Openness to Accept Medical Technology – A Cultural View

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Abstract. Technology acceptance is a widely acknowledged key player in explaining technology adoption. However, there is a notable knowledge gap concerning the impact of cultural factors on technology acceptance, especially in the medical sector. It is evident though that countries differ greatly regarding their technical proneness, development and usage habits what should have considerable impact on acceptance. This study compares the openness to accept medical technology in Germany, Poland and Turkey. 300 respondents (19-85 years, 56% women, 38% chronically ill) participated in a survey, in which the pros and cons for using medical technologies were examined as well as the underlying acceptance motives and utilization barriers. The effects of different cultures, but also of age, gender and health status were analyzed regarding their impact on acceptance patterns. Results reveal both, culturally insensitive as well culturally sensitive acceptance, with strong effects of gender and exercising frequency. Overall, the study corroborates the importance of cultural views on technology acceptance.

Keywords: cross-cultural survey, technology acceptance, medical technology, cardiac illness, acceptance barriers.

1 Introduction

The last decades were characterized by a rapid development of new technical systems, accompanied by fast changing technology cycles, area-wide penetrations of information and communication technologies (ICT), and their pervasive implementation in many fields of social living. The latter development has profound socio-technical consequences. Technology use in private spheres is affected by and is also affecting societal structures and organizational procedures. Different from former times, where only small portions of people were factually working with specific technology in a professional context, today, a diverse user group is confronted with the use of a myriad of technical devices across all fields of professional and private concerns. In the next decennia new generations of technologies, services, and products based on computer technologies will have to master fundamental global societal and technological challenges: the graying society with an increasingly aged work force, the raising need for medical technology for the aged to be continuously

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integrated in the social environments of persons and an increase in the complexity of technologies to be handled by diversely skilled persons. More than ever, usable interfaces, a broad understanding of these technologies as well as slick user experience will be critical success factors for acceptance, sustainability and competitive capacity of any technical system.

1.1 Technology Acceptance

Technology acceptance and technology adoption, respectively, describes the approval, favorable reception and ongoing use of newly introduced devices and systems. The first model of technology acceptance model (TAM) had been formulated and empirically validated by Davies et al. [1]. It refers to *the ease of using a system* (the degree to which a person believes that using a particular system would be free of effort) and *the perceived usefulness* (the degree to which a person thinks that a technical system increases job performance) as the two main determinants.

Even though the TAM was confirmed by many studies, one of the main criticisms of the TAM was that external factors such as the influence of individual user variables on technology acceptance were almost completely disregarded. In later refinements of the model (e.g. [2]), social and cognitive processes of users interacting with technology were added, which influence technology adoption behaviors (performance expectancy, effort expectancy, social influence, and facilitating conditions). Also, individual factors received attention to impact the technology acceptance. Although the vital importance of ensuring that the technology produced is both usable and appropriate for a diverse user group, recognition of the importance of diversity is only slowly influencing mainstream acceptance studies [3, 4, 5]. Design approaches thus have to undergo a radical change taking current societal trends into account, which have considerable impact for the inclusion of a diverse user group. Yet, only few studies concentrated on the diversity of users and their acceptance patterns [6, 7, 8, 9, 43, 44], even though it is clear from daily life experience that people may have different adoption behaviors due to individual characteristics.

1.2 Cultural Impact on Technology Acceptance

Another blind spot of existing models of technology acceptance is their cultural neutrality or, still worse, their ignorance to cultural impacts on acceptance. Still, the development of technology seems to be tailored to predominately young, technology experienced, Western, middle- and upper class males [5, 10, 11, 12]. Up to now there is a notable lack of knowledge on how society and culture affect the technology acceptance and the underlying reasons for or against technology usage [13, 14]. Comparably few studies have been concerned with the investigation of technology acceptance across national boundaries [15, 16, 17, 18]. Undoubtedly, existing knowledge about technology acceptance – mostly referring to highly-developed western countries – cannot be simply transferred to other cultures, as the cultural beliefs and values form a cultural mental model [19], which definitively impacts technology acceptance in a differential way [13, 20, 21, 22].

Persons do not use a single technology in isolation, but within a social and cultural context. These contextual factors are influencing how humans are acting with technology; the use of technology modifies the embedding context [5]. Social taboos, legal and political constraints as well as ethics, religious traditions and values differ across cultures. Thus, users around the world may differ in perception, cognition and style of thinking, cultural assumptions and values. This especially applies to underdeveloped countries, but also to countries, which experienced a quick technology change over the last years, striving for economic welfare and closing the technological gap to highly developed countries [23].

Culturally informed medical technology acceptance is another prominent issue [24, 25]. Whether medical technology is accepted in different cultures depends to a large extent on cultural mindsets of family caring, as well as on cultural ageing concepts [4] and prevailing health-care structures [25], which might imply a different form of social and societal responsibility of others. Also, the cultural handling of illness and the acceptance of end of life decisions are highly culturally sensitive [26, 27, 28].

1.3 The Specificity of Acceptance Towards Medical Technology

In most of the studies, technology acceptance had been examined and validated for ICT, predominantly in a job-related context. This is due to the context in which the TAM had been developed. In the 1980ies, when personal computers entered the offices national wide, there was a considerable need to understand technology adoption behaviors in the working context. A transfer of its assumptions on medical technology acceptance is highly disputable though [3, 7, 9]. Rather, it is reasonable to assume that the acceptance of medical technology distinctly differs from acceptance patterns of ICT technologies: First, medical devices are used not just for fun, but out of (critical) health states and vital medical reasons. Second, beyond its importance for patients' safety and the feeling of being safe, medical technology touch on "taboo" areas associated with disease and illness [4], which has an intricate impact on acceptance. Third, recent studies report that medical technical assistance is often perceived as breaking into persons' intimacy and privacy spheres and leads to a feeling of being permanently controlled [4, 29]. Recently it had been found that users – in case of using a medical device – reported to fear to be continuously controlled, while this was not ascribed to a device in the ICT context (mobile phone) [30]. Finally, a higher heterogeneity in user groups and an even stronger impact of individual factors on acceptance is expected for medical technologies, as users/patients might be far older than "typical ICT-users" and they might additionally suffer from multiple physical and psychological restraints in comparison to healthy user groups.

1.4 Questions Addressed and Logic of Research Procedure

If we want to recognize the impact of technology adoption on persons' social lives, a deeper understanding of technology acceptance is needed. Yet, hardly any study so far considered cultural factors on the acceptance of medical technologies. This was undertaken in the current study. Users in three different countries (Germany, Poland and Turkey) were examined regarding the extent of medical technology acceptance, thereby learning the specificity of pro-using arguments as well as usage barriers. The intention of the recruitment procedure of respondents was to reach a healthy mix of all ages, genders and health conditions, as well as diverse education and income levels across the three countries. This was done primarily on a “best-effort” basis, starting from face-to-face visits to cardiology departments of several different hospitals with the help and/or by selected members of the author’s extended social networks. A small handful of younger and middle-aged participants were reached by online advertisements in medical forums. Special care was taken to not primarily employ the author’s networks to recruit “the usual suspects” of university students for the younger aged group, as it is widely known that external validity is low in participants’ which do not represent the whole target group [31, 32].

2 Methodology

The following section presents the methodology and research model of this study.

2.1 Research Model

The acceptance of and intention to use medical technology was measured with 19 items in total, divided into nine pro items and ten contra items (depicted in Table 1), each on a 4-point Likert scale ranging from 4 (“agree”) to 1 (“do not agree”). The items were developed and tested in earlier studies [15, 42], based on interviews and focus-groups with participants suffering from chronic cardiovascular diseases.

Table 1. Pro items (Cronbach’s α = .903) and Contra items (α = .864) used in three surveys. English translations were done for illustration purposes and did not undergo revision.

PRO	**CON**
Yes, I use / would use medical technology, because …	No, I do not use / I would not use medical technology ,because
I would feel safer.	I do not want to be ruled by technology.
I could see the doctor less often.	I do not want to be annoyed by technology with bad usability.
I would be able to live independently at home.	I do not need it.
I would be relieved of my health responsibilities.	It is too complicated for me.
I find it convenient to not have to remember everything myself (drugs, doctor appointments, measuring vitals...)	I think it is unreliable.
	It can't change my health status.
I would stay mobile in spite of illness.	I cannot stand total supervision.
I would not be a burden for others.	I do not want others to learn of my illness.
I would stay mentally fit in spite of old age and illness.	I do not want to be constantly reminded of my illness.
My health would improve.	I am afraid of false information.

Pro arguments, measuring the perceived benefits and motives to use medical technology, were summed up to a scale ranging from minimum 4 points to a maximum of 36 points (full acceptance and intention to use medical technology). Contra arguments, measuring utilization barriers and motives against the use of medical technology, were also summed up to a scale from 5 to 40 (40 = full rejection and distrust regarding medical technology). Reliability analysis with standardized Cronbach's alpha reached excellent values for Pro (.903) and Con (.864).

In Figure 1, the research model is illustrated. The Pro and Con scales were the *two dependent variables* in this study, each analyzed according to *seven independent variables*: (1) country, (2) age, (3) gender, (4) heart disease, (5) exercise frequency and (6) ICT technology acceptance, measured via 9 items each for (6a) perceived ease of use (PEU) and (6b) perceived usefulness (PU) of mobile phones, chosen based on previous research for the three countries under study [15]. PEU mobile and PU mobile were each measured with 9 items and summed up to a scale with maximum 36 (easy to use / very useful). Standardized Cronbach's alpha values for PEU mobile (.886) and PU mobile (.860) were also very high.

To maintain groups of satisfactory sample size during analysis, median-splits had to be employed for age (50 years), exercise frequency (once per week), PEU mobile (25 out of max 36) and PU mobile (24 out of max. 36). This furthermore kept the analysis complexity manageable. "Best guess" tests without median-split (where appropriate) showed that loss of power was tolerable.

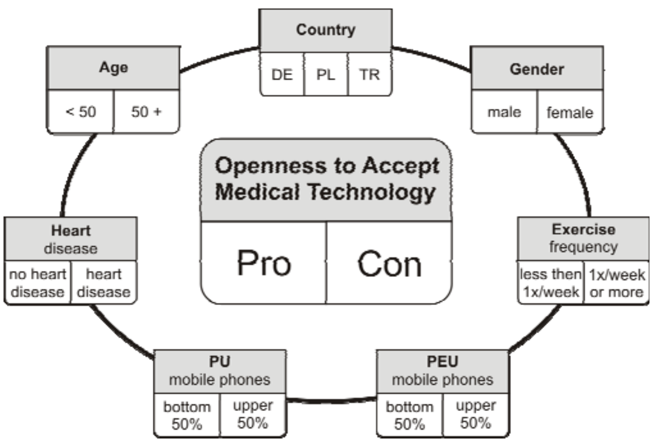

Fig. 1. Research model: dependent variables Pro and Con surrounded by independent variables

2.2 Questionnaire

In order to reach a large number of participants from three different countries and with respect to the diversities in culture, age and health status, the questionnaire-method was employed. The questionnaire was designed to obtain specific data of four main categories: (a) demographic data (country, age, gender, education, profession, income), (b) health status and related variables (chronic cardiovascular condition, risk factors, coping styles, exercise frequency), (c) technology experience (PEU and usability of ICT), and (d) acceptance and intention to use medical technology (pro / contra arguments). Whether participants suffer from a chronic cardiovascular condition (henceforth "heart disease") was self-reported and ranged from having chronic high blood pressure over coronary heart disease to having a heart transplant. The questionnaire was first developed in German during earlier studies [15, 42] and revised by a sample of older adults (n = 10) as well as two usability experts with respect to issues of comprehensibility and wording of items. After passing this quality control step, the questionnaire was translated into Polish and Turkish by professional translators. The final version of the questionnaire consisted of closed multiple-choice questions, using a four-point Likert scale to help force a choice and reduce complexity. The items ranged from "agree" (4) to "do not agree" (1). Every item-block further had a field for additional remarks. The total time to fill in the questionnaire took 20-30 minutes, depending on the health status of the participants.

2.3 Participants

The data of N = 300 respondents were analyzed in this study (see Fig. 2). Of these, 72 (24%) live in Germany, 111 (37%) in Poland and 117 (39%) in Turkey. There were 114 (38%) participants with heart disease, of which 67 (59%) were female.

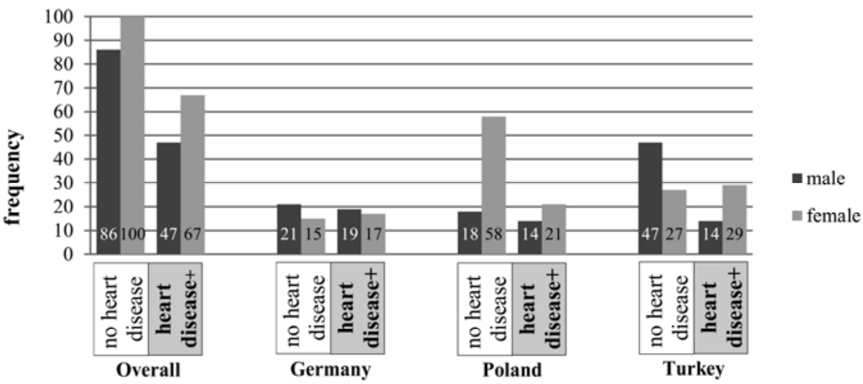

Fig. 2. Frequency distribution of study participants (N = 300)

Participant's age ranged from 19 to 85 (m=50.7; SE=.891). The age distribution is depicted in Fig. 3. An age analysis via three-way independent ANOVA (sig. p=.05) revealed significant main effects of country (F(2, 288) = 11.608; p < .000), showing that Polish participants were the youngest (m_{PL}=44.7), followed by German participants (m_{DE}=50.2). Turkish participants were the oldest group (m_{TR}=56.5). Participants with heart disease also significantly differed by age across countries (F(1, 288) = 68.216; p < .000), with participants without heart disease being younger ($m_{no\ heart\ d.}$=45.4) than those with heart disease (m_{heart}=59.2). Furthermore, there was an interaction of country * gender * heart disease (F(2, 288) = 3.265; p = .040). No further interactions were found.

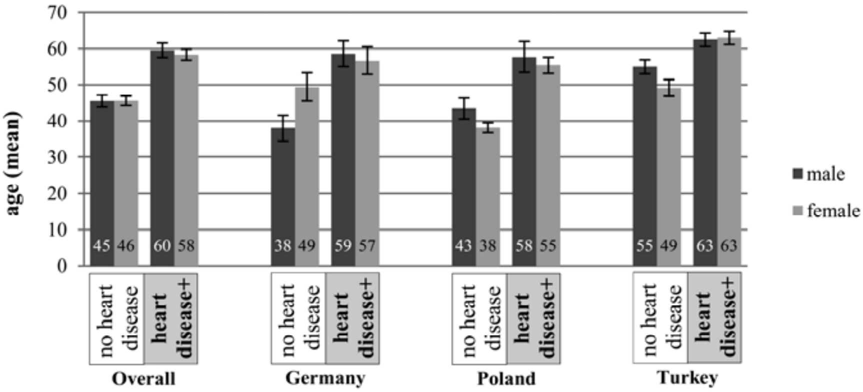

Fig. 3. Age distribution by country, gender and heart disease. Error bars show 95% CI

3 Results

Results are presented in a top-down fashion, first describing effects in the overall study sample, and then analyzing more specific effects, like e.g. effects in-between countries. Beforehand, the employed statistical tests are introduced.

3.1 Employed Statistical Tests

Results were analyzed by Spearman's rank correlations, t-tests and analysis of variance (ANOVA) with Games-Howell post-hoc tests to control type I error rates. Type I error rates were set to $\alpha = 5\%$ (two-tailed), i.e. the chance to have a false positive result is at most 5%. Type II error rates were set to $(1–\beta) = 80\%$, i.e. the chance to detect a genuine effect (if one exists) is at least 80%. Due to the exploratory nature of this study, some results are presented which did not reach the defined error rates. For these results, the exact error rates are computed and reported with the help of the software G*Power 3.1.3 [33].

Games-Howell post-hoc tests for ANOVAs were all re-run and reported via t-tests, as long as they yielded the same results. For effect sizes, Cohen's d was chosen, where d =.2 is referred to as a small effect, d =.5 as a medium effect and d =.8 as a large effect [34]. Effect sizes for nonparametric tests are reported via Pearson's r, with .1, .3 and .5 referred to as small, medium and large effects respectively.

If assumptions of the parametric tests were violated, the nonparametric equivalent test was run and reported. Overall, t-tests and ANOVAs proved very robust with respect to violations of normality, but often parametric tests showed increased effects sizes, albeit very small increases. Only very different variances led to poor type II errors in parametric tests. In those cases, the appropriate nonparametric results are reported.

3.2 Comparing Overall Pro/Con Totals

First, the motives for using medical technology, divided into Pro and Con arguments, were compared overall and by country. For clarity, results were scaled to percent, with 100% representing the maximum (36 points for pro, 40 points for con) and values greater 50% acceptance. Results show that there is a greater tendency towards using medical technology, as depicted by the increased pro results compared to con (see Fig. 4). The countries differed significantly in their pro scores (Welch's F(2,170) = 3.251; p = .41). On average, polish participants had higher Pro scores than Turkish participants (t(226) = 2.459; p = .015), representing a small effect (d = .331; (1-β) = .70). Con arguments also differed across countries (Kruskall-Walis: H(2) = 6.037; p = .049), showing less Con for Germany than Turkey, but the small effect missed a satisfactory type II error rate (t(187) = 2.066; p = .040; d = .300; (1-β) = .50).

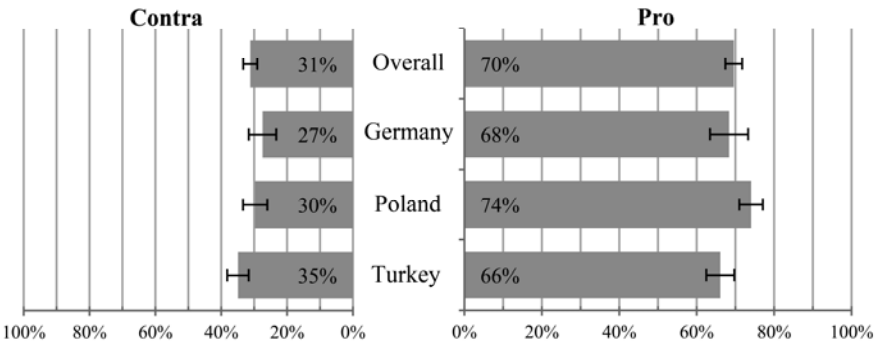

Fig. 4. Pro and Con for medical technology scores by country, scaled to percent, all participants (N = 300). Values >50% equal agreement, 100% is full agreement. Error bars show 95% CI.

3.3 Correlation Analysis between Variables

To guide the following analyses, Spearman's rank correlations were computed (see Table 2). While Con only had one small negative correlation with Pro (r = -.209; p < .001), Pro had three more small correlations with: females (r =.147; p < .01), exercise frequency (r =.177; p < .001) and PU (r = .132; p <. 05).

Table 2. Intercorrelations (Spearman's rank, 2 tailed) of research variables with all participants (N = 300). Only significant values p< .05 are shown (*p< .01; ***p< .001).

N = 300	**Pro**	**Con**	**age**	**gender**	**heart d.**	**exercise**	**PEU**
Pro							
Contra	-.209***						
Age							
gender	.147*						
heart disease			.442***				
exercise	.177***		-.133		-.150*		
PEU mobile			-.516***	-.175***	-.345***	.192***	
PU mobile	.132		-.358***	-.173***	-.294***	.154*	.785***

Age has a medium-to-large correlation with heart disease (r = .442; p < .001) and medium-to-large negative correlations with the technology dimensions PEU and PU. These findings conform to earlier research [3, 4, 6, 35] and show that younger adults and males relate to higher technology experience even across countries.

3.4 Comparing Pro/Con Overall

Detailed effects of the independent variables on Pro and Con are shown in Fig. 5. Overall, when splitting participants into low-Con and high-Con groups via median-split (mdn_{Con} = 16) and comparing differences in Pro scores, the low-Con group (m=29.04; SE=.572) scored higher on Pro than the high-Con group (m=26.72; SE=.542), which is a highly significant difference (t(298) = 2.948; p = .003), representing a small effect (d = .342). This result was alluded to from earlier correlation analysis. For Pro (max 36 points), there was a very significant difference for gender (t(298) = 2.751; p = .006), with females scoring higher (m=28.75; SE=.491) then men (m=26.57; SE=.640), representing a small effect (d = .319; (1-β) = 79%). Also, exercising frequency had a very significant effect on Pro (t(298) = 3.340; p = .001), with participants exercising once per week or more scoring higher (m=28.84; SE=.477) then participants exercising less frequently (m=26.16; SE=.673), representing a small-to-medium effect (d = .387; (1-β)= 92%).

Effects of perceived usability of mobile phones (PU mobile) on Pro missed statistical significance (t(298) = 1.810; p = .071) and was of small size (d = .210). With N = 300 participants, this small effect can only be detected with (1-β) = 44% probability, suggesting a false positive effect of PU on Pro. No statistically significant differences were found on Con by independent values.

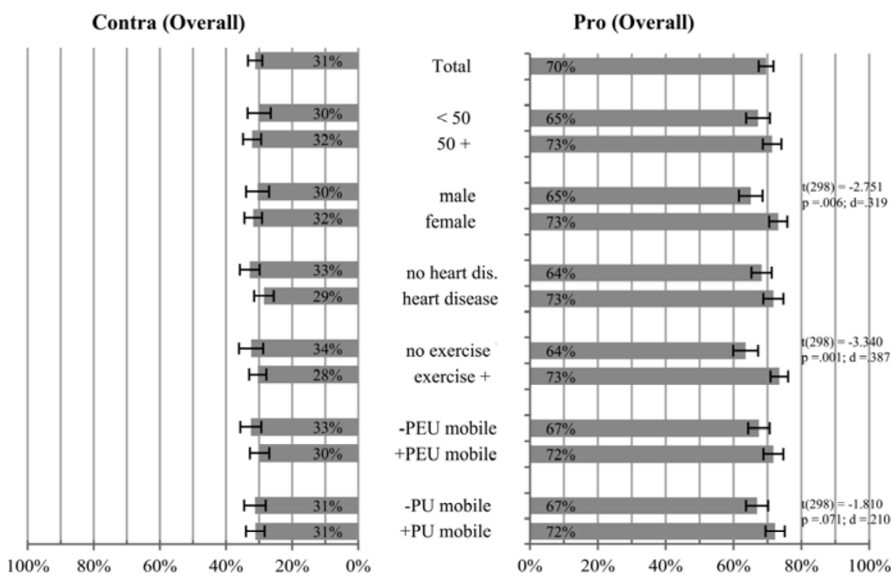

Fig. 5. Pro and Con for medical technology scores, compared by median-splits of independent variables, scaled to percent, all participants (N = 300). Error bars show 95% CI.

There was a significant interaction effect (see Fig. 6 (left)) between age and exercise on Pro scores (F(1, 296) = 10.324; p = .001), indicating that older adults had significantly higher Pro scores when exercising at least once per week (m=30.33; SE=.506) compared to older participants that do not exercise that often (m=25.43; SE=.866). There was no significant effect of exercise frequency on younger adult's Pro scores. The same interaction between age and exercise frequency was also found for Con scores (see Fig. 6 (middle)), but missed statistical significance (F(1, 296) = 3.210; p = .074). A mirror interaction effect of said effect of age and exercise frequency on Pro scores was found for heart disease and exercise frequency on Pro, but missed statistical significance (F(1, 296) = 2.776; p = .097).

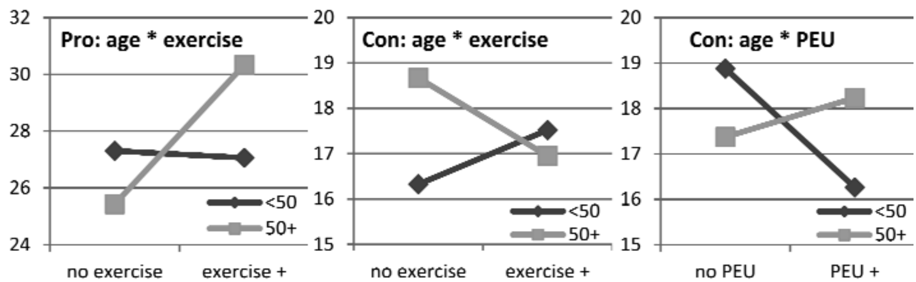

Fig. 6. (Left): interaction graph of age * exercise on Pro. (Middle): interaction graph of age * exercise on Con. (Right): interaction graph of age * PEU on Con.

For Con, there was an interaction of age * PEU (F(1, 296) = 4.340; p = .038) (see Fig. 6 (right)). While older adult's Con scores remained unaffected by PEU, younger adults with low PEU (m=18.88; SE=1.120) scored higher on Con than younger adults with high PEU (m=16.26; SE=.651).

3.5 Pro/Con in Germany

The distribution of Pro and Con values in Germany is depicted in Fig. 7. No statistically significant effects were found. German participants who exercise less than once per week (m=25.80; SE=1.382) scored lower compared to those that exercise at least once per week (m=29.03; SE=1.135), but this effect missed statistical significance (t(70) = 1.814; p = .074) and was too small to be reliably detected in a group of this size (N = 72; d = .434; (1–β) = 44%).

3.6 Pro/Con in Poland

The distribution of Pro and Con values in Poland is depicted in Fig. 8. On the Pro scale, younger Polish adults (m=27.81; SE=.760) scored significantly lower compared to older adults (m=30.93; SE=.697), which was highly significant result (t(109) = 2.792; p = .006) of medium size (d = .535;). Polish participants with heart disease (m_{Pro}=30.80; SE_{Pro}=.803; m_{Con}=15.11; SE_{Con}=1.207), compared to those without (m_{Pro} =28.16;

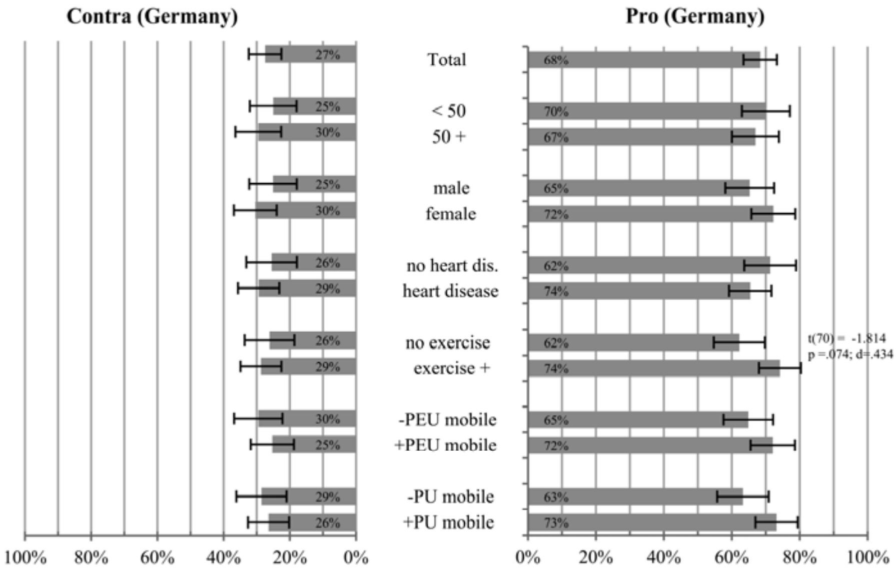

Fig. 7. Pro and Con for medical technology scores in Germany (N = 72), compared by median-splits of independent variables, scaled to percent. Error bars show 95% CI.

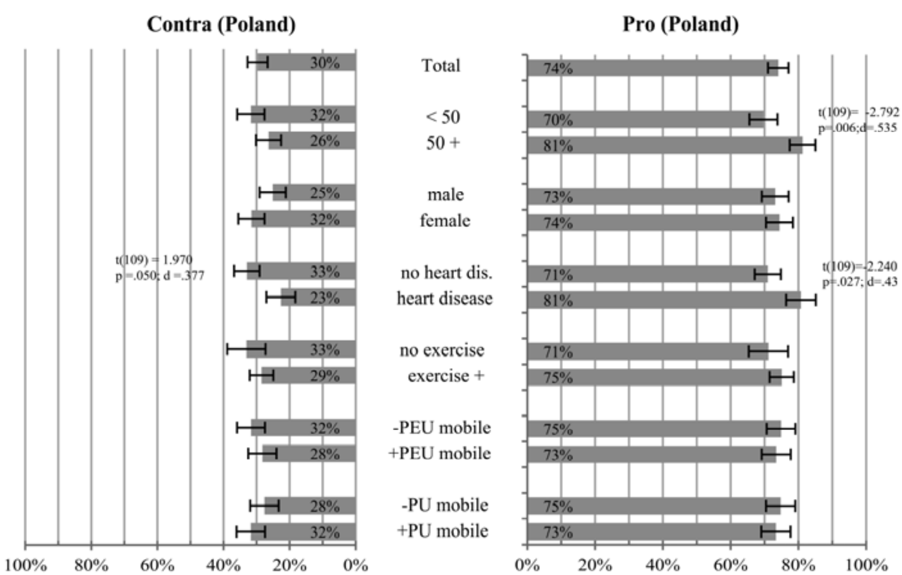

Fig. 8. Pro and Con for medical technology scores in Poland (N = 111), compared by median-splits of independent variables, scaled to percent. Error bars show 95% CI.

SE_{Pro}=.709; m_{Con}=17.89; SE_{Con}=.803), showed higher acceptance of medical technology on both Pro ($t_{Pro}(109) = 2.240$; $p_{Pro} = .027$) and Con ($t_{Con}(109) = 1.970$; $p_{Con} = .05$) scales. The small-to-medium sized Pro effect (N = 111; d = .429; (1–β) = 60%) and Con effect (d = .377; (1–β) = 50%) did not fully reach the desired power of 80%, but the higher prevalence of heart disease in older adults (see Chapter 3.3) and the significant age effect that was found increase the likelihood of a genuine effect.

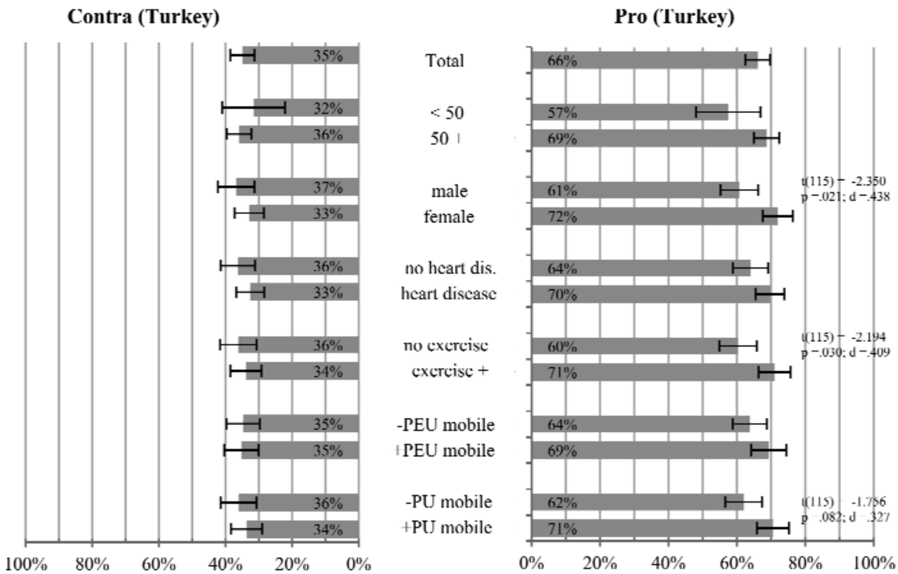

Fig. 9. Pro and Con for medical technology scores in Turkey (N = 117), compared by median-splits of independent variables, scaled to percent. Error bars show 95% CI.

3.7 Pro/Con in Turkey

The distribution of Pro and Con values in Turkey is depicted in Fig. 9. The effects mimic the effects found in the overall sample (see 3.4), although less pronounced. Older adults in Turkey (m=28.43; SE=.806), compared to younger adults (m=25.39; SE=1.009), showed higher Pro scores overall (t(115) = 2.35; p = .021), representing a small-to-medium effect, but did not achieve enough power (d = .438; (1–β) = 65%). Participants that exercised regularly (m=28.17; SE=.857) also showed higher Pro scores (t(115) = 2.194; p = .030) compared to less frequently exercising adults (m=25.30; SE=.1004), revealing a small-to-medium effect, again missing the type II error mark (d = .409; (1–β) = 59%). As in the overall sample, perceived usefulness also increased Pro scores, but missed significance criteria as well (t(115) = 1.756; p = .082; d = .327; (1–β) = 42%).

3.8 Differences in Pro/Con in between Countries

Countries differed in several variables (see Fig. 10). Gender analysis revealed significant differences across countries (Welch's F(2, 81) = 3.841; p = .025), with Turkish males (m=25.39: SE=1.009) scoring lower than Polish males (m=28.75; SE=.727). This effect was mirrored on Con scores as well (F(2, 130) = 4.493; p = .013), with higher Con scores in Turkish males (m=18.93; SE=.808) and more reservation against medical technology than Polish (m=15.78; SE=.960) or German males (m=15.78; SE=.966), as alluded to by correlation analysis in Chapter 3.3.

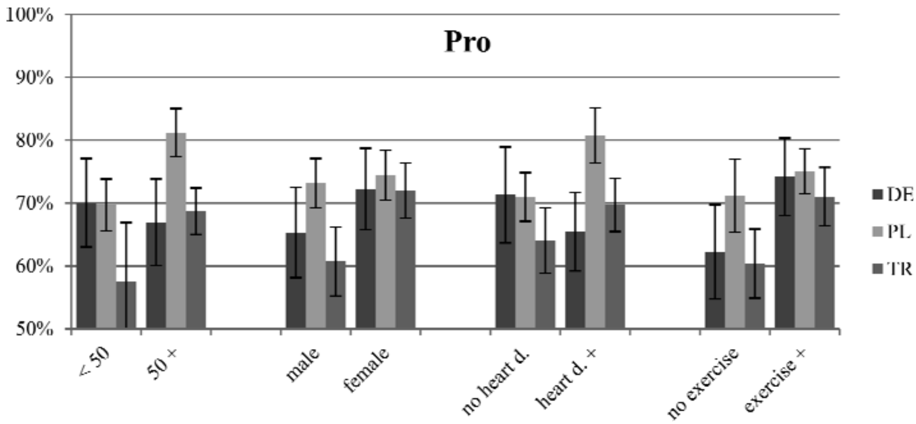

Fig. 10. Pro scores for medical technology (percent) by country (N_{DE}=72; N_{PL}=111; N_{TR}=117), compared by median-split of age, gender, heart disease and exercise. Error bars show 95% CI.

Of the two technology experience scales PEU and PU, only low PU had a difference across countries on Pro scores (Welch's F(2, 82) = 4.330; p = .016). Here, participants within the lower group of PU scores from Germany (m=26.09; SE=1.393) and Turkey (m=25.74; SE=.987) scored lower than participants in Poland (m=29.18; SE=.791).

Analysis of age by country showed significant main effects of age (F(1, 294) = 4.309; p = .39) and country (F(2, 294) = 5.699; p < .000). Fig. 11 shows that older adults alone differed very significantly in their Pro scores across countries (F(2, 168) = 4.851; p = .009), with older adults from Poland (m=30.93; SE=.697) scoring higher than those from Germany (m=27.08; SE=1.269) and Turkey (m=27.54; SE=.679). Participants with heart disease across countries showed the same effect (F(2, 111) = 5.144; p = .007), which may be due to the higher prevalence of heart disease in older adults (see Chapter 3.3). It is interesting to note that the apparent trend of participants in Poland and Turkey, to increase in Pro scores from younger to older adults, did not occur in Germany, although this interaction effect did not reach statistical significance (country*age: F(2, 294) = 2.152; p = .118). The same trend was observable in participants with heart disease, but the interaction also did not reach significance (country*heart disease: F(2, 294) = 2.057; p = .130).

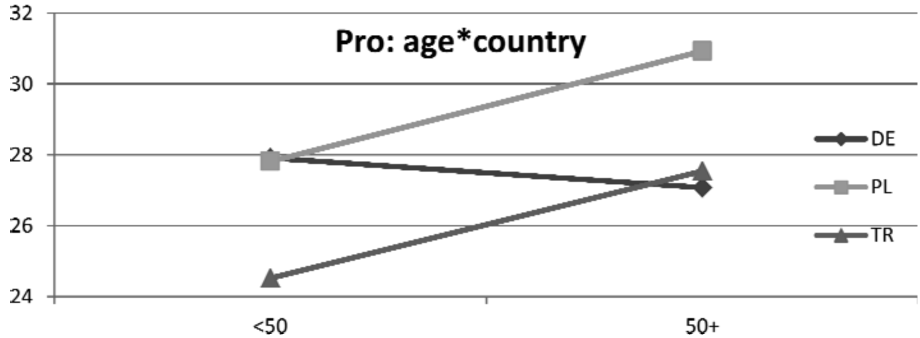

Fig. 11. Differences in Pro scores (absolute) for medical technology by country, compared by median-split of age (N_{DE}=72; N_{PL}=111; N_{TR}=117)

3.9 A Special Look at Gender and Heart Disease

As the previous results suggested that gender and chronic heart disease have significant effects on medical technology acceptance, a more detailed analysis is warranted. An analysis of gender and the technology variables PEU (Fig. 12, left) and PU (Fig. 12, right) again revealed significant main effects of gender ($F(1, 296) = 11.385$; $p < .000$), but this time also PEU ($F(1, 296) = 6.446$; $p = .012$), as well as a significant interactions of gender * PEU ($F(1, 296) = 6.491$; $p = .011$). When graphing the results, it interesting to note that PEU had no effect on women's pro scores, but pro scores of males with low PEU (m = 23.98; SE = 1.180) were significantly lower than the scores of males with high PEU (m = 28.76; SE = .599). The exact duplicate effect was found when analyzing gender and PU, although the interaction of gender * PU was only marginally significant ($F(1, 296) = 2.931$; $p = .088$).

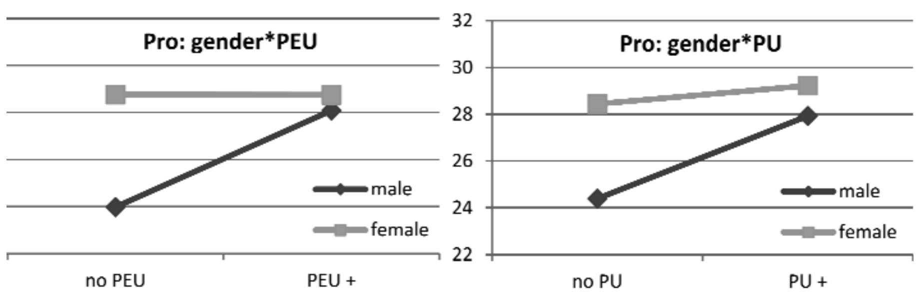

Fig. 12. Interaction graphs of (left) gender * PEU on Pro, and (right) of gender*PU on Pro

Exercising frequency also has an interesting gender component (Fig. 13, right). Again, both gender ($F(1, 296) = 6.920$; $p = .009$) and exercise ($F(1, 296) = 9.725$; $p = .002$) show significant main effects where again male's pro scores increased significantly from no exercise (m = 24.55; SE = 1.012) to exercising at least once per week (m = 28.34; SE = .752). The interaction gender * exercise missed marginal significance ($F(1, 296) = 2.572$; $p = .110$). Comparing exercise and heart disease

(Fig. 13, left), exercising showed a significant main effect ($F(1, 296) = 13.989$; $p < .000$), but while there was no significant main effect of heart disease and only a marginally significant interaction heart disease * exercise ($F(1, 296) = 2.776$; $p = .097$), t-tests revealed ($t(112) = 3.349$; $p < .000$) that participants with heart disease that exercised regularly had significantly higher (m = 25.92; SE = .820) pro scores than those that exercised less than once per week (m = 30.35 ; SE = .632), revealing a large effect (d = .821; (1–β) = 99%).

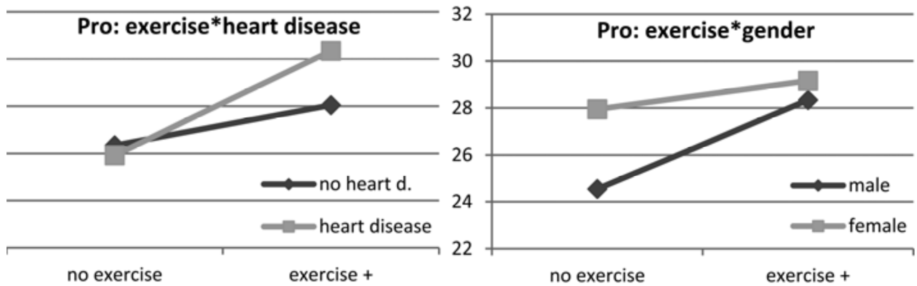

Fig. 13. Interactions of (left): exercise*heart disease on Pro, (right): exercise*gender on Pro

4 Discussion

The present study aimed to investigate the different acceptance factors for medical technology across countries from Europe to the Middle East. Differentiated by motives for use (Pro arguments) and usage barriers (Con arguments), the study analyzed the contributions of individual factors, such as age, gender, exercising frequency, as well as technology experience and chronic cardiovascular disease, on motives for using medical technology. Overall, a quite large group of 300 participants in all countries took part, with a wide age range (19-85 years) and gender equality (56% women). Also, 38% of participants (across countries) were reached in order to analyze the impact of health states on medical technology acceptance.

Before discussing the results, including the study's limitations and implications for future research, it is worthy to note that the acceptance of medical technology is a highly sensitive topic, touching on intimate and personal aspects, and is in many ways different from the usage and acceptance of ICT from the perspective of users, even though the underlying technology might be the very same [30]. Participants showed high interest in the topic as well as high willingness to participate and contribute to the understanding of medical technology, which was valid for all three countries. There was an increased awareness for the societal needs of medical technology and significant motivation to share one's opinions and fears. Apparently, questions about one's individual aging and potential confrontation with medical technology are topics that people are aware of and with which they are dealing thoroughly.

A first insight refers to an overall evaluation of the extent of medical technology acceptance. Results reveal a considerably higher willingness to use medical technology compared to perceived usage barriers, as is reflected by the Pro scores outweighing the Con scores about 7:3, independently of country of origin (even though the absolute extent of pro vs. con differed across cultures). Thus, the weighing of "more pro" than "con" using motivation can be referred to as a culture-unspecific and universal, respectively. It was furthermore reassuring to find that older participants scored equally well as younger participants. This may be due to the fact that older participants may need medical technology more than younger participants, increasing the perceived usefulness of medical technology [7], which in turn might positively influence acceptance scores. This was especially true in this study sample, since heart disease was more prevalent in older participants, and can be summarized in one participant's commentary:

> *"Having to cope with my chronic illnesses, I would like to point out that I'm looking forward to every device that could help ease my life."*
> - Turkish female, 74, suffering from diabetes and multiple heart diseases

In all results obtained in this study, most striking were the effects of gender and exercise on acceptance patterns. Women in particular displayed much higher acceptance of medical technology, although utilization barriers showed no gender effects. This suggests that while both males and females seem to share the same doubts, women are generally more open to medical technology than males. Male participant's acceptance (pro) scores did only catch up to women's scores when a) males exercise at least once per week, although exercising had a positive effect on women's pro scores as well, or b) when males, especially in Turkey, have high scores in PEU and PU. Generally, the effects of PEU and PU were weak overall, especially for women, mostly just affecting only young males. Even though the ender effect in this study was clear and showed a higher openness to use medical technology in female users, a cautionary note regards the "simplicity" of this outcome. Recent studies showed [3, 9] that women's higher openness to medical technology tilts over when not the general usage of medical technology but the acceptance of a specific medical technology has to be evaluated Women's positive attitude towards medical technology declines considerably when it comes to the question of accepting body near or even invasive medical technology (e.g. [9]), in which the perceived risk of physical harm is high. The same applies if a smart robot supporting medial care at home has to be evaluated ([3]): Whereas for both gender the usage motives as well as the usage barriers play an important role for explaining the intention to use a smart robot, women showed an overall lower acceptance to accept a technical device in the caring context at all. In addition, women's acceptance was moderated by age, showing that there is a greater difference in acceptance between younger and older women than it is within the group of men. Thus, gender effects seem to be a highly complex in the medical technology context, torn between gendered differences in social role taking, reluctance to take risks and technology affinity.

This again confirms that traditional acceptance models, like e.g. the TAM, cannot simply be translated and adopted for health related technologies [3, 4, 5, 6, 7, 8, 9].

Furthermore, it was quite unexpected to find such a profound impact of exercising frequency. With participants older than 50 years of age, or those participants suffering from a chronic heart disease, an exercising frequency of at least once per week significantly increased acceptance (pro) scores and reduced barriers (con). It would be interesting to study if this increase in pro and decrease in con scores is connected to a) the increase in mental capacity in older patients who exercise regularly [36], b) increased health awareness and consequently higher perceived usefulness of health related applications, c) personality traits, such as higher conscientiousness in the "big five" [37], or a mixture of all.

Based on these findings, the most receptive target demographic for medical technology products seem to be older women with a chronic cardiovascular condition that exercise regularly, especially in Poland.

Of the three countries studied, each has a unique history and current economical standing, and Poland and Turkey each show a special motivation towards technology, possibly due to wanting to close the economical gap to more developed countries [23], such as Germany. This difference might be reflected in the trend displayed in Fig. 11, where Polish and Turkish participants significantly increased in their acceptance of medical technology as they aged, which was absent in Germany. It is also interesting to note that Turkish participants generally show lower acceptance and more utilization barriers. It would be interesting to see if this might be based on religious aspects [14, 16], as in the following unique commentary (Turkish male, 57):

> *"I am a 57 year old Imam, who was ill only once in his life and who is still carrying the hepatitis B virus (1978). Since then I've always been healthy and have not visited a doctor ever again. I believe that an Imam has to be his own best doctor."*

We should be aware that the claim for "universal access" and the overcoming of the "digital divide" always implies a specific cultural system. Since technology development and designs across countries are highly desirable but intricate on global markets, a deep understanding and appreciation of factors underlying technology acceptance, beyond national boundaries and cultural contexts, is of high importance.

5 Limitations of the Approach and Future Research Duties

Even though the present study revealed interesting insights into cultural facets of technology acceptance patterns, it - of course – can be only a glimpse into medical technology acceptance. We are definitively aware that, strictly speaking, "cultural effects" have been treated quite superficial in this study and this applies to the conceptualization, operationalization and analysis of cultural acceptance, given the many facts of underlying drivers within culture and technology utilization behaviors.
Future studies will have to scrutinize the nature of the culturally formed acceptance, and some of the future research duties are shortly outlined here.

- So far, we only divided the sample according to "health" and a generic category of "heart diseased". Next studies will have to differentiate different forms and extents of heart diseases, and compare the acceptance patterns of heart-affected people to people suffering from other chronic illnesses. This would allow a deeper understanding if acceptance and coping strategies do follow a more universal "illness" pattern or, whether kind and form of chronic disease might impact acceptance differentially [38, 39].
- Another shortcoming regards the selection of countries and culture, respectively. Due to the personal family background of authors we selected these three

countries. We learned that there are large differences regarding the impact and value of family responsibility, commitment and care for the aged and chronically ill across the three countries [15]. Beyond the comparison of these three countries, a more detailed approach would be welcome that informs about the country specific ageing policy, ethical and societal values regarding illness and end of lives and the acceptance of medical technology as part of it.

- Also, the impact of the technical standard and technical development of a country is assumed to form acceptance for medical technology in addition [23]. Here, it would be insightful to include other countries that differ in their technical development (e.g. Nigeria [40] or Japan [41]).
- A next point addresses the type of medical technology, which was not yet differentially investigated in this study. Rather, “medical technology” was used quite generic. However, kind, type and specific characteristics of medical technology differ grossly, ranging from invasive medical technology (e.g. stent, [9]), medical technology implemented in clothes [9] up to mobile devices used in a medical context [30, 38, 39].
- The impact of gender [3,9] and religion [14, 16] with respect to the handling of body-related ethics are distinctive factors that should be further addressed.

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