Journal of Social Sciences of Mus Alparslan University

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Araştırma Makalesi ● Research Article

Adaptation of the Robot Anxiety Scale into Turkish

Robot Kaygısı Ölçeğini Türkçeye Uyarlama Çalışması

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ARTICLE INFO

Article history:
Received 28 September 2018
Received in revised form 26 January 2019
Accepted 07 February 2019

Keywords:
Robot
Anxiety
Human-Robot Interaction
Technology
Work

ABSTRACT

The involvement of robots in people's lives causes concerns about how human-robot interaction can be achieved. In this study, it is aimed to obtain the Turkish version of Robot Anxiety Scale. The data obtained from university students were analyzed by explanatory factor analysis and confirmatory factor analysis. 11 items in the scale were divided into three factors. According to the confirmatory factor analysis, the fit index values of the model were acceptable. This study shows that the Turkish version of the scale has discriminant validity, and the scale is a reliable and valid measurement tool that may help to understand how effective the design and properties of robots to be used in Turkish culture.

MAKALE BİLGİSİ

Makale Geçmişi:
Başvuru tarihi: 28 Eylül 2018
Düzeltme tarihi: 26 Ocak 2019
Kabul tarihi: 07 Şubat 2019

Anahtar Kelimeler:
Robot
Kaygı
İnsan-Robot Etkileşimi
Teknoloji
Çalışma

ÖZ

Robotların insanların hayatında yer alması insan-robot etkileşiminin nasıl sağlanacağına dair endişelere sebep olmaktadır. Bu çalışmada ise Robot Kaygısı Ölçeğinin Türkçe versiyonunun elde edilmesi amaçlanmıştır. Üniversite öğrencilerinden elde edilen veriler açıklayıcı faktör analizi ve doğrulayıcı faktör analizi ile incelenmiştir. Ölçekte bulunan 11 madde üç faktöre bölünmüştür. Doğrulayıcı faktör analizi sonucuna göre modelin uyum indeksi değerleri kabul edilebilir seviyededir. Bu çalışma, elde edilen ölçeğin Türkçe versiyonunun ayırıcı geçerliliğe sahip olan güvenilir ve geçerli bir ölçüm aracı olmasından ve Türk kültüründe kullanılması planlanan robotların dizaynlarının ve özelliklerinin ne derece etkin olabileceğini anlamaya yardım edeceğinden dolayı önemlidir.

1. Introduction

One of the agenda items that draws attention to technology in the world today is robots. According to the World Robotics Federation (IFR) (2017), industrial robots will experience at least a 15% increase in output each year over the previous year. Each year, new features and deeper perception of the world are added to the robots (de Souza & Kak, 2002: 237); also, they are designed to interact more effectively with people (see, Deits, et al., 2013). In addition, they operate in many areas ranging from entertainment to the most dangerous tasks (Young, et al., 2009: 95).

Will robots increase their visibility in our everyday lives and people will accept them in parallel? Considering robots with communication capability in particular, it may not be easy for the human user to interact with robots and to accept the

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http://dx.doi.org/10.18506/anemon.464906

technology, which is an important element in the success of this interaction (Kuchenbrandt, et al., 2012: 463). For example, according to one study, students' anxiety about new technology negatively affected the process of developing their skills in using technology (Marcoulides, 1988: 155). Moreover, a survey shows that people's approach to new communication technologies can sometimes take place at two extremes (Joinson, 2004: 191). Thus, given the robots with communication capabilities, people are likely to develop negative attitudes and emotions. However, according to Bartneck and colleagues (2005: 2), those who have a negative attitude towards robots also find them threatening. Even Japanese individuals who are most likely to be familiar with robots may have negative attitudes, thinking that robots may have an impact on contemporary societies (Bartneck, et al., 2005: 3). Besides, people do not only have negative attitudes, but they also feel anxiety about robots (Nomura, et al., 2003: 376). This anxiety can negatively affect communication with robots. In the study of Nomura and colleagues (2008: 448), participants felt robot anxiety and showed avoiding behavior while communicating with the robot.

Anxiety is, in general, a complicated emotional response or state that varies in intensity and time, as a general psychological feature of the individual or as a consequence of the individual experiencing situational stress (Spielberger, 1966: 4). The most well-known types of anxiety are the trait anxiety which is regarded as a characteristic persistent state of anxiety in individuals; and state anxiety, which varies according to time and situation, is considered to be temporary anxiety (Spielberger, et al., 2017: 147). Furthermore, robot anxiety is anxiety or fear that prevents people from interacting with communicating robots in everyday life (Nomura, et al., 2006: 374).

It is necessary to understand the negative feelings such as anxiety in human-robot interaction. In fact, anxiety in terms of technological products is a concept that is being worked on in many studies. For example, in the last two decades, computer anxiety has been processed fairly often. Given these studies, methods should be developed to measure the anxiety that can occur in humans, as it may interfere with the communication between humans and the robots presented to them (Nomura, et al., 2006: 374). Moreover, the robot image is very different from the computer image consisting of a keyboard, a screen, and a mouse; because, the robot image in people's minds can range from an industrial arm to a human-like robot (Nomura, et al., 2005:126). This reveals that there is a more complex structure that needs to be understood. It is important to get the necessary precautions to understand how the children are affected by these interactions with these robots that may interact with the children and may work in the home. Therefore, when the necessary measures are developed, it will not affect just how robots are designed; we can evaluate the success of humanoid robots by making psychological factors more understandable (Nomura, et al., 2006: 373).

Nomura and colleagues (2006) developed the Robot Anxiety Scale to measure the anxiety about robots, who wanted to know what kind of psychological reactions the robots caused in humans. It is the first and only scale to measure anxiety in human-robot interaction; furthermore, the validity and reliability of the scale have been supported in many studies. The scale is originally Japanese (Nomura et al., 2004), and translated into English (Nomura et al., 2006) and Dutch (de Graaf & Allouch, 2013). As they develop this scale, they go out of two ways. One is the anxiety that can arise in people against new technological products, and the other is the anxiety called "communication apprehension" that people will have when communicating. Communication apprehension is the fear or anxiety felt by the individual in the communication process he or she has established in actual or anticipated situations (McKroskey, 1977: 78). Communication apprehension, which can also be considered as a social concern, is predicted to occur in the interaction that can be established with robots (Nomura, et al., 2006: 373), given that people do not discriminate between humans and robots when interacting (see, Reeves & Nass, 1996).

The scale has three sub-scales: communication capabilities of robots, behavioral characteristics of robots, and the discourse with robots. In particular, it is a useful measure because it can measure anxiety independently of the robot type and robotic task (Nomura, et al., 2006: 377). The translation of this scale into Turkish plays an important role in understanding the acceptability of the produced robotic technology in both the design and the behavioral guideline in the Turkish culture and the adaptation of robots to the working life.

2. Method

2.1. Preliminary Study

2.1.1. Language Adaptation and Content Validity

The items of the study were translated into Turkish by the authors of the current study separately and a Psychologist who speaks English at a professional level translated the items back to English. Subsequently, the similarity between the translations was examined and the translation was finalized in agreement. Afterwards, items were sent to nine academicians and two experts working on the field who were thought to be related to the topic; and, they rated English and Turkish items between 1 and 10. At the same time, the translation suggestions from these specialists were also asked. The results from the experts were analyzed by Kendall's W concordance (Kendall's $W = 0.235$, $p = .004$). It is understood that the translation of the scale was agreed by the experts. Finally, a pilot study with university students ($N = 50$) yielded a Cronbach's alpha value of .84.

2.2. Main study

2.2.1. Sample

There were 304 returns from the scales distributed to the students of 5 universities in Istanbul during the year. In order to carry out explanatory and confirmatory factor analysis, the sample was randomly split into two. In the first half of the sample which is used for explanatory factor analysis (EFA), participants had a mean age of 21, and they were 50 males and 100 females (2 were unreported). In the second half of the sample which is used for confirmatory factor analysis (CFA), participants had a mean age of 23, and they were 61 males and 91 females.

2.2.2. Measures

Robot Anxiety Scale: This scale measures people's anxiety about robots. The short name is RAS. It was developed by Nomura and colleagues (2006). This scale with 11 items was rated on the 6-point Likert scale (1 = I do not feel anxiety at all and 6 = I feel anxiety very strongly). This scale includes 3 subscales: communication capabilities of robots (3 items), behavioral characteristics of robots (4 items), and the discourse with robots (4 items). The scores obtained for each subscale are added to achieve the total anxiety score. Hence, the minimum and maximum scores of the first sub-scale range from 3 to 18; the second and third sub-scale ranges from 4 to 24. In the study of Japanese participants, Cronbach's alpha values were .90 for the first sub-scale, .82 for the second sub-scale, and .80 for the third sub-scale. Permission has been obtained from Nomura and his colleagues to translate the scale into Turkish.

Checklist for Trust between People and Automation: This scale (12 items) measures trust in automation and developed by Jian and colleagues (2000). This scale has been translated into Turkish by Erebak and Turgut (2019). There are 9 items in the Turkish translation and Cronbach's alpha value is .70. In this study, Cronbach's alpha value of .71 was obtained. The one-factor scale was found to have acceptable fit indices, ($\chi 2$ / df = 1, 368, CFI = 0.984, GFI = 0.983, RMSEA = 0.049, and SRMR = 0.036).

3. Results and Discussion

3.1. Construct Validity

Explanatory and confirmatory factor analysis was executed to evaluate the construct validity of RAS. The Kaiser-Meyer-Olkin (KMO) coefficient value (0.801 for EFA; 0.878 for CFA) is used to determine if the sample needed to do a factor analysis of the Turkish-translated material of the RAS scale is sufficient. In addition, the Barlett's Sphericity test, applied to find out whether the correlation matrix of items of scale is suitable for factor analysis, is appropriate for exploratory factor analysis ($\chi 2$ = 997,759; df = 55; p <.001) and confirmatory factor analysis ($\chi 2$ = 1126,222; df = 55; p <.001).

3.2. Explanatory Factor Analysis

According to the explanatory factor analysis results, 11 items over 0.50 of factor loading were distributed between three factors as it was in the original study of Nomura and colleagues (2006). These three factors accounted for 72% of the total variance (see Table 2). According to the reliability analysis result, the total Cronbach's alpha value of the scale is .89.

3.3. Confirmatory Factor Analysis

The three-factor model of RAS was tested with CFA. Scale items were associated with the factor in the explanatory factor analysis of the scale. Before the covariance between error terms was fixed, all observed variables were significantly loaded with appropriate factors (range: 0.69-0.89). However, it was found that this model was out of the acceptable range of fit according to the goodness of fit index of RMSEA ($\chi 2$ / df = 2.224, CFI = 0.955, GFI = 0.904, RMSEA = 0.09, and SRMR = 0.045). In addition, the model's modification indices have been examined and the theoretically acceptable error terms have been allowed to relate to each other. These two error terms belong to item 6 and 7 and in both of these items there is an expression of the degree of a characteristic of the robot. Hence, these two items can have a correlated error. Accordingly, the error terms (4 and 5) of RAS items have been associated. After these corrections suggested by the modification indices, regarding being theoretically appropriate, the model was retested. As can be seen in Figure 1, the variables observed in the model to which the relevant error terms were associated were fitted to the appropriate factors (range: 0.65-0.89). The three-factor structure of Fig. 1 was also found to have more acceptable fit indices, ($\chi 2$ / df = 1.807, CFI = 0.971, GFI = 0.925, RMSEA = 0.073, and SRMR = 0.04). It was seen that the 3-factor structure of the RAS is supported in this study because the ratio of the chi-square value to the degree of freedom was smaller than 3 and the compliance indices obtained from confirmatory factor analysis indicate an acceptable fit. As a result, CFA has shown that the factors that constitute latent variables measure reliably observed variables.

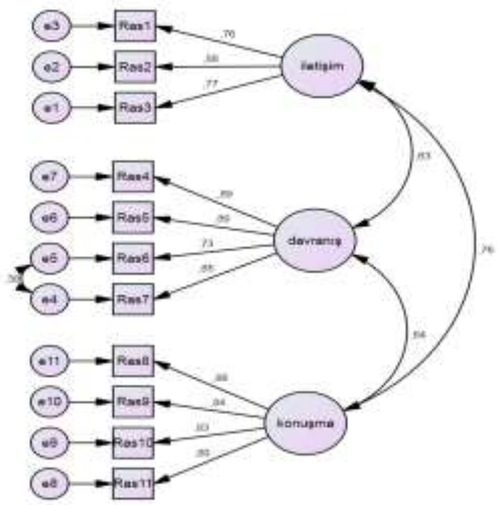

Figure 1. Structure of the final Turkish Robot Anxiety Scale

3.4. Discriminant Validity

When examining the discriminant validity, the constructs must be unrelated or opposite. Theoretically, a negative or no correlation can be expected between trust to robots (it involves a positive attitude) and robot anxiety (it involves a negative emotion). In line with this, in the context of the discriminant validity, according to the correlation results among the total score of RAS and sub-dimensions of RAS with the other variable (Checklist for Trust between People and Automation), there were no significant correlations on any direction (see Table 1). These results confirm discriminant validity.

Table 1. The correlations among variables

	1	2	3	4	5
1 RAS	-	.842**	.834**	.886**	.030
2 RAS - Communication		-	.540**	.679**	.047
3 RAS - Behavioral			-	.570**	.034
4 RAS - Discourse				-	.001
5 Trust					-

**. Correlation is significant at the .01 level (2-tailed).

Table 2. Psychometric properties of the items of RAS

Subscale	Item number	Items	Factor Loads	Variance %	Eigen values	Cronbach's alpha
Anxiety about communication capabilities of robots	1	Robots may talk about something irrelevant during conversation. Robotların konuşma esnasında konuyla alakasız şeylerden bahsetmesi durumunda.	.541			
	2	Conversation with robots may be inflexible. Robotların konuşmamızın akışını takip etmekte zorlanması durumunda.	.898	9.377	1.031	.81
Robotların iletişim becerilerine dair kaygı	3	Robots may be unable to understand complex stories. Robotların konuşma esnasında zor konuları anlamaması durumunda.	.845			
Anxiety about behavioral characteristics of robots	4	How robots will act. Robotların ne tür hareketler yapacağı konusunda.	.740			
	5	What robots will do. Robotların ne yapacağı konusunda.	.825	48.868	5.375	.88
Robotların davranışsal özelliklerine dair kaygı	6	What power robots will have. Robotların ne kadar güçlü olduğu konusunda.	.895			
	7	What speed robots will move at. Robotların ne kadar hızlı hareket edeceği konusunda.	.791			
Anxiety about the discourse with robots	8	How I should talk with robots. Robotlarla nasıl konuşmam gerektiği konusunda.	.825			
	9	How I should reply to robots when they talk to me. Robotlar benimle konuştuğunda nasıl cevap vermem gerektiği konusunda.	.845			
Robotlarla konuşmaya dair kaygı	10	Whether robots understand the contents of my utterance to them. Ne hakkında konuştuğumu robotların anlayıp anlamayacağı konusunda.	.602	13.742	1.512	.82
	11	I may be unable to understand the contents of robots' utterances to me. Robotların ne hakkında konuştuğunu benim anlayıp anlamayacağım konusunda.	.640			

4. Conclusion

In this study, the Robot Anxiety Scale was translated into Turkish, and validity and reliability of this scale were examined. As a result of KMO and Bartlett Sphericity test, it was seen that data is useful for factor analysis, meaningful relationships between variables were established and the data was applicable.

In this study, explanatory factor analysis was applied with the principal component method; so factor extraction can be done. There was no restriction on the number of factors. As a result of the analysis, 11 items were found to be constant and were distributed under three factors as in the original scale and also these factors accounted for 72% of the total variance. This percentage of variance and the factor structure of this scale were found to be high.

The internal consistency coefficients of the Turkish version of the RAS scale were .89 for the whole scale, .81 for the communication capabilities, .88 for the behavioral characteristics, and .82 for the discourse with robots. The internal consistency coefficients in the original study of Nomura et al. (2006: 375) were reported to be $\alpha = .84$ for the communication with robots; $\alpha = .84$ for the behavioral characteristics of robots; and $\alpha = .80$ for the discourse with robots. In addition, the fit indexes obtained from confirmatory factor analysis in this study are similar to those in the original study of Nomura et al. (2006: 375) (GFI

=0.900, AGFI =0.856, and RMSEA =0.080). Furthermore, the non-correlation between trust to robots and the total score of the RAS and the sub-dimensions of the RAS showed the presence of discriminant validity.

This research indicates that the Turkish version of RAS has reliability and validity. Interactions with robots may also increase with the proliferation of work done by robots in business life. The anxiety we feel towards robots may affect the efficiency of the interaction we build with them. Therefore, investigating robot anxiety can provide effective data to better understand the interaction between human and robot, to produce the necessary solutions, and to develop appropriate robot designs.

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