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DOI
10.1016/j.ijhcs.2020.102400

Publication date
2020

Document Version
Final published version

Published in
International Journal of Human Computer Studies

International Journal of Human-Computer Studies 139 (2020) 102400

Contents lists available at ScienceDirect

International Journal of Human-Computer Studies

journal homepage: www.elsevier.com/locate/ijhcs

Simulated thoughts in virtual reality for negotiation training enhance self-efficacy and knowledge

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ARTICLE INFO

Keywords:
Virtual reality
Negotiation skills
Training system
Virtual cognitions
Self-motivation
Social skills training

ABSTRACT

Negotiating serves as an essential skill in our daily life, however, it is quite challenging to negotiate well. Various negotiation training systems have been developed to solve this problem and improve people's performance in negotiation. Nevertheless, these systems mainly focus on skills practice and less on negotiation understanding or self-efficacy development. Aiming at improving both people's negotiation knowledge and self-efficacy, a virtual reality negotiation training system is proposed that exposes users to virtual cognitions during negotiating with virtual characters. The virtual cognitions, delivered as a personalised voice-over, provide users with a stream of thoughts that reflects on the negotiation progress and their performance, and also presents self-motivational statements. To study the effectiveness of the system and the self-motivational statements included in virtual cognitions, an empirical study with 48 participants was conducted. The study employed a between-subjects design with three groups: waitlist, training with self-motivational statements, and training without self-motivational statements. 24 waitlist participants were also randomly assigned to and completed the training following the waiting period. The results indicated that 1) the system significantly enhanced people's knowledge about negotiation and increased their self-efficacy, 2) the self-motivational statements included in virtual cognitions even further improved self-efficacy. Furthermore, these effects remained after multiple weeks.

1. Introduction

Negotiation surrounds our daily lives. Being good at it brings economic and social benefits. People improve these skills by trial-and-error or observing others negotiate. But what if they could also observe the relevant thoughts? What if they could perceive these as their own? This study examines this idea as a training strategy for knowledge and confidence building.

Much research points out that it is difficult for people to negotiate well (Fisher et al., 2011; Hindriks and Jonker, 2008; Thompson, 2005). Hence, various self-help books (Fisher and Shapiro, 2005; Fisher et al., 2011; Malhotra and Bazerman, 2007) have been published and courses (Bordone, 2000) have been given. In recent years, researchers have further extended this training material with a large number of negotiation training systems. Table 1 gives a overview of the characteristics of some of these systems. Although these training systems are shown to be beneficial (Broekens et al., 2012; Durlach et al., 2008; Gratch et al., 2016; 2015; Greco and Murgia, 2007; Lin et al., 2009) thanks to their accessibility and low cost, several limitations attenuate their efficacy. First, as Table 1 shows, the goal of most of these systems is either to offer people opportunities to practice or to impart knowledge. While the former focuses on creating simulated negotiation scenarios, the latter focuses on teaching people what to do and how to act. However, these systems do not support people in operationalizing theoretical concepts and principles into an actual negotiation situation (Core et al., 2006). Often, it results in two situations. 1) The systems only increase people's knowledge, without clear performance improvement or changes in social behavior, see for example Broekens et al. (2012). 2) When users already have basic knowledge or negotiation experience, only giving them a chance to experience a negotiation or teach them negotiation principles is unlikely to result in clear skill improvement. Kim et al. (2009), for example, found for individuals without prior negotiation experience, their situational judgment test score was improved significantly after the training, while for those with prior negotiation experience, the training failed to bring out a significant improvement. Moreover, people, particularly novices, have trouble with applying their newly gained knowledge, despite being able to remember everything taught in the training (Novick, 1988).

Second, training of skills gets the most attention as shown in Table 1. Training systems often neglect the importance of the

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https://doi.org/10.1016/j.ijhcs.2020.102400
Received 18 March 2019; Received in revised form 9 October 2019; Accepted 27 January 2020
Available online 27 January 2020
1071-5819/

Table 1
Negotiation training system reported in the literature.

Author	Intervention goal					Measurement			
	Learn by doing	Imparting knowledge	Motivation	Reflection	Feedback	Performance	Satisfaction	Self-efficacy	Knowledge
Greco et al. (2007)	✓				✓	✓	✓		
Lin et al. (2009)	✓					✓			
Ross Jr et al. (2001)	✓	✓				✓	✓		✓
Broekens et al. (2012)	✓				✓[a]	✓			✓
Gratch et al. (2015)	✓					✓	✓		
Gratch et al. (2016)	✓				✓	✓	✓		
Kim et al. (2009)	✓	✓		✓	✓	✓	✓		✓

[a] Note, *only providing emotions as feedback

individual's own confidence, motivation and willingness to participate in a negotiation. This, however, is essential to initiate the negotiation. People's beliefs about their capabilities, i.e. their self-efficacy not only affect their negotiation behavior and performance (Sullivan et al., 2006), but also influence their performance after negotiation training (Gist et al., 1991; Stevens and Gist, 1997). Fortunately, there are strategies to improve people's self-efficacy, thus increasing their motivation and willingness to engage in activities (Margolis and McCabe, 2006). For instance, according to social cognitive theory (Bandura, 2000), people' s self-efficacy can be affected by four ways: mastery experience, vicarious experience, verbal persuasion, and their emotional and physiological states. If they are not well provided, though, self-efficacy can also suffer. In fact, training systems can provide both a mastery and a failure experience. Such failure experiences can lead to the decrease of one' s self-efficacy, especially when a sense of efficacy has not yet been firmly established (Bandura et al., 1999). A solution to this is the addition of guidance in the form of appropriate instructions, explanations, or reflections. Guidance can be provided in a third-person or first-person perspective, with the latter shows to be more effective. For example, students have been found to learn better from instructional videos recorded from a first-person perspective than a third-person perspective (Fiorella et al., 2017).

Our vision is to create a system that addresses the earlier mentioned limitations by focusing on people's negotiation understanding and self-efficacy. This is done by letting people experience negotiation, both visual and cognitively from a fist person perspective. The cognitive experience is realised in the form of virtual cognitions, i.e. a stream of thoughts, simulating the thinking process during a negotiation. Virtual cognitions consist of guided learning and motivating statements. We believe that virtual experience with virtual cognitions can enhance people's negotiation knowledge, but perhaps more importantly, can also increase their self-efficacy.

2. Background theory and hypotheses

Social skill training systems aim at overcoming shortcomings of face-to-face training such as the high costs and the lack of controlled social interaction (Robillard et al., 2010). With the advent of virtual reality technology, social skills training systems using this technology have been developed. These systems can provide an enriched, ecologically valid, interactive and enjoyable training environment (Zygouris et al., 2015). They can be effective as some studies show. For example, these systems can reduce people's public speaking anxiety (Nazligul et al., 2017; Söyler et al., 2017; Stupar-Rutenfrans et al., 2017), teach communication skills to pediatric residents (Real et al., 2017), and improve individual's job interview skills (Garcia et al., 2018; Smith et al., 2019). More specifically for negotiation, they could boost individual's negotiation skills (Broekens et al., 2012). As discussed above, one important element that a training system should offer is guidance and mentoring. Providing reflections, feedbacks and explanations affects the efficacy of the system (Kim et al., 2009). Taking it one step further, these systems should aim at improving people's self-efficacy in negotiation. This determines how people feel, think, behave and motivate themselves to engage in social interactions (Bandura et al., 1999). Self-efficacy can be altered in four ways as stated previously and this can also be achieved in virtual reality environments (Kang, 2016; Yip and Man, 2009). For instance, individuals can gain mastery experience by actively performing specific tasks in virtual environments (Aymerich-Franch et al., 2014; Nissim and Weissblueth, 2017) or vicarious experience by observing virtual agents perform a task (Fox and Bailenson, 2009; Qu et al., 2015). Further on, as the vision puts forward, these ways of influencing might also be established with an artificial stream of thoughts combined with simulated speech. Offering these thoughts from a first-person perspective as a simulated inner voice could reproduce people's internal psychological world, present people with mental observations and commentary. Inner voice, also known as an internal monologue, is believed to play a role in various cognitive functions, such as self-regulation (Vygotsky, 1964), self-reflection (Morin and Hamper, 2012) and, importantly, learning (Steels, 2003). Guiding users to use inner voice during learning can, for example, reduce anxiety and increase both communicative competence and confidence (Tomlinson, 2001). Receiving guidance through simulated inner voice, therefore, has the potential to enhance mastery or vicarious experience. The impact of the vicarious experience depends on how much people can identify with the observed person (Bandura et al., 1999). For instance, children with autism master more novel letters and even learn more quickly when watching videos of themselves compared with watching videos of someone else (Marcus and Wilder, 2009). This suggests a larger impact if people are exposed to inner voice and simulated speech with sound characteristics similar to their own. If a person would perceive the virtual thoughts and speech as their own, it might also trigger attitudinal change. After all, the cognitive dissonance theory (Festinger, 1957) postulates that people with conflicting cognitions and behaviours tend to resolve this by realigning them. Additionally, verbal persuasion and changes in emotional and physiological states can also be achieved with positive self-motivational statements. For example, reading aloud positive self-statements or self-instructions had a positive effect on people's self-esteem and feelings of inadequacy (Lange et al., 1998) and even on depression (Philpot and Bamburg, 1996). Therefore, one new intervention method to increase self-efficacy is using virtual cognitions as a kind of inner voice or personalised voice-over to present conscious thoughts to the user combined with simulated speech during the negotiation training. These virtual cognitions can play the role of (1) guidance and instructions to enhance mastery and vicarious experience or (2) self-motivational statements to verbally persuade and change emotional and physiological states. It allows users to passively experience how a successful negotiation process unfolds from a first-person perspective. Hence, it opens the possibilities to enhance people's self-efficacy, leading to following hypotheses:

H1 Passive virtual reality negotiation training with virtual cognitions

and simulated speech improves negotiation knowledge and self-efficacy of negotiation compared to no training.

H2 Virtual cognitions with self-motivational statements improve self-efficacy more than virtual cognitions without self-motivational statements.

3. Research approach

Testing these hypotheses involved several activities that ultimately led to a randomised controlled experiment. First of all, the idea discussed above was translated into a fully functional training system. For testing the first hypothesis, this meant that the system was able to provide users with the experience of negotiating from a first-person perspective complete with virtual cognitions and simulated speech. The second hypothesis, about the effect of self-motivational statements, required the creation of a set of these statements. They varied on the expressed self-efficacy in negotiation. The set allowed the system to select a statement appropriate to the individual's level of self-efficacy, and to measure people's negotiation attitude. Also, the developed training consisted of scripts for three consecutive training scenarios. Besides creating the content, dedicated software for recording the virtual cognition text was developed, including software that allows individuals to set sound parameters to match their own recorded voice with that of their inner or outer voice perception (Ding et al., 2018).

The first hypothesis is about negotiation knowledge enhancement. It requires a reliable and validated negotiation knowledge measure. For this, a series of negotiation videos was developed following the strategy also used by Broekens et al. (2012). People's reflections on these videos gave an insight into their negotiation knowledge (Ding, 2016a). This measuring instrument, together with the developed training system, was eventually applied in the experiment. The following chapters provide a detailed account of all these activities.

4. System, content and training

The training system was developed via immersive virtual reality technology. To examine the hypotheses one, we developed a training system with virtual cognitions combined with simulated speech. An initial pilot study (Ding et al., 2017) showed promising results for enhancing knowledge and self-efficacy, however, it was only a single-group study with a quite small sample size. As for hypotheses two, the system provided two type of training, training with and without self-motivational cognitions. The system provided a series of negotiation scenarios in a virtual meeting room.

4.1. General idea

To give a brief idea of the training content, Table 2 shows an excerpt from the negotiation script translated into English. The scripts incorporate the negotiation dialogues and the virtual cognitions that users heard when they were immersed in the virtual reality (VR) negotiation training system. The negotiation occurs between the user, playing the role of an employer, and a virtual employee who sat across the user. To avoid gender effects, the gender of the employee and the employer was matched with that of the user. During the training, users heard both the external dialogue (lines 1–7) and the virtual cognitions as part of an internal monologue (lines 8–10). Line 8 show the virtual cognitions that describe the current situation, reflect on what users heard, what they should do, and why. Line 9 illustrates a self-motivational statement, heard as one key component of virtual cognitions. The virtual cognitions in line 10 introduce the relevant negotiation knowledge.

The negotiation skills training system is a 3D immersive virtual reality system. In the system, users can explore a virtual self-experience in a negotiation context. They play the role of an employer, passively experience negotiating with a virtual employee, sitting opposite to them. It is a passive experience as they do not actively negotiate. Instead, they perceived the negotiation from a first-person perspective, seeing and hearing their virtual-self talk with the virtual employee. Furthermore, they heard their virtual-self thinking by hearing pre-recorded audio. For this, they wore a head mounted display and a pair of microphones (Fig. 1). For any system that provide human-computer interaction, the sense of agency could be a vital consideration as it affects how people experience interactions with technology (Limerick et al., 2014). In our system, users' body movement was captured to synchronize it with their virtual body which they could see in a virtual mirror to enhance the body ownership illusion and sense of agency over the virtual body (Banakou et al., 2013; Slater et al., 2010).

The system delivered three training sessions, with each session addressing a negotiation principle: (1) the main stages of negotiation, (2) best alternative to a negotiated agreement (BATNA), and (3) separate the people from the issue (Fisher et al., 2011). Each session was set within its own negotiation scenario, triggered by a work-related event: (1) continuously being late for work; (2) requesting an immediate holiday; and (3) announcing resignation. During the sessions, users were exposed to three types of virtual cognitions (Table 3): knowledge and principles of negotiation, reflection on the negotiation process, and self-motivational statements. The second and third session also used knowledge and principles addressed in previous sessions, strengthening the users' understanding and recollection. The reflection element also built on experiences in past sessions. Whereas in the first training session, the reflective cognitions only focused on the current situation in progress, in the second and third sessions, they related back to thoughts and experience obtained in the previous negotiations.

Table 2
Excerpt from negotiation scripts between the employer (ER) John (the user's perspective) and virtual employee (EE) Mike.

1. ER (Thinking-reflection) I have already known Mike for a long time, he has a good reputation in the company, but according to the teacher's advice, I need to separate the people from the problem. Be soft on him, hard on the issues we faced. Of course, when he felt down, I should console him in a friendly way. However, when it comes to the rules, I still should consider the problem in a matter-of-fact way, not making concessions because of the relationship between us or to cultivate the relationship. It is better to explore the current situation more.
2. ER (Talking) Mike, let's try to solve the problem together. Have you already got any offer from another company?
3. EE (Talking) No, I haven't. I don't have time to find a job. I am still stuck in the work at hand and my wife recently broke her legs in an accident.
4. ER (Talking) What? Did she break her legs? Is she ok? What happened?
5. EE (Talking) She fell from her bike when she was hit by a motorcycle at a street corner. The accident was quite serious, she was kind of lucky that she just broke her legs.
6. ER (Talking) I am really sorry to hear that. I believe it could be quite difficult for you. Would you mind telling me a little bit more?
7. EE (Talking) It happened last month, the doctor said she had to stay in bed, at least for two months. I must take care of her every day. Taking care of both my family and the job at the same time is very exhausting. My feeling tells me I should leave the team and make some changes in my life.
8. ER (Thinking-reflection) I gathered a large amount of information about Mike's working and living condition. I explored a lot about his desires and the underlying reason why Mike wants to leave his job now. Now, the reasons why he wanted to leave his job seem clear.
9. ER (Thinking-self motivation) John, the negotiation is going quite well, you are doing a great job in the joint exploration stage.
10. ER (Thinking-knowledge) Now, the negotiation will come to the next stage: bidding. The most essential thing in this stage is to develop multiple options for Mike to choose from.
11. ER (Talking) Mike, how would you feel about finishing your work first and I arrange for you to transfer to another team?
12. EE (Talking) Moving to another team? Eee...That sounds ok, but I have to say I am a little bit worried that all the troubles I experienced in the current team will come out again.

Fig. 1. Experiment setting (top) and screen shot (bottom) of the training scenario from the perspective of users where they see their virtual representation in the mirror and the virtual employee in front of them.

4.2. Content generation of self-motivational cognitions

Self-motivational cognitions, they were adapted to users' states, giving positive feedback on the user's performance in current or previous negotiation, stressing feelings of mastery of experience. A potential risk, however, was that people would ignore the virtual cognitions as a strategy to resolve their cognitive dissonance with their actual beliefs. Following the social judgment theory (Sherif and Hovland, 1961), these cognitions could be classified into latitudes of acceptance, non-commitment, and rejection. Cognitions that target the latitude of non-commitment might be able to establish the largest belief change, as cognitions that fall into the latitude of acceptance are already close to people's beliefs. Less likely to be accepted are cognitions that fall into the latitude of rejection, as they are probably rejected or even cause negative effects. In other words, depending on their current self-efficacy belief, people should hear different self-motivational statements, ranging from 'I am an average negotiator.' to 'I have never failed in a negotiation.'.

To create the content of the training delivered by the training system, an ordered list of self-motivational statements that formed the self-motivational virtual cognitions had to be established. For this, we followed the strategy to create a Thurstone scale using the method of

Table 3
Three types of virtual cognitions used in the system.

Type	Function	Example
Knowledge and principles	Introduce the targeted knowledge and principles.	"The teacher also taught me one essential strategy that can be applied during the negotiation. What's that?...hmmm...Yeah, I see. 'Separate the people from the problems'. I should be soft on the people, but hard on the problems."
Reflection on the process	Describe the current situation, analyse the possible thoughts, feelings, and behaviours of the other parties and explain what to do and why to behave in a certain manner.	"It seems Mike was crushed by the work, I ought to console him a little bit. However, when it comes to the issues that he wanted to leave the job immediately, I still have to let him know it's not possible as there is clear notice period for resigning in his contract. Soft on people, hard on the problem. I should keep that in mind and follow it."
Self-motivational statements	Persuade people of their capability to perform social behaviours and encourage themselves to engage in social interactions	"Yeah, we are almost there. I developed lots of options for Mike to choose from and successfully applied the BATNA in a smart way, so I finally figured out a proposal which satisfies the interests of both parties. [User's name], you did a great job in the joint bidding stage. You are a quite good negotiator."

equal-appearing intervals (Mueller, 1986). It was conducted as a separate study before our main experiment that described in the next section. The first step was a brainstorm session to create candidate statements that describe specific attitude people might hold towards negotiation that reveals people's self-efficacy about negotiation. This resulted in a list of 136 statements that were relatively short, colloquial language and containing only one single thought. Afterwards, these statements were given to a panel of 21 judges. They rated each statement on a scale from 1 (no self-efficacy) to 11 (very high self-efficacy) towards negotiation. Finally, the mean score and the standard deviation (SD) of each statement was calculated. A cut off point of maximal SD of 1.42 to include a statement in the final list was empirically determined. Thereby, on one hand, it balances the aim of maximising the number of scale levels and the level of agreement between the judges, and on the other hand, it settles on a sufficient large number of statements in the consecutive interval to create one equivalent Thurstone scales and to fill three negotiation sessions. This resulted in a set of 116 statements, groups in seven consecutive intervals (Ding, 2016b). The statement with the lowest SD in each interval was chosen to represent the group of statements in this interval. Together these seven statements constitute the negotiation attitude scale. Before each training session, users first completed the negotiation attitude scale. Following the Ordered Alternatives Questionnaire (Sherif et al., 1965), participants were asked to sort each item into one of five categories: most objectionable, objectionable, neither accepted nor objectionable, acceptable, and most acceptable. The items that participants find acceptable constitute their latitude of acceptance, the items that participants indicate to be objectionable to them form their latitude of rejection, and the items that participants neither accept nor reject refer to the latitude of non-commitment. The item with highest negotiation attitude scale score that was labeled as non-commitment was chosen. The statements from the interval of this chosen item were then the self-motivational statements the participants heard in the subsequent training. However, if all items of non-commitment are below "4" (the middle of the scale), the items of interval "4" was selected.

4.3. Training

When it came to the training sessions, each consisted of three scenes (Fig. 2). The first scene corresponds to the preparation stage of negotiation. During this period, users were sitting alone in the virtual meeting room, hearing virtual cognitions recalling the knowledge learned from a fictional negotiation course or reflecting on the previous negotiations. The reflection was accompanied by self-motivational statements. The scene ended in reflections on the upcoming meeting with the employee, pre-applying the negotiation knowledge and principles to the possible impending situation. The second scene was the formal start of negotiation between users and a gender-matched virtual employee. Users experience the virtual negotiation in action. To enhance the illusion of being there, when users heard their own external voice, they could see the movement of their virtual mouths in the virtual mirror. When they heard the virtual cognitions, their virtual mouth did not move. Of course, when the employee talked, users also saw the employee's mouth move. Moreover, to create a natural pause in dialogues, the virtual employee drank from his or her virtual mug when users were hearing a virtual cognition. In the closing scene, the users were again alone in the virtual meeting room like the first scene. They heard virtual cognitions that reviewed the process of the past negotiation, their performance, and also motivated them affirmatively. Text of all dialogues and virtual cognitions are available online (Ding, 2017).

5. Method

The study was designed with pre-training, post-training, and 2-week follow-up measures, as shown in Fig. 3. The study was approved by the university's human research ethics committee (ID: 60).

5.1. Participants

48 participants (31 males, 17 females) were recruited throughout the university campus via e-mail or approached personally. Their ages ranged from 23 to 32 ($M = 26.8$, $SD = 2.04$), and all spoke fluently Mandarin.

5.2. Materials and measures

The system captured the body movements of users with a Kinect, which returned real-world distance in meters. For the head-mounted display, we used the Oculus Rift DevKit 2 with a resolution of 1920*1080 pixels, while the virtual environment was created in Unity3D. To strengthen similarity and therefore the effect of this vicarious experience, we gave the virtual employer character the voice of the participants. All dialogues and virtual cognitions were in Mandarin. In the recording phase, they were presented to participants in a random sequence. Participants read them out loud and were recorded with a pair of In-Ear Binaural microphones (SP-TFB-2 Sound Professionals). In the later training sessions, these recordings were played back to them.

5.2.1. Primary outcome measurements

Self-efficacy. Following Bandura's approach (Bandura, 2006), a one-item self-efficacy assessment was conducted. The question was formulated as: "Supposing that you now, as an employer, need to negotiate with your employee about a topic at the workplace, please rate how certain you are that you can successfully negotiate with him/her." The item was rated on an scale from -5 (highly certain cannot do) to 5 (highly certain can do).

Negotiation knowledge. The negotiation knowledge here refers to the three negotiation principles we addressed during the three training sessions. The negotiation knowledge video test was used to measure the participants' mastery of these principles. The test consisted of eight negotiation scenarios (female version and male version) each including six video scenes portraying negotiation situations. After each scene, participants are asked: "What is your advice for the employer?". Written answers were afterwards scored on the participant's ability to identify key negotiation knowledge or principles. To gender match the video material, both a female and male version was created by using all female or male cartoon characters in the videos.

The video test was validated in a separate study with 128 participants (66 females, 62 males). These participants were recruited using Amazon Mechanical Turk, only the participants with HIT Approval Rate greater than 95% were allowed to attend this experiment, which ensures high-quality data suggested by Peer et al. (2014). Their ages ranged from 19 to 71 ($M = 37.9$, $SD = 12.16$). The study was set up as a between-subject experiment that includes two groups: the informed group and non-informed group. In the informed group, the participants were first instructed to watch a training video, which explained the negotiation principles needed for the following test. As a requirement for participation, participants had to answer several questions on negotiation correctly. Then, the remaining participants were assigned to watch the test videos and after watching each video, they were asked to enter their advice for the employer in the video. During this period, informed group participants were allowed to view a description of the principles mentioned in the training video, ensuring that participants in the informed group master the knowledge continuously. The non-informed group took the negotiation knowledge test immediately without any training session or access to the description of negotiation principles. The experiment took about 30 minutes. Participants were awarded 2 US dollars. Afterwards, a coder scored the participants answers on the successful application of the negotiation principles. An acceptable level of agreement ($r = 0.92$) was found with the rating of a second coder on a randomly selected sample ($n = 24$) from the participants' answers. Comparing the group scores, confirmed a significant difference ($t(70.97) = 5.48$, $p < 0.001$, $d = 1.11$) between the informed group

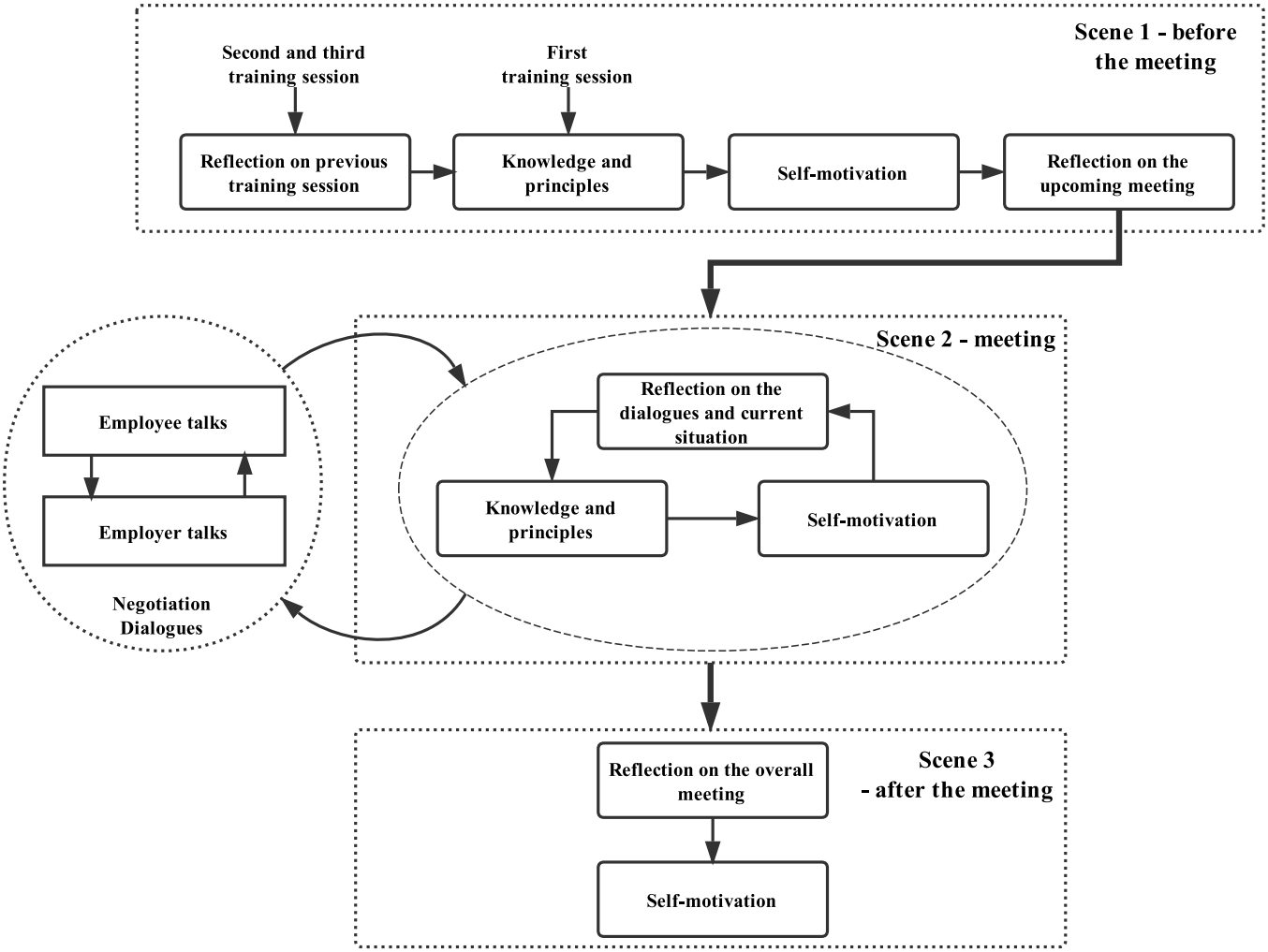

Fig. 2. The flow of virtual cognitions and dialogues in training sessions.

(M = 41.31, SD = 15.81) and in the non-informed group (M = 27.31, SD = 10.24) validating that the test could measure differences in the ability to apply the negotiation knowledge. Mean and standard deviation for each negotiation scenario was hence available to standardize test scores.

5.2.2. Secondary outcome measurements

Negotiation behaviour and performance

Negotiation satisfaction. To measure the participants' satisfaction with the negotiations they experienced pre-post-follow-up the training, a 4-item questionnaire was used, which measures the satisfaction covering four aspects (Curhan et al., 2006): the negotiation process, their own performance, the relationship with counterpart(s) of the negotiation, and the negotiation outcome. All the items were rated on a 11-point scale from -5 (extremely dissatisfied) to 5 (extremely satisfied).

Negotiation frequency. To examine the negotiation frequency pre-post-follow-up the training, a questionnaire was created that following a similar design as the quantitative physical activity recall questionnaire (Kohl et al., 1988). It asked how often people negotiated over a two-week period in different situations, such as buying or selling an item, negotiating a date for a meeting, negotiating the division of work, and so on.

Negotiation results. Participants were asked to self-report their negotiation results in their daily life. The questions were formulated as: "What percentage of negotiations end with a satisfying outcome for you?" and "What percentage of these negotiations were win-win negotiations (both parties benefited)?".

Perceived utility

To investigate how satisfying and useful people found the training, a 7-item utility questionnaire was used. It included three items on the satisfaction of the training process and four items on the effectiveness in improving negotiation performance. This questionnaire was adapted from the one used in a study by Kang (Kang, 2016). All the items were rated on a 7-point scale from 1 (strongly disagree) to 7 (strongly agree).

Co-variation measurements

Self-esteem. Self-esteem was measured using the Rosenberg self-esteem scale (Rosenberg, 2015), a ten-item scale assessing the degree of one's perceived self-esteem. All items were answered on a 4-point scale ranging from 0 (strongly disagree) to 3 (strongly agree).

5.3. Procedure

This study consisted of four phases: pre-training, training, post-training and follow-up phase. In the first phase, participants were informed of the nature of the experiment and signed the consent form. After which, recordings were made of each participant reading out all sentences of the three negotiation training sessions including the dialogues and virtual cognitions. The order of sentences was randomized to limit participants' understanding and memorization of actual training content. Next, to cater for reported variation between individuals outer and inner voice perception (Ding et al., 2018), participants were asked to listen to a part of their voice recordings and instructed to set sound parameters to make the recordings sound as they hear their own outer voice or as their inner voice. Participants were also

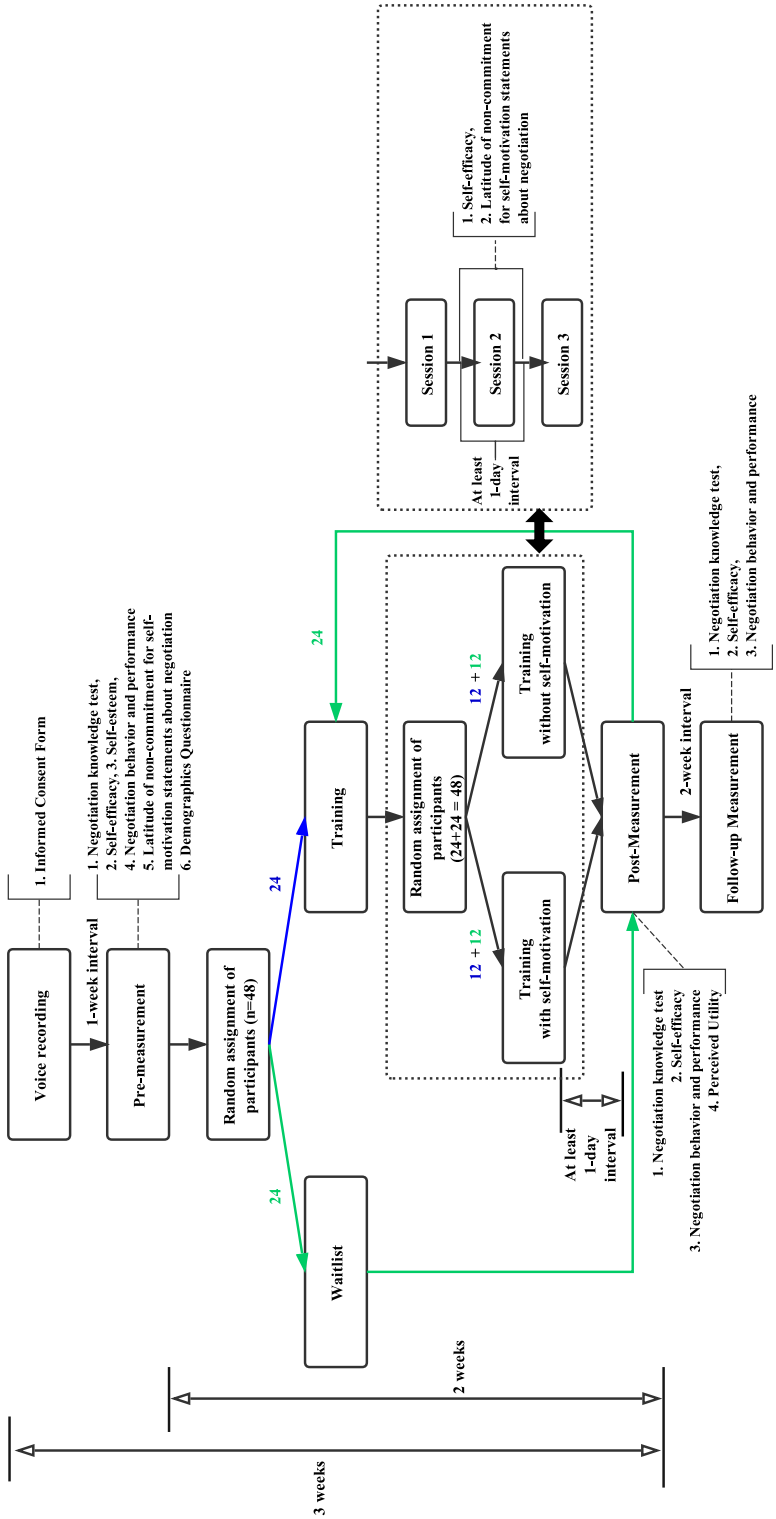

Fig. 3. Experiment procedure and measures obtained in the corresponding phases.

asked to record their names, which were later incorporated into the negotiation dialogues and self-motivational cognitions. After at least one week, participants were invited to complete an online questionnaire collecting demographic information and the pretest measures (self-efficacy question, negotiation performance and behaviour questions, self-esteem, and negotiation knowledge test).

Once the questionnaire was completed, the participants started the two-week training phase. In this phase, they were randomly assigned to one of three groups: waitlist group, direct training without self-motivational statements group, and direct training with self-motivational statements group. The participants who join the latter two groups were given the virtual reality negotiation training consisting of three consecutive sessions, administrated on a separate day. Each training session lasted around 30 minutes, which started with completing the negotiation attitude scale followed by three minutes of immersion into the virtual environment, allowing participants to familiarize themselves with the virtual world and their virtual body before the actual training started. Before each session participants were instructed to be open-

minded towards virtual cognitions as self-affirmation has been reported to lead to more attitude change (Epton et al., 2015). After each session, participants were asked to finish an online questionnaire to measure their self-efficacy and negotiation confidence. Meanwhile, the participants in waitlist group were initially not given any negotiation training. Two weeks after entering the second phase, all participants were asked to fill in all online questionnaires again and finish the negotiation knowledge test. In order to increase the sample size, the participants in the waitlist group were also given the opportunity to experience the training, they were afterwards randomly assigned to the two training groups and experience the training protocol as described earlier.

The fourth phase was conducted two weeks after the post-measurement. In this phase, participants were asked to complete again on the online questionnaires for self-efficacy, negotiation performance and behaviour and also the negotiation knowledge test.

5.4. Data preparation and analysis

5.4.1. Data preparation

Reliability analysis of the self-report questionnaire. We randomly assigned the 48 participants to the training condition ($n = 24$) or a waitlist condition ($n = 24$), training with self-motivation condition ($n = 24$) or training without self-motivation condition ($n = 24$). Table 4 and 5 show demographic information and pre-measurement data of the participants, as well as the randomization check. At baseline, the groups did not differ significantly on any demographic characteristics and pre-measurements (all P values $> .05$)

Reliability analysis of the coding of the negotiation knowledge test After a single coder blindly scored all answers from the negotiation knowledge test, a second coder also blindly scored a sample of the answers. Using the $n = 1/E^2$ rule (Gwet, 2014), a random sample of 28 was considered adequate to examine inter-rater reliability with an error margin of.95 as observed in the pilot study ($pa = 0.95$) (Ding et al., 2017). Comparing scores of two coders revealed an acceptable reliability level of (Krippendorff's $alpha = 0.94$).

Reliability analysis of the utility questionnaire Cronbach's alpha showed acceptable levels of reliability for the two subscales of the utility questionnaire, the satisfaction of the system ($\alpha = 0.68$) and usefulness of the system ($\alpha = 0.83$), respectively. Hence, the mean value of the items was used in subsequent analyses.

Covariation check As Wood et al. (2009) reported that people with high self-esteem will benefit more from self-motivational statements compared to people with low self-esteem, self-esteem was examined as a potential covariation. Likewise gender was also examined as a potential covariation. As no correlation with any of the dependent variables was found, analyses with covariates were not deemed justified.

5.4.2. Analysis

To examine the effects of our training system and the sustainability of the effects, t-tests were conducted on the primary outcome measures, Wilcoxon Signed-Rank test (for one sample) and Wilcoxon Mann–Whitney test (for two samples) were conducted on the secondary outcome measures. They included paired comparisons of pre-post and pre-followed-up measurements. Furthermore, they included between-group comparisons on the differences observed in pre-post and pre-follow-up measurements. We also calculated the effect size d and r, whereby a Cohen's d of 0.20 indicated a small effect, 0.50 a moderate effect, and 0.8 a large effect (Cohen, 1992). For effect size expressed with r, classification was: 0.10 for small effect size, 0.30 for a medium effect size, and 0.50 for a large effect size (Cohen, 1992).

Multi-level analyses examined the effects of the three training sessions on self-efficacy measured directly after each session. The analysis included four multi-level models. Model 1 was the basic model that only included participants as a random intercept. Model 2 added the fixed factor training sessions to model 1. Model 3 was built on Model 2 and added group as a fixed effect. Finally, Model 3 was extended by adding the interaction effect between group and training sessions (Model 4).

One-sample t-tests examined participants' attitude towards the training system, by comparing the scores on perceived utility scale with a value 4, the neutral position on the scale. Furthermore, a t-test examined the effect of two training conditions on the scores of this scale.

All analyses were carried out with R version 3.4.2. All the experiment data, the R scripts, and output files can be found online[1].

Table 4
Demographic characteristics and pre-measurements of waitlist vs training groups.

		Waitlist vs Training			
		Waitlist ($n = 24$)	Training ($n = 24$)	Statistic	P value
Age		26.6 (1.93)	27.0 (2.18)	$t_{46} = -0.56$	0.58
Gender	Female	7	10	$\chi^2_1 = 0.82$	0.37
	Male	17	14		
VR Experience	Yes	9	12	$\chi^2_2 = 0.82$	0.66
	No	13	10		
	Maybe	2	2		
Self-efficacy		2.21 (1.61)	1.83 (2.30)	$t_{46} = 0.65$	0.52
Negotiation knowledge		22.17 (12.29)	23.50 (11.62)	$t_{46} = 0.39$	0.70
Negotiation frequency		6.67 (11.84)	7.50 (8.23)	$Z = 1.25$	0.22
Negotiation satisfaction		2.14 (1.30)	1.75 (1.57)	$Z = -0.73$	0.47
Negotiation results		0.75 (0.23)	0.71 (0.25)	$Z = -0.66$	0.51

Table 5
Demographic characteristics and pre-measurements of training with vs without self-motivation groups.

		Training with self-motivation vs Training without self-motivation			
		with self-motivation ($n = 24$)	without self-motivation ($n = 24$)	Statistic	P value
Age		27.2 (1.56)	26.4 (2.39)	$t_{40} = 1.43$	0.16
Gender	Female	8	9	$\chi^2_1 = 0.09$	0.76
	Male	16	15		
VR Experience	Yes	12	9	$\chi^2_2 = 0.82$	0.66
	No	10	13		
	Maybe	2	2		
Self-efficacy		1.29 (2.03)	2.00 (1.69)	$t_{46} = 1.31$	0.20
Negotiation knowledge		22.88 (10.45)	22.04 (12.01)	$t_{46} = 0.26$	0.80
Negotiation frequency		6.62 (8.27)	5.04 (3.14)	$Z = 0.12$	0.91
Negotiation satisfaction		1.51 (1.60)	1.96 (1.24)	$Z = 1.09$	0.28
Negotiation results		0.64 (0.28)	0.76 (0.22)	$Z = 1.39$	0.17

6. Result

6.1. Pre, post, and follow-up

As shown in Table 6, no significant difference between pre and post measurements on all outcome measures was found for the waitlist group. However, for the training group, significant improvements between pre and post measurements were found for self-efficacy, negotiation knowledge, negotiation results, but not for negotiation satisfaction and negotiation frequency. These difference between waitlist and training group was also confirmed by significant differences found between these two groups and differences observed between pre and post training improvement for self-efficacy, negotiation knowledge, and

[1] These files are stored for public access on a national database for research data with the 4TU Center for Research Data in the Netherlands. The DOI to this storage is doi:10.4121/uuid:f41957e5-8532-40ee-9ddd-24186118813f.

Table 6
Primary and secondary outcome measures comparison between pre and post measurement for the waitlist and training condition, and comparison between pre and post differences between the groups.

	Waitlist			Training			Waitlist vs Training		
	t	*p*	*d*	*t*	*p*	*d*	*t*	*p*	*d*
Self-efficacy	−1.73	0.09	0.43	2.04	0.048	0.71	3.92	< 0.001	1.13
Negotiation knowledge	−0.22	0.82	0.07	3.87	< 0.001	0.95	4.16*	< 0.001	1.20
	z	*p*	*r*	*z*	*p*	*r*	*z*	*p*	*r*
Negotiation Frequency	−0.39	0.69	0.06	−0.61	0.54	0.09	1.12	0.27	0.16
Negotiation Satisfaction	−1.35	0.18	0.19	−1.74	0.08	0.25	2.18	0.03	0.31
Negotiation Results	−0.79	0.43	0.11	−2.34	0.02	0.34	2.02	0.04	0.29

Note, $df = 46$ for *t*-tests, with the exception of * for 39.

Table 7
Primary and secondary outcome measures comparison between pre and post measurement for the training without and with self-motivation condition, and comparison between pre and post differences between the groups.

	Training without self-motivation			Training with self-motivation			Training without self-motivation vs Training with self-motivation		
	t	*p*	*d*	*t*	*p*	*d*	*t*	*p*	*d*
Self-efficacy	0.83	0.41	0.43	3.40	< 0.01	1.26	4.10*	< 0.001	1.18
Negotiation knowledge	2.80	< 0.01	0.76	4.02	< 0.001	0.95	0.21	0.83	0.06
	z	*p*	*r*	*z*	*p*	*r*	*z*	*p*	*r*
Negotiation Frequency	−1.77	0.08	0.26	−1.18	0.24	0.17	1.65	0.10	0.24
Negotiation Satisfaction	−0.52	0.60	0.08	−2.79	< 0.01	0.40	−2.66	< 0.01	0.38
Negotiation Results	−0.13	0.90	0.02	−2.94	< 0.01	0.42	−2.67	< 0.01	0.39

Note, $df = 46$ for *t*-tests, with the exception of * for 39.

self-reported negotiation satisfaction and results. Differences were also found between the two training groups for the degree in pre and post improvement. Moreover, as Table 7 shows, compared to the training without self-motivation, the with self-motivation training showed more improvement in self-efficacy and self-reported negotiation satisfaction and results.

Table 8 shows how well improvement of the training maintained in the two weeks follow-up. Knowledge improvement was still observed for both training groups. However, self-efficacy showed no differences with pre-training levels in the without self-motivation group, whereas it did in the group with self-motivational cognitions. This group was also the only group to maintain improvements in self-reported negotiation satisfaction and results. These group differences were also confirmed by the significant differences found between the two groups on the pre and follow up improvement.

6.2. Training sessions

The multi-level analysis compared the models' ability to fit the self-efficacy data. As shown in Table 9, model 4 had the most appropriate fit ($p < 0.05$). The multilevel analyses indicated a significant main effect for sessions and an interaction effect between session and condition. It suggests that the self-motivation statements the participants heard during the training effectively improve participants' self-efficacy and the training sessions continually increase participants' self-efficacy. Whereas Fig. 4 shows how self-efficacy in general increases in the training, Fig. 5 shows the self-efficacy score especially increased for the training group that received self-motivational cognition.

Table 9
Multilevel analysis results of self-efficacy across the training sessions.

	Models		
	1 vs 2	2 vs 3	3 vs 4
df	3	1	3
χ^2	11.20	0.22	11.04
p-value	0.01	0.64	0.01
	add training sessions	add group	add the interaction

6.3. Perceived utility

When comparing scores on perceived utility with scale middle value, participants had attitude leaning towards positive side of scale for both the satisfaction-related utility ($t(47) = 8.83$, $p < 0.001$, $M = 5.22$, $SD = 0.95$) and the effectiveness-related utility ($t(47) = 9.03$,

Table 8
Primary and secondary outcome measures comparison between pre and follow-up measurement for the training without self-motivation and training with self-motivation condition, and comparison between pre and follow-up differences between the groups.

	Training without self-motivation			Training with self-motivation			Training without self-motivation vs Training with self-motivation		
	t	*p*	*d*	*t*	*p*	*d*	*t*	*p*	*d*
Self-efficacy	0.66	0.51	0.26	2.28*	0.03	0.75	2.18	0.03	0.64
Negotiation knowledge	2.69	0.01	1.01	2.22*	0.03	0.52	-0.71	0.48	0.21
	z	*p*	*r*	*z*	*p*	*r*	*z*	*p*	*r*
Negotiation frequency	−0.40	0.69	0.06	−1.27	0.20	0.18	1.47	0.14	0.21
Negotiation satisfaction	−0.67	0.51	0.10	−2.01	0.04	0.29	−2.07	0.04	0.30
Negotiation results	−0.34	0.74	0.05	−2.32	0.02	0.34	−2.04	0.04	0.29

Note, $df = 45$ for *t*-tests, with the exception of * for 46.

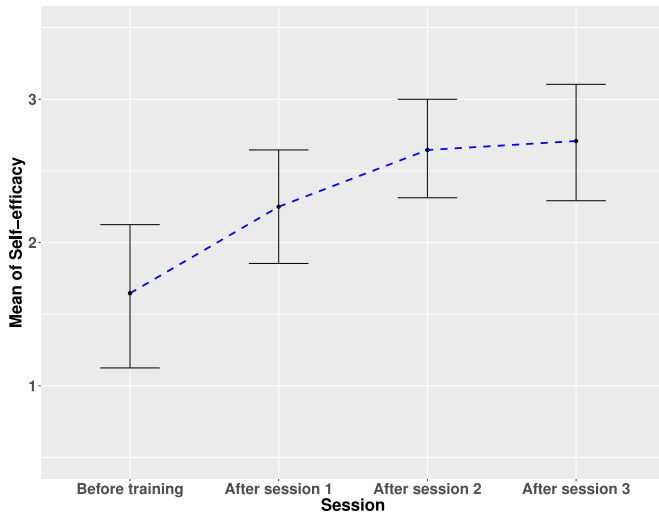

Fig. 4. Mean (error bar 95% CI) self-efficacy score obtained before the training and in the different sessions for the overall training group.

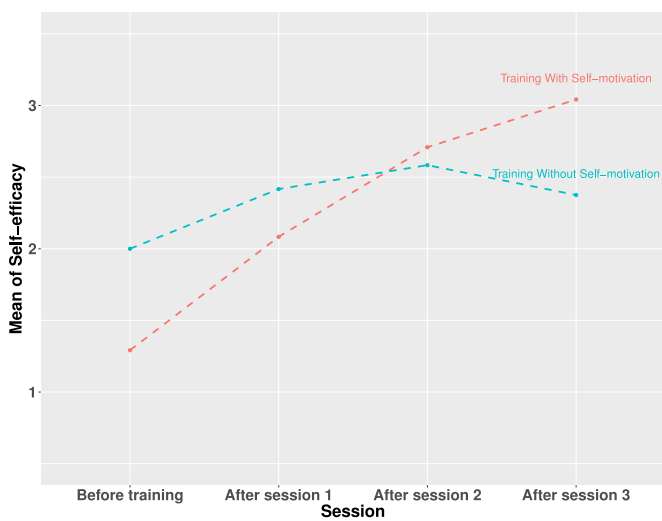

Fig. 5. Mean (error bar 95% CI) self-efficacy score obtained before the training and in the different sessions for training with self-motivation group and training without self-motivation group separately.

$p < 0.001$, $M = 5.33$, $SD = 1.02$). However, no differences were found between two training group for satisfaction-related utility ($t(46) = 1.16$, $p = 0.25$) and effectiveness-related utility ($t(46) = 0.42$, $p = 0.68$).

7. Discussion and conclusion

In this study, we investigated the efficacy of a virtual reality negotiation training system with virtual cognitions. The results show that the training had a large improvement effect on self-efficacy ($d = 1.13$) and negotiation knowledge ($d = 1.20$) compared to the waiting-list condition. This confirms the first hypothesis. What is more, the training condition with self-motivational statements resulted in a larger improvement effect on self-efficacy ($d = 1.18$) than the training condition that did not include these self-motivational statements, and so confirming the second hypothesis. All these improvements were sustained at the two-week follow-up. Secondary outcomes also showed improvements between training and waiting-list condition for negotiation satisfaction and perceived negotiation results obtained in people's daily life. These improvements were also higher for the group that received the self-motivational statements than the other training group. No difference, however, was found in the number of times people reported having negotiated before or after the training. Unlike the pilot study (Ding et al., 2017), where participants rated their satisfaction as neutral and usefulness of the system also as neutral, in this study, attitudes were significantly positive. A possible reason might have been the use of the native language. In the pilot study, non-native English speakers listened to their voice in English, while in the current study, Chinese speakers listened to their voice in Chinese.

The main scientific contribution of the work is the idea of using virtual cognitions as part of a social skills training to provide people with new social skills knowledge, reflections on social interaction, and motivational encouragement. Other existing social skills training systems rarely provide this kind of explanation, reflection, and real-time guidance. Besides the conventional visual experience, the presented training system also gives people thought experiences. Furthermore, this study investigated the effect of self-motivational statements, as a specific type of virtual cognitions, on people's behaviour and self-efficacy. The findings seem to justify it as a new strategy for training in virtual reality. Moreover, in this study, attention was paid to increasing individual's self-efficacy, a factor that is often neglected by training systems. The findings of this study provide a first insight into the efficacy and acceptance of a training system that offers real-time guidance and targets people's self-efficacy. Table 10 shows the effect sizes of pre-post measurement found in experiments with negotiation training systems. Following Cohen (2013)'s classification, the first two studies found large effect sizes and the third study found a medium effect size. Top of the effect size list is the current study, which can also be classified as large. It hints the potential effectiveness of the proposed system, and therefore warrant more research in this area.

Like any empirical study, this study has some limitations that should be considered to appreciate the findings. First, the training system was studied following a system approach principle (Von Bertalanffy, 1968). This meant that the system was viewed as a unified whole. The objective was not to identify the effect of specific functions on the overall effect created by the system. For example, in the training system, users' self-efficacy levels were taken into account to select appropriate self-motivational statements for each individual. While the results suggest that the system was effective, it is not clear how much this personalisation contributed to this result. Secondly, although the sample size in this study was larger than in the pilot study, the participants were again university students or employees. It is, therefore, not clear to which extent findings generalize to other populations. Thirdly, the self-efficacy measures in this study was simple and general by using a one-item measure, however, it was also suggested that self-efficacy measures ought to reflect a particular context or domain instead of global

Table 10
Effect size of pre-post measurement of negotiation training systems.

Study	Measures	Effect size (η^2)	Cohen's classification
Broekens, et al. (2012)	Negotiation knowledge	0.18	Large
	Conversation skill	0.16	Large
Lin et al. (2009)	Utility score of negotiators	0.14	Large
Ross Jr, et al. (2001)	Score of participants	0.13	Medium
This paper	Self-efficacy	0.24	Large
	Negotiation knowledge	0.26	Large

functioning (Bandura et al., 1999), i.e., in our case, several sub-items could be created targeted to different contexts or perspectives of negotiation.

The work can be extended in several ways. For example, what learning improvement can be obtained when the system is combined with an active component? Would an initial self-efficacy boost, have learners benefiting more from a follow-up unguided negotiation experience with an interactive virtual agent (Gratch et al., 2016)? Also, how sustainable are these improvements? The current study only looked at a follow-up period of two-weeks. Could training with virtual cognitions also result in more permanent changes is still an open question. Work can also focus on extending the system. Here, for instance, the pre-recording process of all statements comes to the fore. Before the start of the formal training in the current system, users have to spend time recording all the negotiation dialogues and virtual cognitions that they will hear during training. To some extent, this effort limits the utility of the training system. However, this limitation could be overcome soon with the introduction of machine learning solutions to imitating any human voice. For example, Mehri et al. (2016) propose an unconditional neural audio generation model that uses neural networks to generate audio from training samples. This idea was used by the software app Lyrebird, which claims the ability to mimic any voice from just one minute of sample audio (Colonel et al., 2017). Besides creating an audio illusion of ones' own voice, work can also focus on creating the illusion of ones' own virtual body. For example, Hülsmann et al. (2016) report on a platform with a 3D scanner that they developed to create realistic life-size 3D models or virtual bodies that can mimic or substitute users' real bodies in a virtual environment. In addition to the visual stimulation, Banakou and Slater (2014) have also worked on vibrotactile stimulation of the body. They administered this stimulation on the thyroid cartilage when participants heard a pre-recorded voice to create the illusion of speaking by the participant. It remains, however, to be seen if virtual cognitions could also be regarded as illusions of one's own thought while experiencing them or when remembering them later on. Also, what level of presence and agency would people experience when multiple of these illusion technologies are combined? Even more, how could this experience become more engaging? Currently, the users only passively experience the negotiation. A more active role in the negotiation could increase the sense of presence during the training, causing an increase in learning efficacy (Mantovani and Castelnuovo, 2003). One strategy would be to integrate eye-tracking technology into the training system. The content of the virtual cognitions could then be tailored to the objects people focus their attention on in a virtual environment.

Finally, the use of virtual cognitions could also be beneficial for other domains such as for therapeutic systems or in gaming for storyline delivery or character development. Could it, for example, enhance the STRIVE system (Rizzo et al., 2011)? This system uses virtual reality episodes narrated in first-person to provide soldiers with a feeling of experiencing a stressful event. It already uses a voice-over to deliver psycho-educational knowledge. Extending this with the thought process of the soldiers might potentially also improve their self-efficacy to cope with stressful events.

In conclusion, this study demonstrates the efficacy of a negotiation training system that provides guided learning with the combination of passively virtual reality experience and virtual cognitions. Moreover, these effects were maintained at the follow-up two-week measurement, indicating that the changes in individual's beliefs and gained knowledge are not short-lived.

Declaration of Competing Interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

Acknowledgements

This work was supported by the China Scholarship Council (CSC) [grant number: 201506090167].

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