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Evaluation of Social-Cognitive Determinants of Patients' Hand Hygiene Decisions and the Role of Mental Health in a Cross-Sectional and a Longitudinal Study of German Patients

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Abstract: Patients' effective hand hygiene helps to reduce healthcare-associated infections and prevents the spread of nosocomial infections and communicable diseases, such as COVID-19. Accordingly, this study aimed to describe effective hand hygiene decisions based on the Health Action Process Approach (HAPA) and whether this pattern is invariant for mental health. Data were collected cross-sectionally from patients who had previously been admitted to a hospital ($N_{study\ 1}$ = 279; study 1) and longitudinally from psychosomatic rehabilitation patients ($N_{study\ 1}$ = 1073; study 2). The fit of the HAPA framework and changes in hand hygiene decisions regarding compliance, social-cognitive variables of the HAPA, and mental health status were examined. The results revealed that the trimmed HAPA framework fitted the data well (χ^2 = 27.1, df = 12, p < 0.01, CMIN/df = 2.26, CFI = 0.97, RMSEA = 0.08). According to multi-group structural equation modeling, the HAPA model with hand hygiene behavior was found to be invariant regarding mental health. To conclude, the trimmed HAPA framework was revealed to be a generic framework for explaining social-cognitive processes relating to hand hygiene decisions. Therefore, helping individuals to perform hand hygiene recommendations requires intention formation and bridging the intention–behavior gap. This can be undertaken by promoting planning and self-efficacy. All processes appear generic to participants with and without mental health challenges.

Keywords: hand hygiene; compliance; health action process approach; mental health; depression; generalized anxiety

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1. Introduction

The prevention of communicable diseases and infections is key for overall population health and safety, especially in susceptible populations such as patients [1]. The prevention and containment of viruses and infections received elevated attention during the COVID-19 pandemic [2]. Horga and colleagues, for example, examined non-pharmacological measures implemented in the management of the COVID-19 pandemic. Their results highlighted that social distancing, wearing masks, and hand hygiene were associated with the reproduction rate of the SARS-CoV-2 Virus [3]. Especially in hospital settings, many attempts were made to ensure effective hand hygiene behavior of patients and healthcare professionals to reduce healthcare-associated infections, such as the use of antiseptics [3,4]. It was shown that hand hygiene behavior is a cost-effective way of reducing COVID-19 morbidity and is accepted as a crucial strategy to prevent the spread and transmission of COVID-19 in healthcare facilities such as hospitals [5,6]. Since still relatively little is

known about patients' hand hygiene behavior in hospitals, the aim of this study is to examine patients' hand hygiene and its determinants [7,8]. This is especially important as many patients are often not sufficiently aware that they can actively participate in hand hygiene and thus protect themselves, and others, from infections. It is, however, crucial to understand barriers to good hand hygiene in hospitals in detail in order to effectively increase compliance [9].

In comparison to other preventative measures, especially hygiene behaviors, maintenance of hand hygiene behavior in hospital settings has been rather low, thus calling for a better understanding of the reasons for the lack of performance and maintenance [10]. Even though individuals are often motivated to change their behavior, this initial motivation or intention does not always translate into an actual behavior change due to the intention–behavior gap [11]. Furthermore, it has been shown that even if a desired health behavior, such as hand hygiene behavior, is acquired, individuals may experience difficulties in maintaining this behavior over time and in the face of difficulties. This may result in a relapse to old behavioral habits or patterns [12].

As the regulations to stop or prevent the spread and transmission of the COVID-19 virus have been introduced by the government, individuals were required to change or alter their behavior over a considerable time [13]. Several theories of social cognition have been used to provide an understanding of determinants of health-related behaviors such as hand hygiene behavior. The theory of planned behavior (TPB) as a classic and fundamental health behavior theory [14] and the Transtheoretical Model of Behavior Change (TTM) have widely been used to explain and predict health behaviors [15]. One of the main criticisms of those theories is, however, that they neglect or struggle to address the intention–behavior gap. Therefore, it has been suggested that those traditional models need to be expanded to include a volitional phase in which individuals develop actions after having formed an intention.

The Health Action Process Approach (HAPA) is an example of a theoretical behavior change model that includes both motivational and volitional phases. The HAPA is known as a well-established theoretical framework that describes behavior changes by means of modeling social-cognitive determinants of behavior [16]. One important determinant is the intention to change, which is determined by positive and negative outcome expectancies, belief in one's ability to perform the behavior (action self-efficacy), and acknowledgment of being at risk for not behaving in a healthy way (risk perception). If the intention is high, self-regulatory skills, planning on when, where, and how to perform the desired behavior, as well as having the belief that the individual can engage in the desired behavior despite possible adversities (coping self-efficacy), determine action initiation. To maintain healthy behavior, individuals need to be confident in their ability to sustain the behavior (maintenance self-efficacy) and need to monitor their behavior (action control) to prevent relapse [16–18].

The COVID-19 pandemic has increased the burden on the mental health of individuals. As a result, individuals have reported an increase in perceived distress, anxiety, and symptoms associated with depression or loneliness [19,20]. However, the questions as to whether those individuals have adapted their hygiene behaviors need further analysis. The literature has shown that mental health and compliance with recommended preventive behaviors are associated with one another, thus creating a feedback loop [21,22]. Further, evidence examining anhedonic depression in the context of the COVID-19 pandemic has shown an association between depression and precautionary behaviors, i.e., that depressive symptoms can be a barrier to effective precautionary behaviors [23]. Furthermore, it has been shown that anhedonia has been frequently linked to poorer physical health outcomes, which may be explained by reduced self-care behaviors and self-regulatory strategies [24,25]. In addition, a decreased mental health status during the COVID-19 pandemic has been associated with more difficulties in adhering to health-related behaviors over a longer period of time [26].

Previous studies have shown that with regard to symptoms of depression, motivational deficits are associated with a reduced intention to engage in health behaviors [27]. Depressive symptoms have also been associated with a decrease in self-efficacy and an increase in negative outcome expectations. Depressive individuals have also shown volitional deficits as they are less able to transform intentions into actions and show reduced planning and maintenance self-efficacy capabilities [28]. According to these findings, it may be assumed that individuals with depressive symptomatology may display reduced intentions to engage in effective hand hygiene decisions.

Despite the previous findings suggesting the association between mental health and deficits related to the social-cognitive variables, and consequently health behavior and outcomes, these associations have rarely been examined with regard to hand hygiene behavior. Thus, the present study will investigate whether hand hygiene decisions can be explained by a health behavior theory, namely the Health Action Process Approach (HAPA; [11,29]), and whether the pattern of the HAPA is invariant for the mental health of the study participants.

One study by Gaube et al. [1] has aimed to evaluate the hand hygiene behavior of patients specifically by applying the HAPA model, with inconclusive results. Self-efficacy, action control, and planning were not able to fully bridge the intention–behavior gap. Therefore, the present study aims to validate previous studies on precautionary behaviors by examining the potentially important role of planning in overcoming the intention–behavior gap in hand hygiene. In addition, previous studies have not acknowledged the possible association between mental health and preventative measures (i.e., hand hygiene) in the context of the HAPA. Therefore, the current study will evaluate the HAPA determinants in the context of hand hygiene while acknowledging the role of symptoms of depression and anxiety, therefore examining the invariance of the HAPA model for mental health.

In the first study, the fit of the HAPA model to hand hygiene data will be evaluated with mental health as a moderating covariate to see whether mental health will add additional variance to hand hygiene decisions beyond social-cognitive variables. In a second study, the role of mental health in the change of compliance in individuals with a pre-existing vulnerability (i.e., psychosomatic rehabilitation patients) will be evaluated in a longitudinal design. As vulnerable individuals have revealed motivational and adherence problems concerning health behaviors, it is important to test whether the HAPA is robust for such potential differences. It is assumed that as psychosomatic rehabilitation patients receive behavior change interventions during their treatment, they will be more motivated to engage in hand hygiene behavior over time. Therefore, the following research questions will be tested in study 1: (a) Is the HAPA model applicable to hand hygiene decisions in patients? (b) Does a structural equation model, specified in terms of the social-cognitive variables of the HAPA, fit the data? (c) To what extent are hand hygiene decisions and their social-cognitive determinants invariant for mental health? Study 2 examined the research question: (d) Is mental health predictive of a change in hand hygiene compliance rates?

2. Materials and Methods

To test these hypotheses, two samples were recruited via a pragmatic sample: people from the general population as a cross-sectional online sample (study 1) and patients from four psychosomatic rehabilitation clinics for the longitudinal analyses (study 2). Figure 1 provides an overview of the study design and the variables used in both studies 1 and 2.

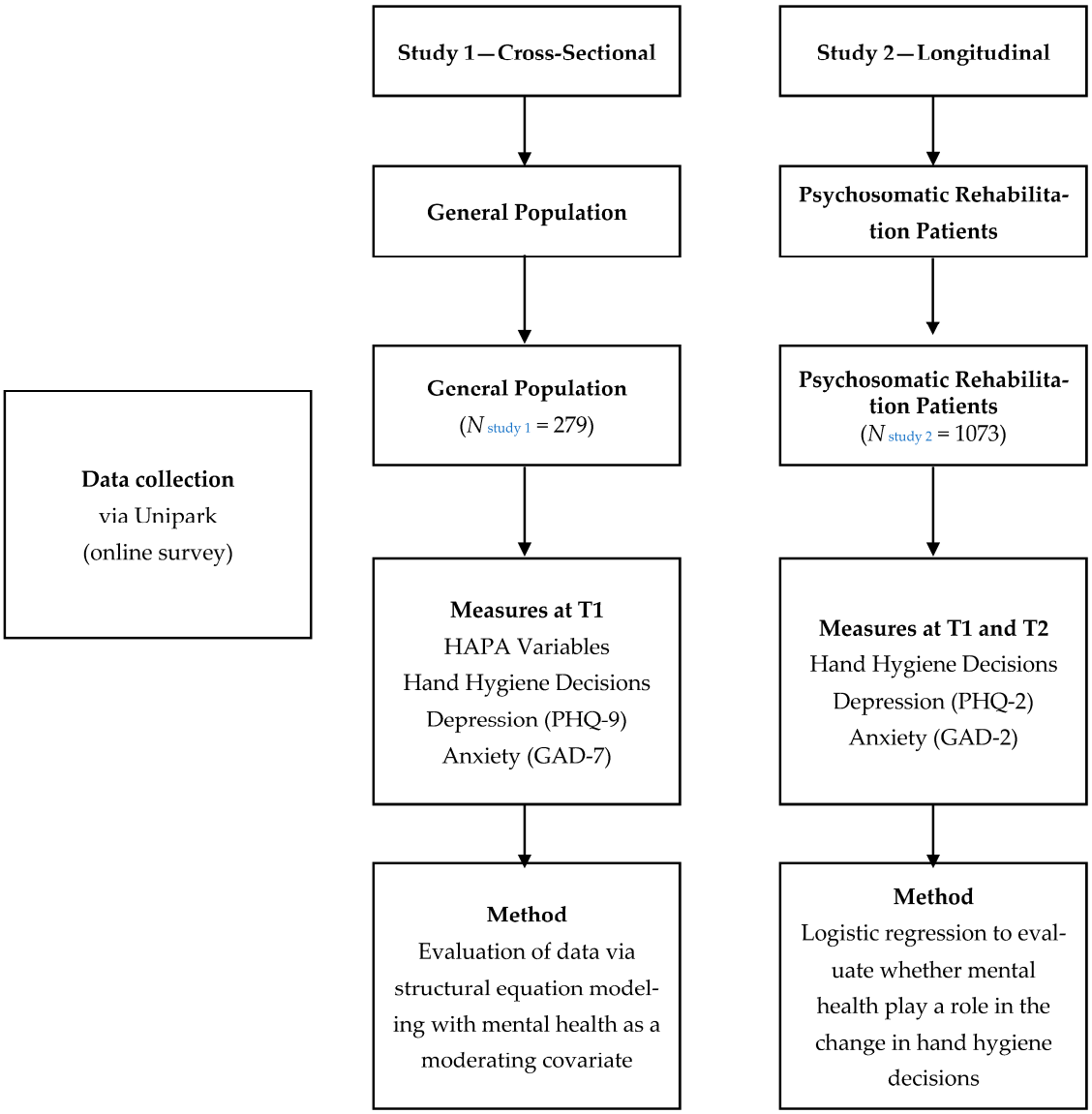

Figure 1. Flow Chart and Study Design of the cross-sectional and longitudinal study.

2.1. Study 1: Cross-Sectional Study

2.1.1. Procedure and Participants

Participants ($N_{study\ 1}$ = 279) were recruited through press releases, social networks, and study homepages to answer an online survey. Only those indicating being admitted to a clinic during the last 60 months were included in the subsequent analyses. Data were collected anonymously between November 2019 and June 2020 in Germany in three waves before SARS-CoV-2 (n = 97), during the first lockdown (n = 85), and after lockdown measures were reduced (n = 97) (no significant differences were found for social-cognitive variables and mental health variables between the three measurement timepoints except for resources and support, see Appendix A). All participants were informed about the purpose of the survey and data security measures, and were asked to indicate informed consent. The study was approved by the Ethics Committee at Jacobs University (now Constructor University; ClinicalTrials.gov Identifier: NCT04453475).

Participants who had previously been admitted to a hospital as either an inpatient or an outpatient completed the online questionnaire (194 (69.5%) female, 16 (5.7%) missing) (no significant differences were found for social-cognitive variables and mental health symptoms (i.e., depression and anxiety) with regard to time between hospital visit and

partaking in the survey, see Appendix B). Age ranged from 18 to over 60 years. Subjectively perceived symptoms of depression and anxiety were evaluated during the last two weeks by means of a self-reported measure. A total of 206 (73.8%) participants revealed no depressive symptoms, while 42 (15.1%) participants showed depressive symptoms according to the threshold by Kroenke and colleagues [30]. A total of 224 (80.3%) participants revealed no symptoms of generalized anxiety, whereas 33 (11.8%) revealed symptoms above the threshold according to Spitzer and colleagues [31].

2.1.2. Measures

Socio-Demographic Information

Socio-demographic data included patients' age and sex. Age was assessed in five categories ("younger than or 29 years old", "30 to 39 years old", "40 to 49 years old", "50 to 59 years old", and "60 years and older"). Sex was categorized into two groups ("men" and "women").

Hand Hygiene Decisions and HAPA Constructs

The questionnaire used to investigate social-cognitive variables of the HAPA model [32] was adapted for the purpose of hand hygiene behavior in primary healthcare settings. Risk perception was assessed using a single item on a seven-point Likert scale on which 1 indicated 'Significantly below average', and 7 indicated 'Significantly above average'. Action self-efficacy ($\alpha = 0.87$) was investigated by four items on a six-point Likert scale from 1 'Not at all' to 6 'Completely'. Outcome expectancies ($\alpha = 0.83$) were measured using five items on a six-point Likert scale from 1 'Not at all' to 6 'Completely'.

Intention ($\alpha = 0.68$), action planning ($\alpha = 0.92$), and coping planning ($\alpha = 0.78$) were assessed using two questions each on a six-point Likert scale, where 1 indicated 'Not at all', and 6 indicated 'Completely'. However, according to the literature, action and coping planning have frequently been combined as "planning", increasing the content validity of the predictor. Hence, planning ($\alpha = 0.86$) was used as a general construct for the following analysis [33,34]. Maintenance self-efficacy ($\alpha = 0.91$) was assessed by three items on a six-point Likert scale from 1 'Not at all' to 6 'Completely'. Mean scores for all HAPA constructs were computed. Measures of hand hygiene decisions were adapted from the recommendations provided by the "Clean Hands Campaign". Hand hygiene decisions were measured by twelve items on a five-point Likert scale (1-'Never'; 5-'Always'; $\alpha = 0.87$). Hand hygiene decisions were measured retrospectively after discharge.

Mental Health Status

Symptoms of depression were assessed using the PHQ-9, which is a self-report depression module of the Patient Health Questionnaire, on a four-point Likert scale from 0 'Not at all' to 3 'Nearly every day' by asking patients to think about the past two weeks. For the analysis, composite mean scores were computed. A sum score of $\geq$10 depicts the cut-off value for the symptom threshold. Cronbach's alpha was 0.89 in primary care settings [30].

The GAD-7, a self-report measure of generalized anxiety disorder symptoms, was used to determine the symptom threshold of generalized anxiety. The seven items were measured on a 4-point Likert scale from 0 'Not at all' to 3 'Nearly every day'. The questionnaire requires patients to think about the past two weeks. A sum score of $\geq$10 represents the cut-off value for the symptom threshold for symptoms of generalized anxiety. Primary validation estimated a Cronbach's alpha of 0.86 [31].

The PHQ-9 and the GAD-7 were not used as diagnostic tools in this study but, rather, were used to highlight symptoms associated with depression and anxiety.

2.1.3. Data Analysis

A bivariate correlation table (Table 1), including all HAPA variables, was used to examine correlations between the social-cognitive variables and hand hygiene decisions. Furthermore, structural equation modeling (SEM) with latent variables was performed to

test whether the HAPA fitted the data, as well as to examine whether planning mediated the behavior-intention gap. For SEM fit, indices including chi-square (χ^2), degrees of freedom (*df*), chi-square to df ratio (CMIN/df), *p*-values for χ^2-Test, Comparative Fit Index (CFI), and root mean square error of approximation (RMSEA) were evaluated. A model is evaluated to have a good fit to the data if the following fit indices have been fulfilled: a CFI and TLI with values higher than 0.90 and a value of below 0.08 with regard to the RMSEA [35]. As the χ^2 statistic is dependent on the sample size, the χ^2/df ratio was used as a goodness-of-fit criterion for the purposes of this paper. As suggested by [36], χ^2 should not be larger than 2–5 times the degrees of freedom. The model with the best-fit indices was used for multi-group structural equation modeling to test for invariances across subsamples. Differences in the HAPA constructs and hand hygiene behavior between individuals below and above the symptom threshold for psychological symptoms were analyzed by latent means. Hence, mental health was treated as a moderating covariable.

Table 1. Correlations between Health Action Process Approach (HAPA) constructs, hand hygiene decisions, and mental health status of *N* = 279 participants.

	α	***M***	***SD***	**ASE**	**OE**	**RISK**	**INT**	**MSE**	**PL**	**RES**	**SUP**	**HYG**	**DEP**	**ANX**
ASE	0.87	19.13	4.28	-										
OE	0.83	24.61	3.83	0.41 **	-									
RISK	- [1]	3.16	1.33	−0.20 **	0.03	-								
INT	0.68	10.04	1.87	0.55 **	0.50 **	−0.08	-							
MSE	0.91	19.58	3.99	0.56 **	0.48 **	−0.08	0.55 **	-						
PL	0.86	12.43	5.34	0.40 **	0.38 **	−0.14 **	0.40 **	0.28 *	-					
RES	0.81	20.28	5.03	0.27 **	0.34 **	0.03	0.21 **	0.26 **	0.16 **	-				
SUP	0.92	5.82	3.15	0.27 **	0.30 **	0.05	0.24 *	0.06	0.33 **	0.44 **	-			
HYG	0.87	48.12	7.98	0.39 **	0.32 **	−0.20 **	0.52 **	0.44 **	0.36 **	0.22 **	0.12 *	-		
DEP	0.86	5.89	4.75	−0.08	−0.03	−0.04	0.01	−0.03	0.01	−0.12	−0.07	−0.07	-	
ANX	0.85	4.70	3.82	−0.08	−0.03	−0.08	0.03	−0.10	0.01	−0.05	−0.10	−0.01	−0.48 **	-

Note. HAPA variables: ASE = Action Self-Efficacy, OE = Outcome Expectancies, RISK = Risk Perception (single-item), INT = Intentions, MSE = Maintenance Self-Efficacy, PL = Planning, RES = Resources, SUP = Social Support, HYG = Hand Hygiene Decisions, DEP = Depression, ANX = Anxiety; α = Cronbach's alpha, * $p < 0.05$, ** $p < 0.01$, *M* = Mean, *SD* = Standard deviation; [1] Risk perception was examined via a single item. Therefore, no Cronbach's alpha can be provided. *N* = 279.

2.1.4. Missing Data

The amount of missing data per item was below 5% for both samples. Participants with missing data on the social-cognitive variables were included in the analysis if they had at least one non-missing data point under the assumption of missing (completely) at random. Missing data were imputed via the full information likelihood method (FIML) in AMOS v. 28.

2.2. Study 2: Longitudinal Study

2.2.1. Procedure and Participants: Longitudinal Study

Participants ($N_{\text{study 2}}$ = 1073) were recruited through four psychosomatic rehabilitation clinics from the Dr. Becker clinic group between July 2020 and August 2021. Data collection was performed longitudinally with two measurement timepoints. Data was collected from six weeks until the first day of the rehabilitation treatment and up to 12 weeks post-rehabilitation treatment. All participants were informed about the purpose of the study as well as associated data security measures on the clinic's own study portal.

Ethical approval for the study was obtained by Jacobs University on 17 September 2019 (protocol code 2020_09; date of approval: 25 June 2020; the Ethics Committee at Jacobs University (now Constructor University; ClinicalTrials.gov Identifier: NCT04453475). In total, $N_{\text{study 2}}$ = 1073 participants took part in the study at both timepoints (before rehabilitation and after rehabilitation). Patients' age, measured in categories, ranged from 18 to above 60 years. The most frequently reported age group was between 50 and 59 years (50.6%). A total of 697 (65.4%) patients reported to be female.

2.2.2. Measures

Changes in Hand Hygiene Decisions

Measures for socio-demographic information were the same as in the cross-sectional study. Participants from the psychosomatic rehabilitation clinics (longitudinal study) were asked to answer a stage item assessing the intention to perform hand hygiene behavior on a 5-point Likert scale (1 = No, I do not intend to; 2 = No, but I have thought about it; 3 = No, but I have decided to do it; 4 = Yes, but it is hard for me; 5 = Yes, and it is easy for me). Answers were dichotomized as "non-compliant" (1–3) and "compliant" (4–5). For patients progressing from non-compliant at the first timepoint to compliant at the second timepoint, a '1' was coded. Conversely, for patients regressing, a '−1' was coded. With respect to patients who did not change their compliance, a '0' was coded.

Mental Health Symptoms

To measure depressive symptoms during the past two weeks, the PHQ-2 was administered which is part of the Patient Health Questionnaire-4 (PHQ-4) with two items [37] on a 4-point Likert scale from 0 'not at all' to 3 'nearly every day'. A scale sum score of $\geq$3 (T1 Spearman's rho = 0.83; T2 Spearman's rho = 0.85) depicts the cut-off value between the normal range and a probable case of depression [38]. The PHQ-2 was used as a self-reported measure of symptom intensity.

In addition, the generalized anxiety index was examined via the GAD-2 which is a questionnaire part of the PHQ-4 [39]. The GAD-2 encompasses two items measuring symptoms of generalized anxiety during the past two weeks on a 4-point Likert scale from 0 'not at all' to 3 'nearly every day'. A sum score of $\geq$3 [40] serves as the cut-off value between the normal range and a possible case of a generalized anxiety disorder (T1 Spearman's rho = 0.80; T2 Spearman's rho = 0.83). In contrast to the GAD-7, the GAD-2 was only used as a measure of symptom intensity.

The PHQ-2 and the GAD-2 were not used as diagnostic tools in this study but, rather, were used to highlight symptoms associated with depression and anxiety.

2.2.3. Data Analysis

To evaluate whether mental health (i.e., depression and generalized anxiety) played a role in changes in compliance regarding hand hygiene decisions, the change was evaluated by a logistic regression analysis controlling for gender and age. An odds ratio with a 95% confidence interval was used to report the effect size estimate. Wald static was used as an indicator of the significance of each regression coefficient in the binary logistic regression. All analyses were conducted using IBM SPSS v.28 and AMOS v.28.

3. Results

3.1. Study 1

3.1.1. Scale Internal Consistency and Correlations between Constructs

Table 1 shows bivariate correlations between the social-cognitive variables for participants.

3.1.2. Structural Equation Modeling

To examine links between HAPA variables, structural equation modeling was performed (see Figure 1). The hypothesized model had a poor fit with the proposed data according to the literature [41,42]. Fit indices for the model were as follows: χ^2 = 339.20, df = 19; $p < 0.001$, CMIN/df = 17.85, CFI = 0.53, and RMSEA = 0.25. Standardized estimates for each path are reported in Figure 2.

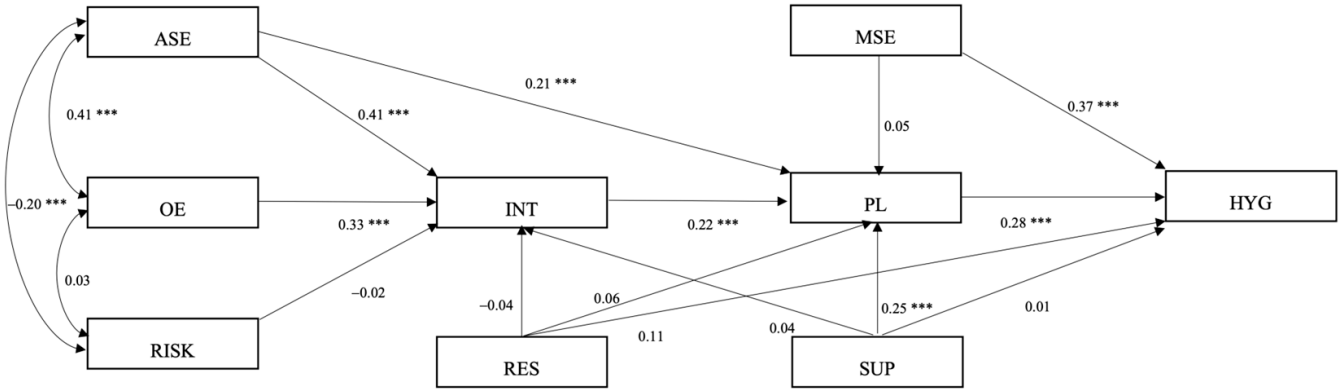

Figure 2. Structural equation modeling of the full Health Action Process Approach. Note: HAPA variables: ASE = Action Self-Efficacy; OE = Outcome Expectancies, RISK = Risk Perception; INT = Intentions; MSE = Maintenance Self-Efficacy; PL = Planning, RES = Resources, SUP = Social Support, HYG = Hand Hygiene Decisions; $N_{\text{study 1}}$ = 279; Intention R^2 = 39.5%; Planning R^2 = 19.8%; Hand Hygiene R^2 = 21.6%. The values reported represent the standardized estimates of each path in the model. Significant path at *** $p < 0.001$.

Considering age and gender, as well as depressive and generalized anxiety symptoms as covariates, modifications proposed by AMOS lead to a final adaption of the HAPA framework with a reasonably good fit: χ^2 = 27.1, df = 12, $p < 0.01$, CMIN/df = 2.26, CFI = 0.97, and RMSEA = 0.08. The standardized estimates for each path in the trimmed HAPA framework are reported in Figure 3. All paths were significant at either $p < 0.01$ or $p < 0.001$ ranging between ß = −0.20 and ß = 0.43. All covariates were revealed to be non-significant except for symptoms of generalized anxiety which were associated with hand hygiene behavior, ß = −0.16, $p < 0.05$. Adding mental health as a moderating covariate to the model increased variance from 38.1% to 39.3% of explained variance regarding intention and from 21.8% to 23.5% for planning. All HAPA variables were able to explain 31.9% of the variance in hand hygiene decisions and 33.2% when mental health was added as a moderating covariate to the model. However, the increase in variance was revealed to be not significant.

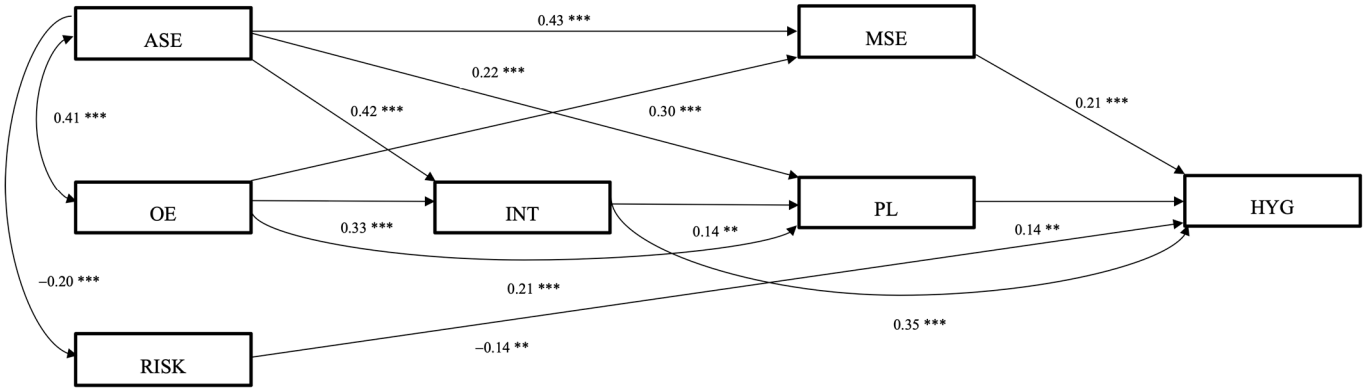

Figure 3. Structural equation modeling of the trimmed Health Action Process Approach. Note. HAPA variables: ASE = Action Self-Efficacy; OE = Outcome Expectancies, RISK = Risk Perception; INT = Intentions; MSE = Maintenance Self-Efficacy; PL = Planning; HYG = Hand Hygiene Behavior; $N_{\text{study 1}}$ = 279; Intention R^2 = 39.3%; Planning R^2 = 23.5%; Hand Hygiene R^2 = 33.2%. The values reported represent the standardized estimates of each path in the model. Age, gender, depressive symptoms, and symptoms of generalized anxiety were included as covariates. Significant path at *** $p < 0.001$, ** $p < 0.01$.

3.1.3. Latent Mean Differences across Mental Health Status

To test for potential differences in the HAPA constructs from the trimmed HAPA framework (Figure 3) between patients above and below the symptom threshold for generalized anxiety and depression, a three-step multi-group analysis was conducted applying (1) an unrestricted model, (2) a semi-restricted model, and (3) a fully restricted model. All were subsequently compared with the χ^2 difference indices according to Yuan and Bentler [43].

Regarding depression, the indices indicated a good fit for the unrestricted, semi-restricted, and full-restricted models (Table 2). Hence, χ^2-difference tests between the unrestricted and semi-restricted model ($\chi^2(12) = 11.29$, $p = 0.501$) and between the semi-restricted and fully restricted model ($\chi^2(15) = 11.38$, $p = 0.734$) were performed and did not reach significance. The results confirmed measurement invariance and allowed for group comparison. This suggests structural equivalence [43], stating that, for patients above and below the symptom threshold for depression, the HAPA constructs were equivalent concerning their structural pattern and magnitude. Therefore, no differences were detected concerning the symptomatology of depression in the pattern of relationships.

Table 2. Model fit indices for the unrestricted model, the semi-restricted model, and the fully restricted model for the multi-group mental health status model for individuals below and above the symptom threshold for depression ($N_{\text{study 1}} = 279$).

Indices	Unrestricted Model	Semi-Restricted Model	Fully Restricted Mode
χ^2—Test of model fit	40.49	51.77	63.15
df	16	12	27
χ^2	$p < 0.01$	$p < 0.01$	$p < 0.05$
CFI	0.94	0.94	0.95
TLI	0.85	0.92	0.95
Model 1 Delta TLI	–	−0.07	−0.09
RMSEA (90% CI)	0.08	0.06	0.04

Note. *df* = degrees of freedom, χ^2 = Chi square, CFI = comparative fit index, TLI = Tucker–Lewis Index, RMSEA = root mean square error of approximation.

With regard to symptoms of anxiety, indices again indicated a good fit for the unrestricted, semi-restricted, and full-restricted model (Table 3). Hence, a χ^2-difference test between the unrestricted and semi-restricted model ($\chi^2(12) = 10.884$, $p = 0.543$) and between the semi-restricted and fully restricted model ($\chi^2(15) = 23.17$, $p = 0.082$) was performed and did not reach significance. The results confirmed measurement invariance and allowed for group comparison. Hence, for patients above and below the symptom threshold for generalized anxiety, the HAPA constructs were equivalent concerning their structural pattern and magnitude. Therefore, no differences were detected concerning the symptomatology of generalized anxiety in the pattern of relationships.

With the results showing that factor loadings and covariances were invariant across individuals below and above the symptom threshold for depression as well as anxiety, the assumption for latent mean analysis was met. Therefore, it was analyzed to determine if the latent means of the HAPA constructs of the trimmed framework were different across individuals below and above the symptom threshold for depression and generalized anxiety. To estimate the latent mean differences between groups, the group below the symptom threshold for depression and generalized anxiety operated as a reference group. The latent mean was fixed to zero, against which the latent means of the other group were compared. The latent mean for the other group, above the symptom threshold for depression and generalized anxiety, was freely estimated.

Table 3. Model fit indices for the unrestricted model, the semi-restricted model, and the fully restricted model for the multi-group model of individuals below and above the symptom threshold for generalized anxiety ($N_{\text{study 1}}$ = 279).

Indices	Unrestricted Model	Semi-Restricted Model	Fully Restricted Model
χ^2—Test of model fit	29.75	40.63	63.80
df	16	12	27
χ^2	$p = 0.020$	$p = 0.062$	$p = 0.013$
CFI	0.97	0.97	0.97
TLI	0.92	0.95	0.95
Model 1 Delta TLI	-	−0.03	−0.03
RMSEA (90% CI)	0.06	0.04	0.04

Note. *df* = degrees of freedom, χ^2 = Chi square, CFI = comparative fit index, TLI = Tucker–Lewis Index, RMSEA = root mean squared error of approximation.

Analysis of latent means of HAPA constructs revealed no significant differences between individuals below the symptom threshold and above the symptom threshold for depression and generalized anxiety (Table 4).

Table 4. Latent Mean Analysis: Mean estimates, standard error, and critical ratio ($N_{\text{study 1}}$ = 279).

	ASE	OE	RISK	INT	MSE	PL	HYG
With symptoms of *depression* in comparison to the reference group without depressive symptoms							
Mean estimate (ME)	−0.194	−0.090	−0.137	0.049	−0.239	0.050	0.016
Standard error (SE)	0.163	0.126	0.238	0.154	0.150	0.282	0.018
Critical ratio (CR)	−1.252	−0.715	−0.576	0.320	−1.159	0.177	0.907
p	0.233	0.475	0.565	0.749	0.110	0.859	0.365
With symptoms of *anxiety* in comparison to the reference group without symptoms of anxiety							
Mean estimate (ME)	−0.227	−0.102	−0.310	0.068	−0.072	0.127	−0.043
Standard error (SE)	0.212	0.136	0.242	0.176	0.168	0.294	0.029
Critical ratio (CR)	−1.073	−0.752	−1.280	0.384	−0.429	0.433	−1.466
p	0.283	0.452	0.201	0.701	0.668	0.665	0.143

Note. HAPA variables: ASE = Action Self-Efficacy; OE = Outcome Expectancies, RISK = Risk Perception; INT = Intentions; MSE = Maintenance Self-Efficacy; PL = Planning; HYG = Hand Hygiene Behavior.

3.2. Study 2

Changes in Compliance and Its Predictors

To analyze whether mental health presents as a predictor in changes regarding compliance or non-compliance in hand hygiene decisions, data from the longitudinal sample of psychosomatic rehabilitation patients were used. Table 5 shows the distribution and transitions of compliance with hand hygiene decisions from before to after rehabilitation.

Table 5. HAPA stage distributions and changes of the longitudinal sample ($N_{\text{study 2}}$ = 1058).

		Time 2 (after Rehabilitation)		
		Non-Compliance	Compliance	Total
Time 1	Non-compliance	25 (45.46)	30 (54.54)	55 (100)
	Compliance	47 (4.69)	956 (95.31)	1003 (100)

Note. Numbers in parentheses represent percentages of $N_{\text{study 2}}$ = 1058.

Stages of compliance differed significantly regarding hand hygiene behavior ($F(1, 1064) = 2152.79$, $p < 0.01$): those who were compliant had an average compliance score of 4.80 ($SD = 0.40$) compared to non-compliant patients ($M = 2.11$; $SD = 0.76$).

The results of the binary logistic regression indicate that neither symptoms of depression nor generalized anxiety were significant predictors of change in compliance. Odds ratios, Wald statistics, and descriptive data are summarized in Table 6.

Table 6. Summary of results from the binary logistic regression analysis and descriptive data for mental health variables and control variables predicting changes in compliance in hand hygiene decisions (n = 71).

Predictors	Wald	OR	95% CI_{OR}	p-Value	Remaining in Baseline		Change in Compliance	
					M	*SD*	*M*	*SD*
Change in compliance: remaining non-compliant (0) versus progression (1)								
Depression	1.03	1.36	0.75–2.48	0.31	2.79	1.14	3.27	1.89
Anxiety	0.32	0.84	0.45–1.57	0.58	2.84	1.25	3.10	1.69
Change in compliance: remaining compliant (0) versus regression (1)								
Depression	1.14	1.15	0.89–1.48	0.29	3.45	1.66	3.83	1.61
Anxiety	0.05	0.97	0.75–1.26	0.84	3.61	1.67	3.82	1.35

Note. CI_{OR} = 95% confidence interval of the OR.

4. Discussion

The current study aimed to evaluate, as part of study 1, whether the theoretical structure of the HAPA model with its social-cognitive variables predicting health behavior can be fitted to hand hygiene decisions and whether the model is invariant for mental health (i.e., symptoms of depression and anxiety). Study 1 especially investigated whether planning is able to bridge the intention–behavior gap. Our results support the hypothesis evaluating interrelations between all HAPA variables and hand hygiene decisions: all variables (except for risk perception) were positively correlated with each other. Risk perception was negatively correlated with action self-efficacy, intention, maintenance self-efficacy, planning, and hand hygiene behavior as predicted.

With regard to whether the HAPA fitted the data well, the first attempt revealed a poor fit according to commonly accepted fit indices [44]. This, however, is not surprising as models with a good fit found in literature often are incomplete and do not include all of the HAPA constructs [29,45].

The final attempt to fit the HAPA model to the data after iterative changes revealed significant paths and acceptable fit indices. Still, the latest model needs to be treated with caution as the model fit was not strong according to the RMSEA [46]. However, as Kenny et al. [47] suggested, sample size and degrees of freedom also need to be considered when interpreting RMSEA. Hence, models with small sample sizes and low degrees of freedom tend to display an elevated RMSEA. Therefore, taking all fit indices into consideration, we can assume that the proposed model fits our data. This is in line with the literature as the HAPA model has been used previously to explain healthcare workers' hand hygiene as well as to inform successful interventions [48]. In a recent study, Gaube et al. found that the HAPA model could explain patients' and visitors' hand hygiene [1]. Hence, based on previous evidence, it seems that hand hygiene behavior is a health behavior developing in a dynamic process that is similar between patients with a reduced or a good mental health status. Therefore, as expected, the process of performing hand hygiene along the HAPA may be described as follows: In the motivational phase, outcome expectancies and action self-efficacy were associated with intention.

These results indicate that improving beliefs about the beneficial effects of performing good hand hygiene might be promising when motivating patients to become more active concerning their hand hygiene. Contrary to the hypothesized structure of the HAPA, risk perception was not associated with intention. Risk perception does not seem to be significantly associated with the intention to practice good hand hygiene in the context of the HAPA model. This is in line with other studies in the area of physical activity [49,50]. These last findings suggested that risk perception may not be sufficient to form an actual

intention to change health behavior [16] and may instead be a distal predictor of hand hygiene behavior [34].

However, for effective maintenance and performance to occur, necessary self-regulatory strategies, such as planning, need to be developed and maintained in the volitional stage. It has been assumed that planning bridges the intention–behavior gap, thus ensuring the maintenance of hand hygiene. Similar to the results by Gaube et al. [1], our results have shown a direct link between intention and the desired behavior. However, their study lacks results regarding the mediating effect of planning. Hence, the present study is the first to show that, for the hand hygiene behavior of patients to be maintained, planning has the function of bridging the intention–behavior gap. Nevertheless, the present study did not include or acknowledge other self-regulatory skills, automatism, and action control as part of this study. Hence, integrating those variables should be regarded in future research.

Validating the HAPA as a generic framework in explaining social-cognitive processes of hand hygiene decisions, invariant for mental health is in line with previous studies examining compliance to hand hygiene behavior in the general population, as well as in psychosomatic rehabilitation patients. Prior research indicates that both groups of participants display good hand hygiene behavior when either possessing a greater fear of infection or being more susceptible to anxiety [51,52]. In addition, the systematic review by Farholm and Sørensen [27] suggested no differences in motivational mechanisms between the normal population and individuals with mental illnesses.

Finally, as part of study 2, we aimed to investigate whether symptoms of depression and generalized anxiety are predictive of a change in compliance with hand hygiene decisions in psychosomatic rehabilitation patients. Our results indicate that neither symptoms of depression nor generalized anxiety are predictive of a change in compliance. Firstly, these findings confirm results from the general population that compliance with hand hygiene behavior is independent of mental health status [52]. However, previous researchers assumed that a reduced mental health status would be associated with poorer compliance in hand hygiene behavior and that psychosomatic rehabilitation treatments would encourage health behavior change in patients. The present results do not support these assumptions. Possibly, hand hygiene is a rather stable construct irrespective of mental health status. For example, individuals who were compliant with hand hygiene behavior prior to the pandemic also were compliant during the pandemic and vice versa [53], which may also explain the absence of any differences based on the two data collection points (see Appendix A). Therefore, non-compliant individuals need to be encouraged to perform adequate hand hygiene. One way to do so may be to implement interventions that foster planning and self-efficacy measures, helping to overcome the intention–behavior gap where needed [48].

The study is subjected to several limitations. All variables examining hand hygiene decisions within the general population are (retrospective) self-report measures collected at one point in time. This was undertaken to validate previous research (e.g., [45]) and to assess data during the COVID-19 pandemic. However, recall bias and social desirability need to be considered when interpreting participants' responses. To overcome this limitation, the handwashing behavior of patients should be observed by trained observers or tracked by technical devices. Still, even with testing for differences in time between hospitalization and participation in the survey (with regard to the self-reporting of hand hygiene behavior), no significant differences were found. This suggests that even though self-reporting biases and social desirability should be acknowledged, reported hand hygiene decisions remained stable. Additionally, mental health was examined by a validated questionnaire but not via an official diagnosis during their hospital admission according to the International Classification of Disease (ICD-10) manual. Hence, to make informative conclusions on the exact role of mental health with regard to hand hygiene decisions, this study would have benefited from an official ICD-10 diagnosis among patients. Furthermore, mental health symptoms might have been exacerbated by the COVID-19 pandemic (e.g., through increasing uncertainty, and reduced social contact). Hence, the expression of depressive

symptoms, or symptoms of generalized anxiety, may be confounded by the current situation and should be considered in future research.

A further methodological limitation may be that study 1 used data from a cross-sectional study to investigate hand hygiene processes in the general population. Using structural equation modeling on cross-sectional data does not reflect the dynamic nature of underlying processes over time and thus violates model assumptions. However, testing for differences in depression and generalized anxiety has shown no significant differences across the two timepoints of measurement, suggesting relatively stable constructs irrespective of situational context. It is recommended that future research should validate the results from the trimmed HAPA model in the form of a prospective or experimental study (i.e., a randomized controlled trial) to determine causal effects conclusively. Prospective behavioral measures, especially of the main outcome of hand hygiene decisions, should be applied.

Another limitation is that only a few participants with symptoms of depression and generalized anxiety could be included in this study from the general population, thus compromising the statistical power. Nevertheless, the findings of this cross-sectional study and longitudinal examination can contribute to the understanding of the current state of hand hygiene adherence of patients and provide a basis for designing interventions to improve psychological aspects related to hand hygiene.

The results indicate that encouragement for patients, regardless of their mental health status, to create hand-washing plans for specific situations should be considered when designing interventions. In this regard, digital tools could be employed to function as reminders of plans and past successes. The present results indicate that social-cognitive variables and self-regulatory processes are necessary determinants for effective hand hygiene behavior. Therefore, to make patients more aware of the necessity and to support them by reducing the need for self-regulatory processes, hospitals should be encouraged to promote hand hygiene behavior throughout the healthcare facilities with visible posters or dispensers at accessible and visible locations as shown in studies by Hobbs et al. [54].

To increase the intention to perform hand hygiene behavior, visual, auditory, and dynamic videos should be employed to encourage patients to clean their hands, as this has been shown to be effective in other hospitals [55]. Furthermore, individuals should be better informed about the potential risks associated with reduced hand-washing behavior and compliance. The literature has shown that, in general, and irrespective of mental health status, individuals report more compliance if they are aware of the potential risks [52]. Hence, communication in the public media and in hospitals (i.e., on leaflets or posters) needs to be clearer and more objective while focusing on the risks.

5. Conclusions

In conclusion, the trimmed version of the HAPA model fitted hand hygiene data collected from the general public while highlighting significant associations between intention, planning, and hand hygiene decisions. Furthermore, planning bridged the intention–behavior gap with regard to hand hygiene decisions. Irrespective of the mental health status of individuals, hand hygiene decisions could be explained by the social-cognitive variables of the HAPA model. In addition, the mental health status of the patients did not play a significant role in changes in compliance (i.e., from non-compliance to compliance or vice versa) with hand hygiene decisions.

The present findings indicate that interventions should focus on social-cognitive predictors rather than on the role of mental health with regard to hand hygiene behavior. Drawing on the actual findings, it needs to be stressed that hand hygiene behavior should be part of a more complex strategy of surveillance in primary healthcare settings to control healthcare-associated infections. Further, it is feasible to help individuals perform hand hygiene by intention formation and bridge the intention–behavior gap by planning and self-efficacy, regardless of mental health status.

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Appendix A. Difference between Participants from the Three Measurement Waves

To examine differences in participants across the three measurement waves, chi-square analyses and analyses of variance were performed. The results showed no significant differences with respect to symptoms of depression $\chi^2(2, n = 248) = 0.08$ and for symptoms of generalized anxiety controlling for age and gender. In addition, no significant differences between the three waves were found with regard to the HAPA variables: outcome expectancies $F(2, 266) = 1.07$, $p = 0.34$, $\eta_p^2 = 0.02$, risk perception $F(2, 266) = 1.75$, $p = 0.18$, $\eta_p^2 = 0.01$, action self-efficacy $F(2, 266) = 2.76$, $p = 0.06$, $\eta_p^2 = 0.02$, intention $F(2, 278) = 2.49$, $p = 0.07$, $\eta_p^2 = 0.02$, maintenance self-efficacy $F(2, 266) = 1.79$, $p = 0.17$, $\eta_p^2 = 0.03$, and planning $F(2, 278) = 3.00$, $p = 0.51$, $\eta_p^2 = 0.02$ controlling for age and gender. In addition, no significant differences were found with regard to hand hygiene behavior between the three measurement waves $F(2, 266) = 0.45$, $p = 0.64$, $\eta_p^2 = 0.01$. However, the results were revealed to be significant with regard to resources $F(2, 266) = 15.08$, $p < 0.01$, $\eta_p^2 = 0.10$, and support $F(2, 266) = 13.67$, $p < 0.01$, $\eta_p^2 = 0.10$ while controlling for the covariates age and gender.

Appendix B. Differences in Variables with Regard to Time of Hospital Visit

In order to control for time differences with regard to hospital visits as either an inpatient or an outpatient, variables related to the HAPA model as well as hand hygiene behavior and mental health-related symptoms were examined for significant differences. No significant differences were revealed for the following variables: hand hygiene behavior, $F(2, 266) = 2.67$, $p = 0.07$, $\eta_p^2 = 0.02$, action self-efficacy, $F(2, 266) = 2.37$, $p = 0.10$, $\eta_p^2 = 0.02$, risk perception $F(2, 266) = 1.13$, $p = 0.32$, $\eta_p^2 = 0.01$, outcome expectancies, $F(2, 266) = 0.29$, $p = 0.75$, $\eta_p^2 = 0.01$, intention $F(2, 266) = 0.06$, $p = 0.94$, $\eta_p^2 = 0.01$, maintenance self-efficacy, $F(2, 266) = 0.30$, $p = 0.74$, $\eta_p^2 = 0.01$, planning, $F(2, 266) = 0.51$, $p = 0.60$, $\eta_p^2 = 0.01$, resources, $F(2, 266) = 3.04$, $p = 0.54$, $\eta_p^2 = 0.02$, support $F(2, 266) = 0.73$, $p = 0.48$, $\eta_p^2 = 0.01$, symptoms of depression, $F(2, 237) = 0.49$, $p = 0.61$, $\eta_p^2 = 0.01$, and symptoms of generalized anxiety, $F(2, 246) = 2.50$, $p = 0.08$, $\eta_p^2 = 0.02$ while controlling for age and gender.

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