TAPAS
Training Adapted Personalised Affective Social Skills with Cultural Virtual Agents

ANR AGENCE NATIONALE DE LA RECHERCHE

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CREST

Relationship between Mood Improvement and Questioning to Evaluate Automatic Thoughts in Cognitive Restructuring with a Virtual Agent

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Cognitive Restructuring [Beck et al., 2011]

- A mental health care method to find helpful thoughts instead of unhelpful thoughts
- Well-established as a treatment for mental illness including depression

Composition of Cognitive Restructuring

Item	Description
Situation	No reply from my friend yet.
Mood (Mood score: 0 to 100%)	Anxiety (80%)
Identifing an automatic thought	He hates me.
Evaluating the automatic thought	(e.g.) I haven't received a reply for two days since I sent messages.
	(e.g.) He is getting busy these days.
Considering a balanced thought	He have overlooked my message or he is too busy to handle it.
Mood score after change (0 to 100%)	Anxiety (80% → 30%)

Mood Change

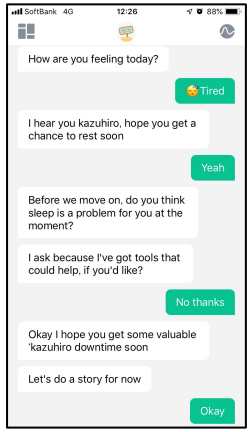
Automatic thought: distorted and unhelpful thought that automatically crossing the mind

• Judith, S, B., & Aaron, T, B. ``Cognitive behavior therapy: Basics and beyond.” Guilford Publication, 2011.

Related work

- Virtual agents have been anticipated to promote Cognitive Restructuring
- However, existing systems can't adaptively select questions for individual thought tendencies

- [Kathleen et al., 2017]
  - Text-based dialogue
  - Enter choices and text



- [Kimani et al., 2019]
  - Face-to-face dialogue
  - Enter choices

- [Shidara et al., 2020]
  - Face-to-face dialogue
  - Neural language input

- Fitzpatrick, K. K., Alison, D., & Molly, V. ``Delivering cognitive behavior therapy to young adults with symptoms of depression and anxiety using a fully automated conversational agent (Woebot): a randomized controlled trial." JMIR mental health 4.2, 2017: e19.
- Kimani, E., Bickmore, T., Trinh, H., & Pedrelli, P. ``You'll be Great: Virtual Agent-based Cognitive Restructuring to Reduce Public Speaking Anxiety." In IEEE ACII, 2019, (pp. 641-647).
- Shidara, K., Tanaka, H., Adachi, H., Kanayama, D., Sakagami, Y., Kudo, T., & Nakamura, S. ``Analysis of Mood Changes and Facial Expressions during Cognitive Behavior Therapy through a Virtual Agent." In ICMI, 2020, (pp. 477-481).

Objective

- Objective: Implement a system that enables dialogue with a higher mood score
- Research question: Which items of the dialogue help to improve mood?

Composition of Cognitive Restructuring

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Mood Change

Hypothesis: this part directly affect mood changes.

Approach

- Compare two scenarios in a user survey

Which scenario make Mood Change larger?

Group A scenario

Item	Description
Situation	No reply from my friend yet.
Mood (Mood score: 0 to 100%)	Anxiety (80%)
Identifing an automatic thought	He hates me.
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Mood score after change (0 to 100%)	Anxiety (80% → 30%)

Group B scenario

Item	Description
Situation	No reply from my friend yet.
Mood (Mood score: 0 to 100%)	Anxiety (80%)
Identifing an automatic thought	He hates me.
Considering a balanced thought	He have overlooked my message or he is too busy to handle it.
Mood score after change (0 to 100%)	Anxiety (80% → 30%)

Question to evaluate an automatic thought

- Use existing 7 questions referenced from [Beck et al., 2011]

1	If your automatic thought is true, what evidence do you have to support this?
2	If your automatic thought is not true, what evidence do you have to support this?
3	Besides your automatic thoughts, is there an alternative explanation?
4	What's the effect of your believing automatic thought?
5	So, what's the most realistic outcome?
6	If your friend was in the situation and had this thought, what would you tell him or her?
7	What action would you do about your automatic thoughts?

Virtual agent design

- Virtual agent platform: Greta [Niewiadomski et al., 2009]
  - Speech natural language interface
  - Turn-taking is based on the system's speech recognition
  - Virtual agent's parameters of facial actions, speech, and poses were default settings

Greta

Interaction

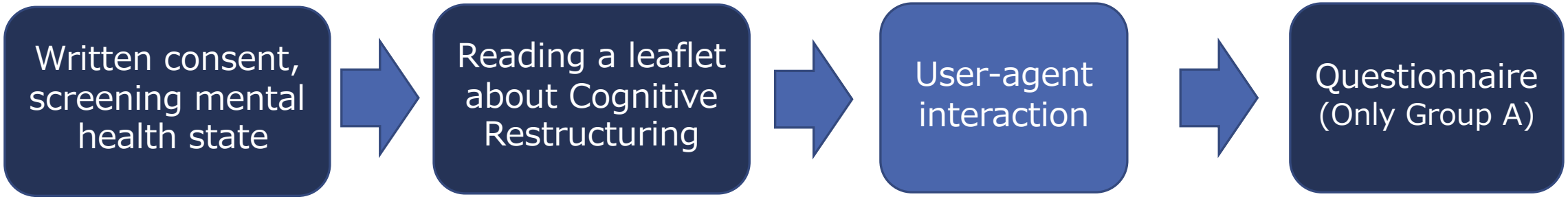
Niewiadomski Radoslaw, et al. "Greta: an interactive expressive ECA system." Proceedings of The 8th International Conference on Autonomous Agents and Multiagent Systems-Volume 2. 2009.

Experiment

■ Participants (20 in total)

- 10 people each in Group A and Group B
- All participants are graduated college students at NAIST
- Screening mental health state: K6 [Kessler, 2002]
  (Scores range from 0 to 24, with 13 or more likely to be mentally illness)
  - Mean K6 score of Group A was 3.90, and Group B was 4.30

■ Experiment procedure



Analysis –Mood Change between two groups

■ Compare mean Mood Change between Group A and Group B

$$Mood\,change = \frac{(Mood\,score\,at\,beginning) - (Mood\,score\,at\,end)}{(Mood\,score\,at\,beginning)}$$

Group A scenario

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Mood score after change (0 to 100%)	Anxiety (80% → 30%)

Group B scenario

Item	Description
Situation	No reply from my friend yet.
Mood (Mood score: 0 to 100%)	Anxiety (80%)
Identifing an automatic thought	He hates me.
Considering a balanced thought	He have overlooked my message or he is too busy to handle it.
Mood score after change (0 to 100%)	Anxiety (80% → 30%)

Analysis –Amount of helpful question and Mood Change

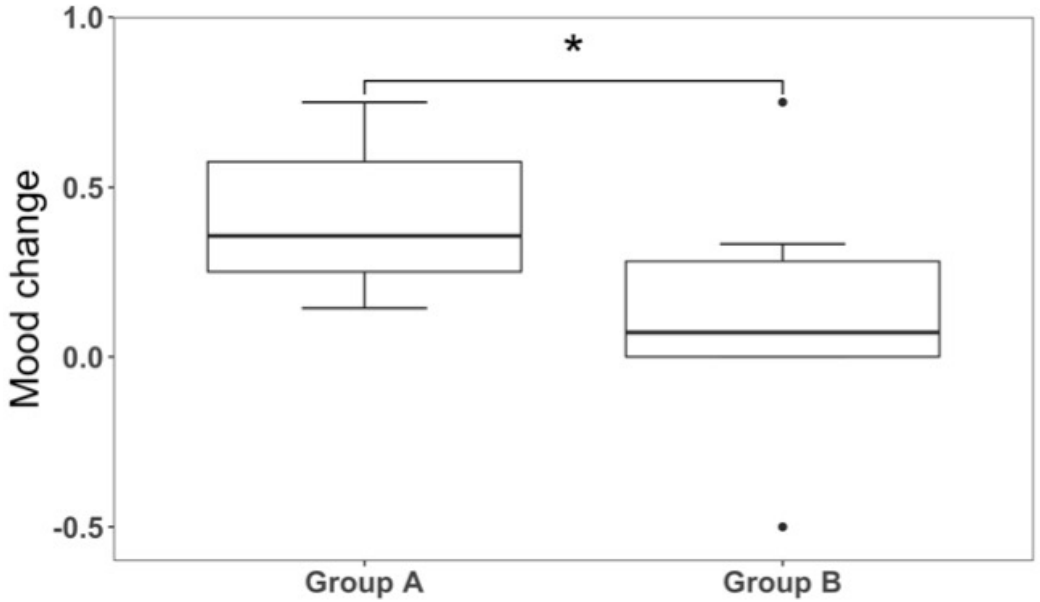
- Only Group A was targeted
- After the interaction
  - Participants of Group A answered each question was helpful or not
- Correlation analysis
  - Spearman's rank correlation test

Questionnaire (sample)

Question	Helpfulness
What is the strongest thought that comes to your mind? (Question to identify an Automatic thought)	
If your automatic thought is true, what evidence do you have to support this?	○
If your automatic thought is not true, what evidence do you have to support this?	
Besides your automatic thoughts, is there an alternative explanation?	
What's the effect of your believing automatic thought?	○
So, what's the most realistic outcome?	
If your friend was in the situation and had this thought, what would you tell him or her?	
What action would you do about your automatic thoughts?	○
If you think of a new thought, try to connect them to your automatic thought with "but...". (Question to consider a balanced thought)	○

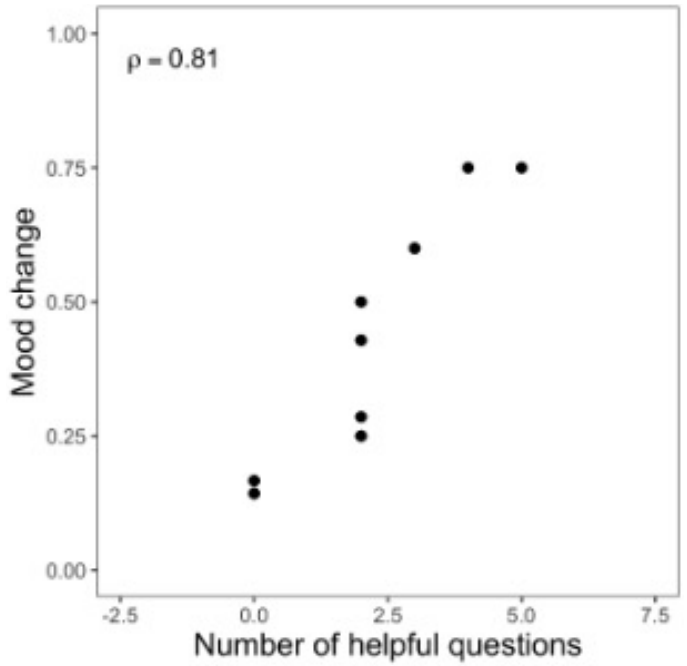
Results

- Mood change comparison
  => Group A was significantly changed than Group B



Boxplot of Mood Change of Group A and B
(Mean of Group A = 0.41, Mean of Group B = 0.13, p=0.037)

- Correlation analysis
  => Significantly correlated



Scatterplot of the questions and Mood Score
(N=10, ρ=0.81, p=0.005)

Discussion

- Asking questions significantly improves mood compared to not
- Number of helpful questions significantly correlated with Mood Change
  => Evaluation of an automatic thought directly affect Mood Change
  => The more amount of helpful questions, the greater improvement achieved
- Future work
  - Behavior analysis of recorded videos
  - Implementation of the personalized question selection system

Thank you for your attention!

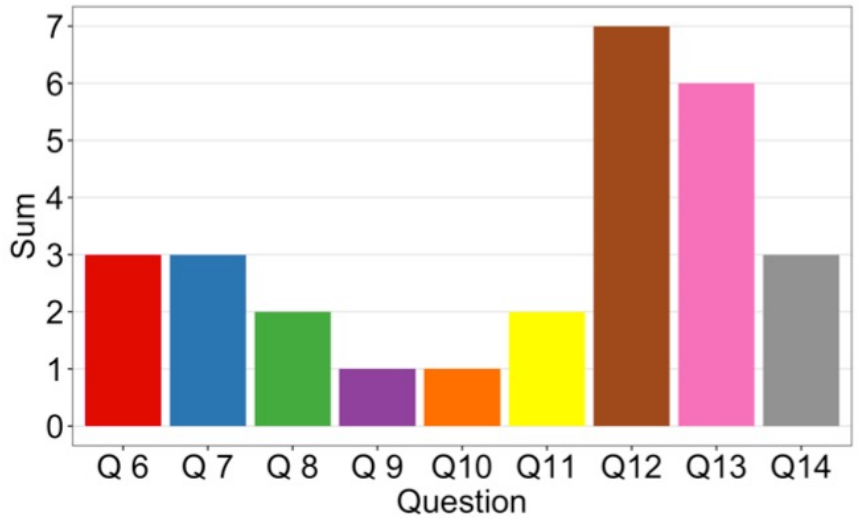
Appendix

Cognitive Restructuring with a virtual agent

- Virtual agent
  - Automatic dialogue is possible
  - Dialogue interfaces embodied with CG or animation
- Advantage in mental health care
  - Can be used anytime, anywhere
  - Reduce mental barrier to mental health care
  - Response selection using facial expression and voice characteristics of a participant is possible

Results –Evaluation of each question

- Most selected questions: Q12, Q13



Distribution of helpful questions (n=10, multiple answers possible).

Questionnaire (sample)

	Question	Helpfulness
Q6	What is the strongest thought that comes to your mind? (Question to identify an Automatic thought)	
Q7	If your automatic thought is true, what evidence do you have to support this?	○
Q8	If your automatic thought is not true, what evidence do you have to support this?	
Q9	Besides your automatic thoughts, is there an alternative explanation?	
Q10	What's the effect of your believing automatic thought?	○
Q11	So, what's the most realistic outcome?	
Q12	If your friend was in the situation and had this thought, what would you tell him or her?	
Q13	What action would you do about your automatic thoughts?	○
Q14	If you think of a new thought, try to connect them to your automatic thought with "but...". (Question to consider a balanced thought)	○