at baseline. However, many of the participants who completed SWM training demonstrated a ceiling effect in their perspective-taking performance at Time 2 (100% correct). An alternative possibility, therefore, is that a more challenging perspective-taking measure would simply reveal greater gains in perspective-taking performance from

SWM training. Future research is needed to determine which of these two possibilities best reflect SWM training induced changes in perspective taking.

It would also be fruitful to explore whether the transfer effects observed in our study extend to real-world forms of perspective-taking as well as prosocial behaviors associated with perspective taking. For example, a large literature in social psychology finds that perspective-taking is associated with reduced prejudice and stereotyping (e.g., Galinsky & Moskowitz, 2000). Could SWM training also enhance these outcomes? Do different kinds of social cognitive information (e.g., information about out-groups rather than information about one's own friends) need to be manipulated during SWM training to see reduced stereotyping and prejudice? And can we see improved perspective-taking not only in the lab but also in the field, where perspective-taking accuracy matters the most? Research addressing questions such as these will better our understanding of SWM training effectiveness and may identify novel routes to prosocial behavior.

More broadly, this is the first study to show that "mentalizing" (Frith & Frith, 2006), an umbrella term for thinking about the thoughts, feelings, and personality characteristics of people, can be improved in healthy adults. A major barrier to examining how to improve mentalizing in healthy adults is that they frequently perform at ceiling on many previously used measures of mentalizing (Brunet, Sarfati, Hardy-Bayle, & Decety, 2000; Fletcher et al., 1995; Walter, Ciaramidaro, Enrici, Pia, & Bara, 2004), making it difficult to examine whether and how their performance could improve. In fact, the standard measure of mentalizing abilities—the "Sally Anne Test" (Baron-Cohen, Leslie, & Frith, 1985; Wimmer & Perner, 1983)—only requires considering two characters' minds and even 7-year-olds score near ceiling on the task (Happé, 1995). And yet, participants in our training group showed performance gains for SWM test trials in which more than two friends were considered. Thus, the SWM paradigm developed here opens a new window into the boundaries of mentalizing capacities and the extent to which they are plastic in adults.

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Declaration of Conflicting Interests

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