Polish Version of the Negative Attitude Toward Robots Scale (NARS-PL)

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Grzegorz Pochwatko, Jean-Christophe Giger, Monika Różańska-Walczuk, Justyna Świdrak, Krzysztof Kukiełka, Jakub Możaryn, Nuno Piçarra

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Abstract:
This paper presents the Polish adaptation of the Negative Attitude toward Robots Scale (NARS-PL), primarily created by Nomura et al. (2004). 213 individuals participated in the study (49 professionals and 164 non-professionals). The Polish version obtained satisfactory psychometric properties for a two-factor structure. Both subscales, the Negative Attitudes toward Robots that Display Human Traits (NARHT) and the Negative Attitudes toward Interactions with Robots (NATIR) possess good internal consistency. Effects of participant gender and robot's appearance were found. Theory consistent relationships between attitude toward robots, belief in human nature uniqueness and robots' human-likeness are discussed.

Keywords: *social robots, acceptance of robots, anthropomorphism, human uniqueness, human-robot interaction*

1. Introduction

Thanks to new technical solutions we are coming closer than ever before to integrating social robots into our daily life. Defined as physically embodied agents, social robots are created for human-machine peer-to-peer interaction [1]. They are designed to assist as partners in multiple duties, both at home and at work. User knowledge and attitude toward robots are essential factors in human-robot interaction (HRI) [2], [3]. A special scale, the Negative Attitude towards Robots Scale (NARS), was developed by Nomura, Kanda and Suzuki [4], [5] to measure psychological variables possibly discouraging people from interacting with social robots.

The main purpose of this paper is to present the Polish adaptation of NARS. The factorial structure of the scale was analyzed and compared to the Japanese original and the Portuguese version. The reliability of the emerged subscales (Negative Attitudes toward Robots that Display Human Traits and Negative Attitudes toward Interactions with Robots) was tested. Moreover, the relationships between NARS and related constructs (belief in human nature uniqueness and perceived anthropomorphism of robots) were investigated in order to assess the validity of the scale.

The structure of this paper is as follows: Section 1 presents an in-depth overview of different scales and measures, i.e. the Negative Attitude toward Robots, Belief in Human Nature Uniqueness, and Anthropomorphism scale. Section 2 describes the applied methods and procedure, i.e. modification of the scales, methods of statistical data analysis, and a description of robots used as target stimuli. Section 3 contains the obtained results. Finally, in Section 4 a brief discussion of the results and suggestions for further work are proposed.

1.1. The Negative Attitudes Towards Robots Scale (NARS)

The scale [4] measures psychological reactions to humanlike and non-humanlike robots. The main focus is put on the extent to which one would be reluctant to interact with a robot. The original Japanese scale contains 14 items, ordered in three subscales: 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). Satisfying levels of goodness-of-fit indices (GFI=.90, AGFI=.86, RMSEA=0.08, N=240) and Cronbach alphas (α=.77, .78 and .65 for NARS-Interaction, NARS-Social Influence, NARS-Emotion, respectively) were obtained and confirmed in yet another study [5].

The NARS scale has been used in numerous studies, measuring different dimensions of Human-Robot Interaction (HRI) like predicting verbal and behavioral reactions to social robots [6] or the effect of interacting with robots on attitudes towards robots [7]. Some research compared different social groups and cultures on attitude towards robots [8], [9], [10].

Although several attempts of translations were made, only a few studies reported the structural and psychometric properties of NARS. A thorough psychometrical analysis was provided in [11]. Authors used the English version of NARS with a sample of British students and university employees. Three items (7, 8, and 14; compare Table 4.) had to be removed from the original scale due to inconsistency and the final three-factor structure differed from the original NARS. Piçarra, Giger, Pochwatko, & Gonçalves [12] carried out a series of four studies to validate the Portuguese version of NARS (PNARS), which showed significant differences from the Japanese scale. A confirmatory factor analysis demonstrated the two-factor structure: the Negative Attitudes toward Robots that Display Human Traits (NARHT, α

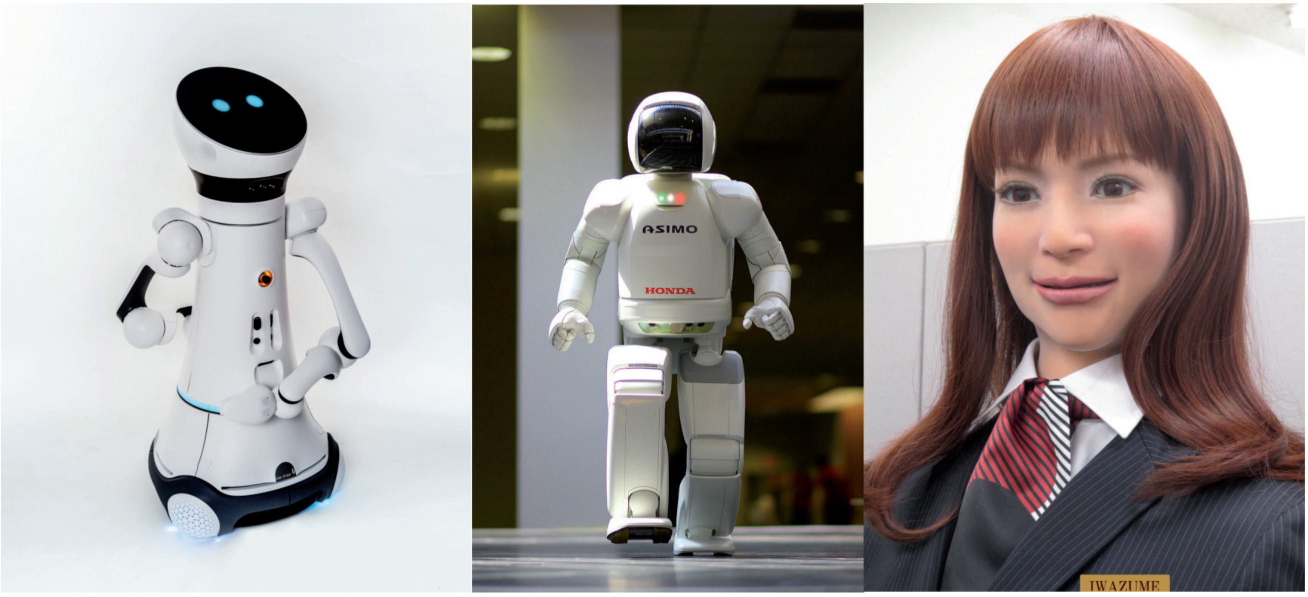

Fig. 1. Robots used as stimuli in attitude towards robots activation (a. Care-o-bot [1)], b. Asimo [2)], c. Actroid [3)]

from .80 to .89) and the Negative Attitudes toward Interactions with Robots (NATIR, α from .73 to .85), and reasonable goodness-of-fit indices (CFI=.93, AGFI=.92, RMSEA=.065). The final PNARS contained 12 items. Both the British and the Portuguese validations support the conclusion that various cultural variables (e.g. familiarity with the idea of robots) may be responsible for discrepancies between the Japanese and European factors structure [12].

1.2. Belief in Human Nature Uniqueness (BHNU)

The essentialist belief that human nature is unique and that human beings share a deep underlying natural essence can influence attitudes toward robots and acceptance of robots as a social category. It has been shown that such psychological essentialism is associated with prejudice, perceived differences between groups, dispositional attributions, and justifying social inequalities [13]. People who believe that humans share a unique essence are more likely to hold stronger negative attitudes toward robots with human-like characteristics. Both BHNU and attitude (measured with NARS) are associated with the level of perceived anthropomorphism of social robots [14] [15]. The BHNU index is an average of responses to 6 items regarding essentialist beliefs (see Table 2). The higher the results, the stronger the belief in human nature's uniqueness.

1.3. Anthropomorphism of Robots

Epley, Waytz and Cacioppo [16] define anthropomorphism as the attribution of humanlike psychological traits, emotions, intentions, motivations and goals to non-human agents (robots in this case, but it refers also to avatars and agents in virtual environments). Those attributions are based on the robot's behavior and the homocentric knowledge (i.e. self-knowledge and knowledge about other humans) that is accessible at the moment of judgment. The attribution of human characteristics to robots is considered to be crucial for the quality of HRI. Expecting robots to behave in a human way is a good predictor of intention to cooperate with them.

2. Method

2.1. Participants

Participants of a convenience sample (N=164) were recruited via ads placed in social networks, various Internet groups and discussion boards. A mailing list of participants of previous studies conducted in VRLAB IPPAS was also used. Additionally, a subsample of professionals (mainly engineers, working in area of robotics) was included (n=49). See Table 1 for the characteristics of the sample.

2.2. Materials

The robots: Perceived anthropomorphism of social robots was primed with short movies presenting one of the robots we chose based on the objective level of human-likeness

Starting with the lowest level – **Care-o-bot** (Fig. 1a) is a mobile assistant designed to support humans in various environments [17]. It was developed in Germany by the Fraunhofer Institute for Manufacturing Engineering and Automation IPA. It has been experimentally used in homes and offices, hospitals and airports. It is wheel based, possesses two arms, and has a display with a pair of eyes (that are frequently replaced with necessary data, depending on the current activity).

The medium level of human-likeness represents **ASIMO** (fig. 1b), a small walker developed by Honda Company, designed to be a multifunctional mobile assistant. It has the ability to understand voice commands and to respond in the same way, and it also recognizes faces. One of the applications is to help people who lack full mobility.

1) Care-o-bot homepage: http://www.care-o-bot.de/
2) Asimo homepage: http://asimo.honda.com/
3) Actroid homepage: http://www.kokoro-dreams.co.jp/english/rt_tokutyu/actroid.html

ACTROID (Fig. 1c) developed by Osaka University and manufactured by Kokoro Company Ltd., is a humanoid robot with the highest level of human-likeness [18]. It can mimic such lifelike functions as blinking, speaking, and breathing. The Actroid can also imitate human-like behavior with slight shifts in position, head and eye movements, and the appearance of breathing with its chest. It has been modelled after an average young woman. In our study, it is supposed to activate the highest level of anthropomorphism.

Table 1. Characteristics of the participants

	Non-professionals	Professionals	Total
N	164	49	213
Age M(SD)	29,10 (9,53)	30,37 (12,40)	29,36 (10,15)
Gender M/F/n.r.	59/77/28	21/14/14	80/91/42
Education			
Vocational school	3	–	3
High school	12	1	13
Student	50	17	67
College	71	17	88
Profile			
Humanities	30	1	31
Social sciences	24	3	27
Engineering	42	31	73
Life sciences	13	–	13
Arts	3	–	3
Other	24	–	24

2.3. Measures

NARS-PL: The English 14-item version of NARS [4] was translated to Polish. Participants responded using a 7-point scale (1 – strongly disagree to 7 – strongly agree).

Belief in human nature uniqueness scale [12], [15]: A 6-item scale assesses the extent to which humans reserve human nature for their own group and deny the possibility of a human essence to robots. Participants responded on a 7-point scale (1 – totally disagree to 7 – totally agree). The English version of the BHNU scale was translated to Polish by the authors.

Level of anthropomorphism of robots: The Epley, Waytz, Akalis, and Cacioppo´s [17] scale was used to measure the level of anthropomorphism as a function of the robot's appearance. It is a 14-item scale composed of three dimensions: the supportive anthropomorphic traits, the non-supportive anthropomorphic traits, and the behavioral traits. The scale was translated to Polish by the authors. Participants responded on a 7-point scale (1 – totally disagree to 7 – totally agree).

2.4. Procedures

An online study was conducted with the use of the GEX platform[4)]. Participants were informed that no personal data are collected and that they can quit at any stage without consequences. After accepting an informed consent form and reading a brief instruction, participants watched a randomly selected movie presenting one of the three above mentioned robots.

Care-o-bot, ASIMO, or Actroid introduced itself as an exemplar of a social robot. It then described its possible usage and functions. In each movie the same female voice recording was applied. After the movie participants responded to the NARS, BHNU, and Anthropomorphism questionnaires. In the last step the socio-demographic data were collected. After completing the task, participants were thanked for their contribution.

[4)] www.gex.net.pl/vrlab/run/social_robot

2.5. Quality Indices

Principal Components Factor Analysis – (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components [19].

Varimax rotation is an orthogonal rotation of the factor axes to maximize the variance of the squared loadings of a factor on all the variables in a factor matrix. Each factor will tend to have either large or small loadings of any particular variable [20].

Kaiser-Meyer-Olkin (KMO) is the measure of sampling adequacy. The test assesses the appropriateness of using factor analysis on data. Values over 0.8 are considered good [20].

Bartlett test of sphericity is another sampling adequacy measure applied together with factor analysis [20]. It tests the hypothesis that the correlation matrix is an identity matrix, which would indicate that variables are unrelated and therefore unsuitable for structure detection. It should be significant.

Reliability Analysis in psychometrics refers to the overall consistency of a measure [20]. Highly reliable measures produce similar results under consistent conditions. One of the common methods of reliability testing is checking internal consistency of a measure.

Cronbach's alpha is a commonly used measure of internal consistency [21]. It is used to assess the consistency of results across items within a test. Values above 0.60 are acceptable for scientific uses of the test, and above 0.85 are considered sufficient for psychological diagnosis.

Validity analysis in psychometrics refers to the degree to which evidence and theory support the interpretations of test scores, referred to the proposed uses [21]. It is not a single elegant statistic; instead, many different methods are used. A usual practice is looking for predicted differences and correlations. In other words, if significant differences are observed between groups that are supposed to differ in a certain way, the test is valid [22].

3. Results

3.1. Factorial Structure of NARS-PL

All 14 items of the original NARS were used to conduct principal components factor analysis with varimax rotation. The Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy reached the required level (.863), and Bartlett test of sphericity was significant (chi^2=1097.31, df=91, p<.001). The three factor solution explained 56.28% of variance. The results were consistent with the Portuguese translation results (see Table 4 for details).

Unfortunately, the original Japanese structure was not replicated. What is more, factors did not have any content coherence. A couple of items had high loadings in more than one factor. The third factor consisted of only one unique item (14) and all other items had stronger loadings in the remaining two. The Scree plot suggested a possible two factor solution, and these factors had low internal consistency (Cronbach's alpha .77 and .49, respectively). Items 7 and 14 showed very low item-total correlations. Additionally, these items seem to be outdated or inadequate in our conditions, and it is probable that item 14 is culturally biased due to the differences in the familiarity with the idea of robots in popular culture in both countries [12]. The Japanese are used to higher robots exposure and that might lead to a more complex cognitive representation of robots and their future role in society than Europeans have.

Consistently with the Portuguese version, it was decided to remove items 7 and 14 and run the analysis on the remaining 12 items. The principal components analysis with varimax rotation met all minimal requirements (KMO=.861; Bartlett's p<.001). The two obtained factors explained 55.29% of variance. Factor loadings are presented in table 4 (compared with Portuguese and Japanese solutions). Polish and Portuguese factors are loaded with exactly same questions, whereas Japanese subscale structure is substantially different. NATIR consists mostly of questions loading Japanese S1 factor – negative attitude towards interaction with robots, but it also includes two items from S2 factor – negative attitude towards social influence of robots. NARHT gathers all S3 items – negative attitude towards emotions in interactions with robots and those S1 and S2 items that refer to robots with human traits or humanlike functions.

3.2. Reliability of NARS-PL

Differences between professional and non-professional samples were marginally significant (p=.07), but due to theoretical reasons (different experiences and knowledge about robots in particular and robotics in general)

Table 2. English-Polish translation of the Belief in Human Nature Uniqueness Scale

English version	Polish version
Even if ultra-sophisticated…	Nawet najbardziej zaawansowany technicznie:
a robot will never be considered as human being;	robot nigdy nie będzie uważany za człowieka.
a robot will never feel the same emotions as a human being,	robot nigdy nie będzie odczuwał emocji tak jak człowiek.
a robot will never use language in the same way as a human being;	robot nigdy nie będzie posługiwał się językiem tak samo jak człowiek.
a robot will always be a mechanical imitation of the human being;	robot będzie zawsze imitacją człowieka.
a robot will never have consciousness;	robot nigdy nie posiądzie świadomości.
a robot will never have morality.	robot nigdy nie będzie miał moralności.

Table 3. English-Polish translation of the Anthropomorphism Scale

Subscale	English version	Polish version
Supportive Anthropomorphic Traits	thoughtful	miła
	considerate	taktowna
	sympathetic	sympatyczna
Nonsupportive Anthropomorphic Traits	devious	przebiegła
	embarrassable	zakłopotana
	jealous	zazdrosna
	creative	twórcza
Behavioral Traits	aggressive	agresywna
	agile	zwinna
	active	aktywna
	energetic	energiczna
	fearful	strachliwa
	lethargic	ospała
	muscular	silna fizycznie

Table 4. Factor structure of NARS-PL (compared to Japanese and Portuguese versions)

Item number	Original and translated item***	Polish factor loadings 1	Polish factor loadings 2	Label**	Japanese factor loadings (subscales)*	Portugese factor loadings (subscales)**
1	Czuł(a)bym się nieswojo, gdyby roboty naprawdę odczuwały emocje. I would feel uneasy if robots really had emotions.	0.331	0.718	NARHT	s2	NARHT
2	Gdyby roboty ożyły, mogłoby stać się cos złego. Something bad might happen if robots developed into living beings.	0.309	0.545	NARHT	s2	NARHT
3	Czuł(a)bym się swobodnie rozmawiając z robotem. I would feel relaxed talking with robots.	0.568	0.454	NATIR	s3	NARHT
4	Czuł(a)bym się nieswojo, gdybym dostał(a) pracę, w której musiał(a)bym używać robotów. I would feel uneasy if I was given a job where I had to use robots.	0.796	0.178	NATIR	s1	NATIR
5	Gdyby roboty odczuwały emocje, mógłbym/ mogłabym się z nimi zaprzyjaźnić. If robots had emotions, I would be able to make friends with them.		0.809	NARHT	s3	NARHT
6	Czuł(a)bym się pewnie przebywając z robotami obdarzonymi emocjami. I feel comforted being with robots that have emotions.	0.106	0.87	NARHT	s3	.NARHT
8	Obawiał(a)bym się kierować robotem w obecności innych ludzi. I would feel nervous operating a robot in front of other people.	0.791		NATIR	s1	NATIR
9	Nie podoba mi się pomysł, aby roboty lub jakaś sztuczna inteligencja wydawały sądy w różnych sytuacjach. I would hate the idea that robots or artificial intelligences were making judgments about things.	0.358	0.49	NARHT	s1	NARHT
10	Denerwował(a)bym się bardzo, nawet gdybym musiał tylko stanąć przed robotem. I would feel very nervous just standing in front of a robot.	0.751	0.127	NATIR	s1	NATIR
11	Sądzę, że gdybym zbyt uzależnił(a) się od robotów, coś złego mogłoby się stać. I feel that if I depend on robots too much, something bad might happen.	0.516	0.301	NATIR	s2	NATIR
12	Czuł(a)bym się dziwnie rozmawiając z robotem. I would feel paranoid talking with a robot.	0.629	0.428	NATIR	s1	NATIR
13	Obawiam się, że roboty mogłyby mieć zły wpływ na dzieci. I am concerned that robots would be a bad influence on children.	0.526	0.459	NATIR	s2	NATIR

* Japanese subscale labels: S1: negative attitudes towards interaction with robots; S2: negative attitudes towards social influence of robots; S3: negative attitudes towards emotions in interaction with robots.

** Polish and Portuguese subscale labels: NARHT: negative attitudes towards robots with human traits; NATIR: negative attitude towards interaction with robots.

*** Removed items no. 7 – "Słowo "robot" nic dla mnie nie znaczy" („The word „robot" means nothing to me") and 14 – Czuję, że w przyszłości społeczeństwo będzie zdominowane przez roboty" („I feel that in the future society will be dominated by robots".

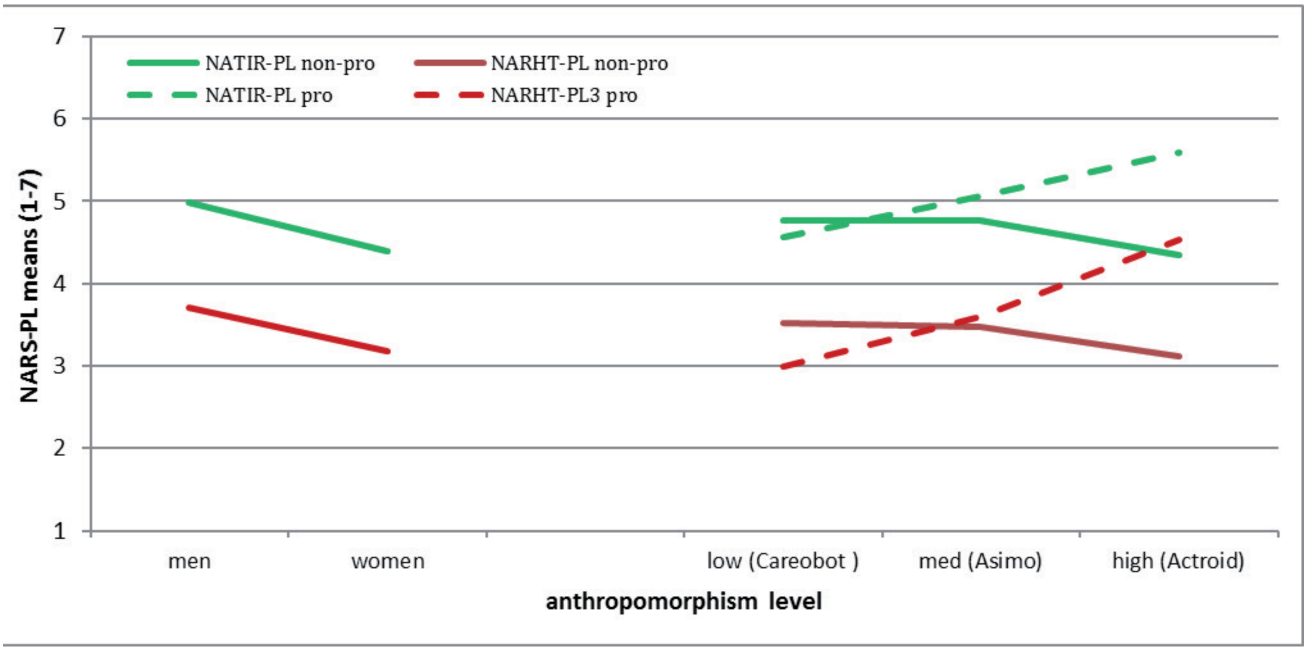

Fig. 2. Appearance of stimulus robot, participant sex, and expertise level differences in NARS-PL (non-professional sample=non-pro; professional sample=pro)

and sample size differences we analyzed the results separately. Below, the results of a large non-professional sample are shown. The results of the professional sample are mentioned in some comparisons, when indicated.

Both obtained subscales have good internal consistency. Cronbach's alpha coefficients are .84 for NATIR and .79 for NARHT.

3.3. Validity of NARS-PL

Analysis of variance was conducted with NATIR and NARHT as dependent variables, and participants gender, expertise (professionals and non-professionals), BHNU (high or low, split based on median), and robot's appearance (low, medium, high human-likeness) as independent factors. Expected differences were found for both NARS–PL subscales accounting for diagnostic and nomological validity (see fig. 2). There was a significant main effect of participant gender (men had more positive attitude than women; NATIR $p<.05$; NARHT $p=.065$) in the non-professionals sample. What is more, a significant main effect of robot appearance was found in the professional sample (attitudes towards more anthropomorphic robots were more positive; NATIR $p<.01$; NARHT $p<.05$). No interaction effects were found.

A significant main effect of the Belief in human nature uniqueness scale was obtained. Participants scoring high in BHNU had significantly lower scores in NARS-PL (NATIR $p<.001$; NARHT $p<.001$). It was more visible for Actroid – a highly anthropomorphic robot. Correlations with BHNU were moderate and negative (NATIR $r=-.39$, $p<.001$; NARHT $r=-.48$, $p<.001$).

4. Conclusions

The preliminary study aimed at the adaptation of NARS [4, 5] and comparison with PNARS [12], and showed that the Polish version of the scale consists of two subscales:

1) **The Negative Attitudes toward Interactions with Robots** (NATIR), that encompasses the reactions to interactions with robots;

2) **The Negative Attitudes toward Robots with Human Traits** (NARHT), that captures the responses to robots that display human traits like emotions, language, and agency.

This is consistent with PNARS structure and suggests that a cross-cultural study may be necessary. NARS-PL is both reliable and valid. High values of internal consistency indices for both subscales were obtained. Theory consistent associations with robot anthropomorphism ratings, participant sex, and their expertise level were also observed.

Further studies showing the predictive validity of NARS and its applications to virtual reality agents and avatars are in progress.

It is argued that NARS-PL is a useful tool to predict human responses to social robots in HRI studies in Poland.

Limitations. One of the drawbacks is the sampling method used in the study. It is posible that it favours participants that have already more positive general attitudes toward technology or robots in particular. It also differs from methods used in the original and Portuguese studies. Replication on a broader sample is necessary. Another issue might be the subjective choice of robots used as attitude activation stimuli. They should represent three levels of human-likeness, but the differences are not only quantitative, but also, if not mainly, qualitative due to the fact that they were designed by different constructors. What is more, the used robots may not cover the full dimention of human-likeness. For example, Care-o-bot as representing low level of human-likeness posesses already quite a few human features. In future studies two solutions should be provided. First, using robots especially designed for the study, and differing minimally in attractiveness, size etc. Second, higher and lower levels of human-likeness could be introduced in the design, namely: very low level represented by e.g. factory robots, and very high, not to say ideal level represented by humans themselves [23].

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AUTHORS

Grzegorz Pochwatko* – Virtual Reality and Psychophysiology Lab, Institute of Psychology, Polish Academy of Sciences, Warsaw, 00-378, Poland.
E-mail: grzegorz.pochwatko@psych.pan.pl.

Jean-Christophe Giger – Department of Psychology and Sciences of Education, University of Algarve and Research Centre for Spatial and Organizational Dynamics – CIEO.
E-mail: jhgiger@ualg.pt.

Krzysztof Kukiełka – Institute of Automatic Control and Robotics, Faculty of Mechatronics, Warsaw University of Technology, Warsaw, Poland. E-mail: k.kukielka@mchtr.pw.edu.pl.

Justyna Świdrak – Virtual Reality and Psychophysiology Lab associate, Institute of Psychology, Polish Academy of Sciences, Warsaw, 00-378, Poland. E-mail: jswidrak@psych.pan.pl.

Jakub Możaryn – Institute of Automatic Control and Robotics, Faculty of Mechatronics, Warsaw University of Technology, Warsaw, Poland.
E-mail: j.mozaryn@mchtr.pw.edu.pl

Monika Różańska-Walczuk – Institute of Automatic Control and Robotics, Faculty of Mechatronics, Warsaw University of Technology, Warsaw, Poland.
E-mail: m.rozanska@mchtr.pw.edu.pl

Nuno Piçarra – University of Algarve, Faro, Portugal.
E-mail: nuno.psicologia@outlook.pt

*Corresponding author

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