On Proposing the Concept of Robot Anxiety and Considering Measurement of It

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Abstract

This paper proposes a conceptual definition of anxiety which prevents humans from interaction with communication robots in daily life, named with "robot anxiety", by taking into account computer anxiety and communication apprehension. Then, it discusses construction of a psychological scale for measurement of robot anxiety and reports the current situation of our research on it.

1 Introduction

When a novel technology or media is developed, humans tend to feel anxiety for it. One of the representatives is computer anxiety [1, 2]. From educational perspectives for computer literacy, computer anxiety in individuals should and can be reduced by educationally appropriate programs, and several psychological scales for measurement of it have been developed.

On the other hand, robots having functions for communication with humans, such as pet and humanoid robots, are also a novel type of technological products consisting of robotics and artificial intelligence. On the analogy of computer anxiety, it can be imagined that humans feel anxiety or apprehension for these robots. Moreover, this type of anxiety may consist of not only anxiety for the novel technology, but also anxiety for communication with robots itself. If these communication robots are applied to areas of daily life, in particular, psychiatric and educational fields [3, 4, 5, 6], important is to clarify which situation and personal trait interfere with interaction between individuals and these robots. From viewpoints of mental therapy and education, not only anxiety in clients and children interacting with communication robots for aiming to therapy and learning, but also anxiety in human mediators helping them to communicate with these robots should be considered since emotions of these mediators may influence the clients and children, and as a result, effects of these robots in the fields.

However, it has still not sufficiently investigated which situation and personal trait interfere with interaction between humans and communication robots, and no psychological scale has not been proposed for measurement of them. Although there are some research results on measurement of persons' subjective evaluation for pet robots [7] and a psychological scale for measurement of persons' images for robots [8, 9], there has still not been scale for measurement of concrete emotions, and their related social situations and personal traits that prevent individuals from interaction with robots.

In this paper, we focus on emotions of anxiety and propose a conceptual definition of "robot anxiety" which prevents humans from interaction with communication robots. Then, we discuss a psychological scale for measurement of it and report the present situation of our research on construction of it.

2 A Definition of Robot Anxiety

In this paper, we firstly introduce the concepts of computer anxiety and communication apprehension, and then define the concept of robot anxiety by considering relations with these concepts.

2.1 Computer Anxiety

Computer anxiety is considered as anxiety or apprehension evoked in individuals when they use computers, do things leading them to computers, or think on the meaning of using computers. It is dealt with as one of important problems in education of computer literacy.

Emotions of anxiety is generally classified into two categories: state and trait anxiety [10]. Trait anxiety is a trend of anxiety as a characteristic stable

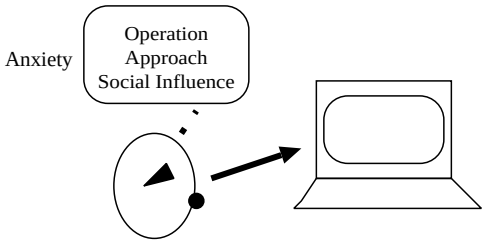

Figure 1: Computer Anxiety

in individuals. State anxiety is an anxiety transiently evoked in specific situations and is changed dependent on situations and time. Computer anxiety is an anxiety evoked in situations related with computers and is necessarily not dependent on individuals' personal traits. Thus it is classified into state anxiety, and is considered to be vanished or reduced by educationally appropriate programs.

There has been some psychological scales for measurement of computer anxiety. One of these scales in Japanese is Aikyodai's Computer Anxiety Scale (ACAS)[2]. Computer anxiety in ACAS is defined as "emotions of anxiety preventing persons from touching, using, and learning computers in daily life and pedagogical situations". ACAS consists of 21 questionnaires and each questionnaire item has a score with five grades (from 1 to 5). The total of all the item scores (including inversion of some specific item scores) means the degree of computer anxiety in an individual. Moreover, ACAS consists of three subordinate scales: anxiety for operation of computers, anxiety for approach to computers, and anxiety for social influence of computers. Each subordinate scale is measured by the corresponding seven items in the items of ACAS.

2.2 Communication Apprehension

Communication apprehension is one of concepts in communication avoidance research investigating difference between individuals on fear and avoidance for social communication, or preference of attendance to and acceptance of social communication [1]. It is defined as a level of fear or anxiety in individuals for real communication with the other or others and prediction of it, such as speech, writing, singing, and so on. Communication apprehension is generally classified into the following four types:

[1]The introduction of communication apprehension in this section is based on [11].

Traitlike: a stable personality type for a communication method across various contexts,

Context–Based: a stable personality type for communication in a specific context,

Audience–Based: a stable trend of reaction for communication with a specific person or people,

Situational: a transient trend of reaction for communication with a specific person or people.

Tratlike and context–based communication apprehension are defined as a kind of personal traits, more stable and independent on situations. Audience–based and situational communication apprehension are defined as transient reactions for situational constraints.

One of important properties of communication apprehension is that it is an anxiety for communication itself. In general, social anxiety is caused by facing to negative evaluation from the others and predicting it in real or imaginary social situations. In other words, it is mediated by cognition of evaluation from the others. Figure 2 shows the difference between social anxiety and communication apprehension. Although communication apprehension is influenced by the others and situations, it is not mediated by cognition of evaluation from the others, but by conditional anxiety caused through repetition of communication and negative stimuli, negative thinking, and skills deficit.

There are some questionnaires for measurement of communication apprehension, and Personal Report of Communication Apprehension Scale (PRCA–24) [12] has frequently been used. PRCA–24 consists of twenty four questionnaire items related to emotions felt in communication and these items are divided into four contexts: public speaking, meetings, small group discussion, and dyads, corresponding to six questionnaire items. Each item has a score with five grades (from 1 to 5) and the total of all the item scores (including inversion of some specific item scores) means the degree of communication apprehension in an individual. If the scores are higher in total, it means that his/her communication apprehension is traitlike. If the scores are higher only at specific items, it means that his/her communication apprehension is situational.

2.3 Robot Anxiety

By taking into account the previous sections, we consider the definition of robot anxiety.

Communication robots consist of various hardwares such as motors and sensors, and control mechanisms mediated by computers. Thus, they have possibility to make individuals feel anxiety similar to computer anxiety. In particular, if it is predicted that these

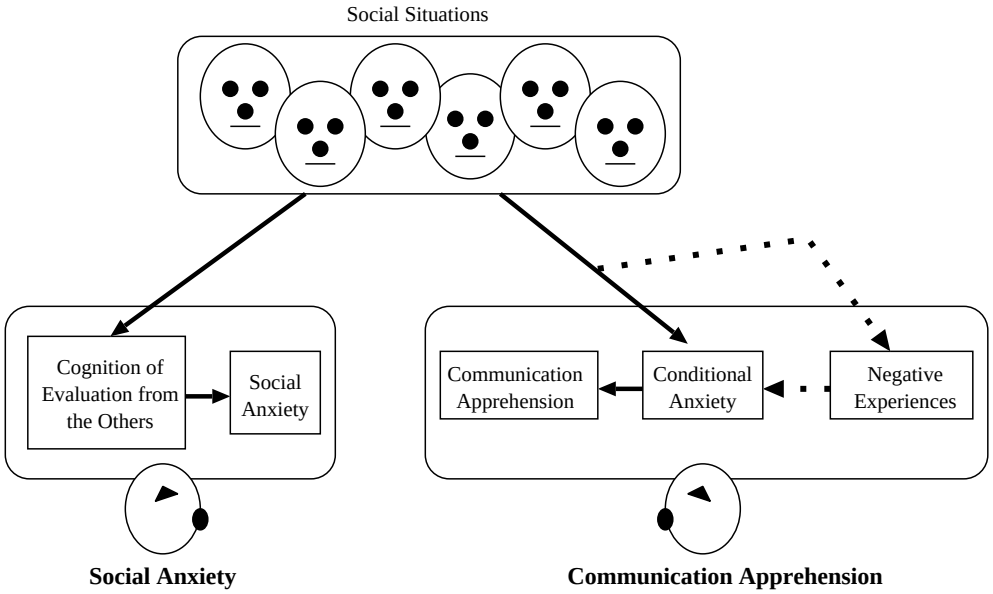

Figure 2: Difference between Social Anxiety and Communication Apprehension

robots are introduced to wider contexts of everyday life, anxiety for social influence of these robots, similar to anxiety for social influence of computer as a subordinate category of ACAS mentioned in section 2.1, should be considered.

Moreover, it should be considered that anxiety for communication robots may include communication apprehension. In fact, quality of communication between a person and robot has still been different from that between humans. However, The research by Reeves and Nass [13] shows that there is no difference between mental influence to humans in interaction with computers and that with humans. Important in their research is that subjects in their experiments recognized that they interacted with computers, not humans. This fact shows that humans are affected by communication itself, regardless of interaction with humans, computers, or robots. In addition, communication apprehension is caused by communication itself as mentioned in section 2.2. Thus, even communication robots have possibility to cause communication apprehension in interaction with users.

Figure 3 shows a conceptual mechanism of robot anxiety. Based on the above consideration, we define robot anxiety as " **emotions of anxiety or fear preventing individuals from interaction with robots having functions of communication in daily life, in particular, dyad communication with a robot** ". This definition means that robot anxiety is a concept composite of computer anxiety and communication apprehension. It includes not only state anxiety in computer anxiety but also trait anxiety in communication apprehension.

3 Robot Anxiety Scale

Robot anxiety should carefully be considered in cases that communication robots are introduced to psychiatric and educational fields. Therefore, a psychological scale for measurement of it is needed. If this scale is developed, it also can be used for comparison between countries on people's mental resistance for robot applications. [2]

We are constructing questionnaires in Japanese for psychological measurement of robot anxiety defined in section 2.3, Robot Anxiety Scale (RAS). In this section, we introduce the present situation of our research process on constructing RAS.

3.1 A Pilot Survey

In order to collect candidates of items in RAS, we executed a pilot survey based on questionnaires with free writing form. In this survey, 39 Japanese respondents answered for the following questionnaires: "Please answer freely how you feel when you imagine

[2] For example, there is a report claiming a religious influence of Confucianism as a source of the original culture of robots in Japan [14].

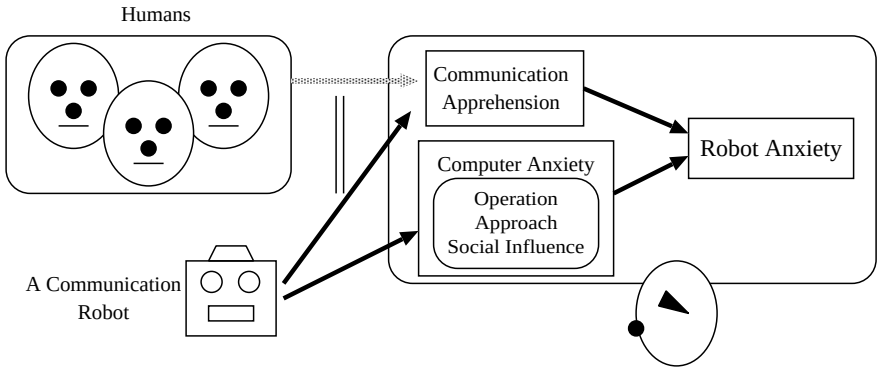

Figure 3: A Conceptual Mechanism of Robot Anxiety

a scene that you interact with a robot having emotions", and "Please answer freely how you feel if robots are introduced to educational and psychiatric fields". Then, we extracted sentences related to emotions, objects and situations that the emotions are evoked.

Some types of sentences were extracted for the first questionnaire. The following items show these types and and examples of these sentences:

Expectation and Interest:

"I want to talk with those robots largely.",
"I will unconditionally feel much pretty for those robots. But I may feel a little pity for them if they have emotions.",
"Although I feel grad for them, I may contrarily feel depressing by thinking that I may interact with those robots since I cannot normally communicate with humans."

Anxiety, Fear, and Apprehension:

"If those robots have the same emotions as humans, I may feel both surprising and terrible.",
"I fear that those robots cannot understand things I talk.",
"I may not say something to say, caring for those robots.".

Others:

"It is hard for me to interact with those robots in the same way as humans if their surfaces are mechanical, even though they have emotions.",
"I will want to investigate inner structures in those robots.".

One of characteristics in the answers was that many respondents reported both positive and negative opinions for affective robots.

Moreover, some types of sentences were extracted for the second questionnaire. The following items show these types and and examples of these sentences:

Expectation:

"I think that there is no problem if safety of those robots is confirmed.",
"If pet robots such as AIBO are introduced, I think that it is good in psychiatry, for example, for reduction of clients' loneliness."
"I think that these robots are very effective. I also think so in welfare such as facilities for the elderly."

Anxiety, Fear, and Apprehension:

"I think that it is impossible for machines to work well in these fields.",
"Naive introduction of those robots should not be done but should be done after sufficient investigation.",
"Dependent on methods of the usage, I fare that those robots have evil influence on development of children, and so on.".

Others:

"I think that ethics of users is critically evaluated.",
"I think that those robots should be considered as assistant for humans.".

One of characteristics in the answers was that several respondents allowed introduction of robots to these fields with some conditions.

3.2 Item Selection in Construction of RAS

By taking into account the above result in the pilot survey, we considered candidates of items in RAS. In

Table 1: All the Questionnaire Items in the First Version of Robot Anxiety Scale (*: inversive items)

1	I feel anxiety if robots really have their own emotions.
2	I fear interacting with robots actively.
3	Robots are useful machines complementing humans' defects.*
4	I surmise that something negative for humans happen when robots become more similar to humans.
5	I will be able to be relaxed if I interact with robots.*
6	I feel anxiety when I imagine that I may be employed and assigned to a workplace where robots should be used.
7	I will be familiar with robots if they have their own emotions.*
8	I am mentally healed when I see robots behaving affectively. *
9	I am left helpless even by hearing something on robots.
10	I am likely to bring shame on myself when I use robots in public.
11	The words "artificial intelligence" or "decision by robots" make me feel unpleasant.
12	Even standing in front of robots will strain me.
13	Communication between humans and robots will stimulate and activate that between humans themselves as a result.*
14	I surmise that extreme dependence on robots may cause something negative for humans in future.
15	Robots are likely to be more honest and reliable than humans.*
16	I will feel nervous if I interact with robots.
17	I am afraid that robots may negatively influence children's mind.
18	I surmise that future societies may be dominated by robots.

this paper, we present only the overview of our construction process.

In RAS, it is supposed that the number of grades at each item is five (1: I strongly disagree, 2: I disagree, 3: It is not decidable, 4: I agree, 5: I strongly agree), the total of all the scores means the degree of robot anxiety in a respondent in the same as ACAS and PRCA–24, and respondents are more than high school students.

First, thirteen items were extracted from the sentences obtained in the pilot survey. Second, several items were selected among the items of ACAS and PRCA–24 in order to complement the item pool. Sixteen items were extracted from ACAS, any word "computers" in these items was substituted for the word "robots", and then the sentences were sophisticated. Four items were extracted from PRCA–24, in particular, the items related to dyad situations, and then, any words "a new acquaintance" and any word "conversation" were substituted to the word "a robot" and the words "conversation with a robot" respectively. In addition, since the sentences of the original items in PRCA–24 ask respondents' experiences related to communication, the form of the constructed items were modified so that they ask respondents to imagine scenes of communication with robots. Then, the content validity was investigated by the authors and two researchers on psychology. As a result, two items in the candidates were removed, one item was added, and then several sentences were more sophisticated. Finally, the primitive version of RAS consisted of thirty two items.

Then, the pretest was executed based on this primitive version of RAS and 263 data samples were assembled. Factor analysis was executed for these pretest data, and as a result, 5 factors consisting of 20 items were extracted. In order to verify the internal consistency, item analysis consisting of good–poor analysis, correlation coefficients, and α coefficients was executed for the pretest data limited to the above 20 items, and as a result, 2 items were removed. Table 3.1 shows all the questionnaire items of RAS after item selection. Note that the English sentences in table 3.1 were just ones naively translated from the original Japanese sentences, not translated according to formal procedures including back translation. This final version of RAS consists of 18 items. Moreover, it includes 5 subordinate scales; anxiety for social influence of robots, anxiety for interaction with robots, anxiety for control in interaction with robots, anxiety for emotions in interaction with robots, and anxiety for reliability of robots.

This version of RAS has still not been investigated about its reliability or validity. We have been executing several tests for investigating test–retest reliability, concurrent validity based on correlation analysis between RAS and an existing general anxiety scale (for example, state–trait anxiety inventory [10, 15]), predictive validity based on multiple regression analysis between RAS and some indicators on respondents' actions for a communication robot (for example, frequencies of their approach to and distance from the robot).

4 Conclusion

In this paper, we proposed the concept of robot anxiety by taking account of computer anxiety and communication apprehension. Then, we reported the present situation of our research on construction of Robot Anxiety Scale (RAS) for measurement of it.

In addition to investigation of reliability and validity of RAS, as future works, we are going to apply RAS to communication robots in psychiatric and educational fields, for example, influence of robot anxiety in clients of robotic therapy to therapeutic effects. Moreover, we are going to investigate cultural influence to robot anxiety based on comparison between US, European, and Asian counties by using RAS.

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