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Original article

Validation of the Portuguese version of the Negative Attitudes towards Robots Scale

Validation de la version portugaise de l'Échelle d'Attitudes Négatives envers les robots

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ABSTRACT

Introduction. – Social robots are robots capable of a peer-to-peer communication with humans. Nomura, Kanda, and Suzuki (2004) developed the Negative Attitude towards Robots Scale (NARS) to measure the attitudes towards robots. NARS proved to be a useful tool to study human-robot interaction.
Objective. – To assess the psychometric properties of the Portuguese version of the NARS (PNARS).
Method and results. – Four studies were conducted. In study 1 ($n = 300$), a principal component analysis showed that PNARS comprised two components: the negative attitudes towards robots with human traits (NARHT) and towards interaction with robots (NATIR). In study 2 ($n = 536$), a confirmatory factorial analysis was conducted. Results confirmed the two-factor solution of PNARS obtained in study 1. Study 3 ($n = 107$) tested the nomological validity of PNARS and showed that PNARS, NARHT and NATIR correlated with attitudes towards technology. Study 4 ($n = 59$) tested the predictive validity of PNARS and showed that scores on NARHT and NATIR predicted the future intention to work with a social robot and its affective and cognitive antecedents.
Conclusion. – Globally, results indicate that PNARS is a reliable instrument to use in human-robot interaction studies.

Mots clés :
Robots sociaux
Attitudes négatives envers les robots
Intention de travailler avec un robot
Théorie du comportement planifié

RÉSUMÉ

Introduction. – Les robots sociaux sont des robots capables de communiquer avec les humains sur un mode humain. Nomura, Kanda, et Suzuki (2004) ont créé l'échelle d'Attitudes Négatives envers les Robots (NARS) pour mesurer les attitudes à l'égard des robots. NARS s'est avérée être un instrument utile pour étudier l'interaction homme-robot.
Objectif. – Le présent travail vise à adapter la NARS en portugais et tester ses caractéristiques psychométriques.
Méthode et résultats. – Quatre études ont été menées. Dans l'étude 1 ($n = 300$), une analyse en composantes principales montre que la version portugaise du NARS (PNARS) est composée de deux éléments : les attitudes négatives envers les robots qui ont des traits humains (NARHT) et envers l'interaction avec les robots (NATIR). Dans l'étude 2 ($n = 558$), une analyse factorielle confirmatoire a été menée. Les résultats ont confirmé la solution à deux facteurs de PNARS obtenus dans l'étude 1. L'étude 3 ($n = 107$) teste la validité nomologique de la PNARS et montre que les PNARS, NARHT et NATIR sont corrélées avec les attitudes envers la technologie. L'étude 4 ($n = 59$) teste la validité prédictive de la PNARS et montre que les NARHT et NATIR prédisent l'intention future de travailler avec un robot social et ses antécédents cognitifs et affectifs.

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Conclusion. – Globalement, les résultats indiquent que la PNARS est un instrument fiable qui peut être utilisé dans les études de l'interaction homme-robot.

1. Introduction

Social robots are physically embodied agents created for a peer-to-peer human-machine interaction (Fong, Nourbakhsh, & Dautenhahn, 2003). They are planned to interact with humans in their daily lives as assistants and partners, carrying out various tasks at home and at work. Research in human-robot interaction (HRI) has stressed the importance of users' prior knowledge and expectations about robots (e.g. Komatsu, Kurosawa, & Yamada, 2012; Stafford, MacDonald, Li, & Broadbent, 2014). Nomura, Kanda, and Suzuki (2004, 2006) have developed the Negative Attitudes towards Robots Scale (NARS) to measure the psychological factors that prevent people from interacting with social robots. The aim of the present paper is to adapt NARS to Portuguese and to test its psychometric properties, in order to contribute, *in fine*, to the standardization of research tools in HRI.

2. The Negative Attitudes towards Robots Scale (NARS)

The NARS (Nomura, Kanda, & Suzuki, 2004, 2006; Nomura, Kanda, Suzuki, & al., 2004) was elaborated to assess psychological reactions evoked in humans by humanlike and non-humanlike robots. Specifically, NARS gauges the extent to which people feel unwilling to interact with a robot. The NARS is a 14-item scale (Table 1), composed of three subscales: the negative attitudes towards interacting with robots (NARS-Interaction), towards the social influence of robots (NARS-Social Influence) and towards emotions in interaction with robots (NARS-Emotion). A confirmatory factor analysis with a sample of 240 Japanese participants conducted by Nomura, Kanda, and Suzuki (2004) showed that NARS displayed reasonable goodness-of-fit indices (GFI = .90, AGFI = .86, RMSEA = .08) and Cronbach alphas of α = .77, .78 and .65 for NARS–Interaction, NARS–Social Influence and NARS–Emotion, respectively. In a later study, Nomura, Kanda, et al. (2006) confirmed NARS' structural and psychometric properties (n = 263 Japanese participants; GFI = .92, AGFI = .89; RMSEA = .06; Cronbach α = .74, .73, .66 for NARS–Interaction, NARS–Social Influence and NARS–Emotion, respectively).

Since its elaboration, NARS has been used to study various dimensions of HRI. First, NARS was administered to predict verbal and behavioral reactions to social robots in live HRI studies (e.g., Nomura, Kanda, & Suzuki, 2004; Nomura, Kanda, Suzuki, & Kato, 2008; Nomura, Shintani, Fujii, & Hokabe, 2007). These studies have provided mixed results. For example, the subscales of NARS predicted behavior toward robots, such as time spent talking with and touching it, differentiating participants according to gender (Nomura et al., 2008), but they failed to predict the physical distance allowed by participants between them and a robot (Nomura et al., 2008). Moreover, the Robot Anxiety Scale (Nomura, Suzuki, Kanda, & Kato, 2006), under some conditions (e.g., according to gender), turned out to be a better predictor of behaviors than NARS (Nomura et al., 2007).

Second, NARS has been used to:

- measure attitude towards social robots (Nomura, Kanda, & Suzuki, 2004; Nomura, Kanda, Suzuki, Yamada, & Kato, 2009);
- measure the effect of attitudes towards robots on the perception of robots' behavior (Cramer, Goddijn, Wielinga, & Evers, 2010; Cramer, Kemper, Amin, Evers, & Wielinga, 2009; Syrdal, Dautenhahn, Koay, & Walters, 2009);
- measure the effect of interacting with robots on attitudes towards robots (Weiss, Bernhaupt, Tscheligi, & Yoshida, 2009);
- measure the evaluations of different types of robots (Nomura, Suzuki, Kanda, & Kato, 2006; Syrdal et al., 2009);
- compare different social groups and cultures on their attitudes towards robots (Bartneck, Nomura, Kanda, Suzuki, & Kato, 2005; Bartneck, Suzuki, Kanda, & Nomura, 2007; Halpern & Katz, 2012; Weiss, Igelsbock, Wurhofer, & Tscheligi, 2011);
- predict social acceptability of robots (Nomura et al., 2009).

The NARS has already been translated into different languages (see Tsui, Desai, Yanco, Cramer, & Kemper, 2011, for a review). However, translations were generally made for the purpose of the studies and few of the studies provide NARS' structural and psychometric properties. For example, Bartneck et al. (2005a,b) asked Dutch and Chinese participants to fill NARS, but they did not report any psychometric information about NARS and its subscales. Bartneck et al. (2007) used Dutch, Chinese, German, Mexican and English versions of NARS and reported the Cronbach's α for each of NARS' subscales for the total sample (α = .79, .65, .60 for respectively, NARS-Interaction, -Social Influence and -Emotion) but not by nationality/country. Cramer et al. (2009) and Syrdal et al. (2009) reported the Cronbach α for the full scale (α = .82 and .80, respectively) but not for each of the three subscales. Finally, Syrdal et al. (2009) used an English version of NARS and have provided a more thorough analysis by conducting a principal components analysis with a sample of students and staff from a British university. They showed that the English version displayed a factorial structure that differed from the original Japanese version, and they had to remove 3 items (namely items 7, 8, 14), leading them to conclude that NARS may be sensitive to cultural differences. In short, little is known, so far, about NARS' structural properties in non-Japanese samples.

3. Aims and overview of the current research

Overall, the results of studies using NARS indicate that, although its capacity to predict *in situ* human behaviors towards robots is still under debate, it still remains a useful tool to study the social representations and perceptions about robots, as well as the acceptance they receive. Moreover, unlike other existing scales that focus on interaction with a specific type of robot, set of tasks, and context, like the CEDAR scale (Riek et al., 2010) or the Robot Attitude Scale (Broadbent et al., 2009), NARS has the advantage to provide a general measurement of the attitude towards robots. Indeed, despite focusing on attitude towards robots with human traits (e.g., emotions, intentions, language), NARS does not make any specific assumptions on how the robot should look and where and how it should operate. As such, NARS is a general and easy-to-administer measurement of the attitudes towards social robots, independent of the type of robot or context, and offers the possibility of being used both in real and imagined interactions.

Several authors have pointed the heterogeneity of measurements and methodologies in HRI and how the lack of common benchmarks and measurement tools impair communication and application of results across research groups and projects (e.g. Dautenhahn, 2007; Steinfeld et al., 2006; Syrdal et al., 2009). The development and validation of common standardized tools about