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Development and validation of the treatment self-regulation questionnaire assessing healthcare professionals' motivation for flu vaccination (TSRQ-Flu)

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ABSTRACT

Objective: We use self-determination theory to extend the conceptual understanding of flu vaccine hesitancy among health professionals. The scale sheds light on the role played by motivational factors above and beyond traditional cognitive factors such as biased risk judgements and health beliefs.
Design: Across five phases using data from 718 healthcare professionals we establish factor structure, reliability, discriminant, convergent, criterion-related, incremental validity, and measurement invariance of the Treatment Self-Regulation Questionnaire assessing healthcare professionals' motivation for flu vaccination scale (TSRQ-Flu).
Main Outcome Measures: In addition to the four factors of the TSRQ-Flu (autonomous, introjection, external and amotivation regulations), we assess intentions to vaccinate, past vaccination behaviour and validate the scale using measures of cognitive empowerment, vaccine attitudes and social desirability.
Results: Our findings indicate that the newly developed 11-item scale is distinct from and contributes over and beyond other psychosocial measures of flu vaccination intentions and can be used to understand the motivation of both vaccinated and not-vaccinated healthcare professionals.
Conclusion: This new scale has the potential to make a marked change in the conceptualisation of the roots of vaccine hesitancy among healthcare professionals and aid healthcare managers in developing evidence-based interventions to promote vaccination among their staff.

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KEYWORDS
self-determination theory; autonomous motivation; influenza vaccination; healthcare professionals; scale development; vaccine hesitancy

Introduction

The World Health Organization has identified vaccine-preventable diseases and vaccine hesitancy among the top ten global health threats (World Health Organization, 2019). There is a clear public health need for healthcare professionals to get vaccinated to

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Supplemental data for this article can be accessed here.

protect themselves against viral infections given the increased risk of exposure to, and spread of, infectious agents within healthcare settings. Ensuring improved immunity among healthcare professionals may help to reduce the risk of nosocomial transmission and potential pandemics (Goins et al., 2011), and will be even more important if the SARS-CoV-2 continues to circulate next flu season in order to avoid overburdening the healthcare system. Yet, even with organisation-led immunisation programmes specifically targeting healthcare professionals, vaccination uptake remains suboptimal. For example, only 52.2% of the England National Health Service organizational units achieved the recommended 75% target for the flu vaccine (Public Health England, 2019).

Vaccine hesitancy generally refers to the unwillingness to receive a recommended vaccine and remains a complex issue influenced by a multitude of factors (Corace et al., 2013; Dubé et al., 2020). Vaccination behaviour is commonly conceptualised as a personal decision under risk and uncertainty (Betsch et al., 2015), and traditional approaches include identifying the psychological, social and environmental barriers, and drivers of vaccination uptake to predict behaviour (Betsch et al., 2018; Thomson et al., 2016). However, little research has investigated why healthcare professionals may *want* to get vaccinated against the flu. Recently, the cognitive model of empowerment (CME) has been adopted to understand healthcare professionals' flu vaccination behaviour, measuring intrinsic motivations to engage with purposeful behaviour. Autonomy emerged as a significant predictor of behaviour. However, an acknowledged limitation was that only a single item addressed autonomy (Vallée-Tourangeau et al., 2018).

Autonomy may play an important role in healthcare professionals' decisions to vaccinate against the flu. For example, healthcare professionals in the United States who were asked to provide statements related to mandatory flu vaccination policies frequently reported (54.4%) the violation of choice as a barrier to get vaccinated (Hakim et al., 2011). Israeli nurses' demand for an autonomous decision to be vaccinated was related to acceptance of the whooping cough vaccine (Baron-Epel et al., 2013). Additionally, higher autonomous feelings have been found to significantly increase the likelihood of medical students' intention to vaccinate (when instrumental attitude was positive, Lehmann et al., 2015). More recently, self-determination theory (SDT) – the only theory of human motivation placing emphasis on the conceptualisation of autonomous motivation (Ryan & Deci, 2000) – has been applied to understand associations with parental vaccination intentions in HPV vaccination (Denman et al., 2016) and the flu vaccination intention of university students (Chan et al., 2015; Fall et al., 2018). However, empirical measures of healthcare professionals' motivation to receive the flu vaccination are lacking, and there is a need to extend our understanding of vaccine hesitancy as a conative act. Therefore, through the lens of SDT, the present paper outlines the validation of the Treatment Self-Regulation Questionnaire (TSRQ) assessing healthcare professionals' motivation to receive the flu vaccination.

The TSRQ has been used to assess different motivation regulations across various health behaviours, such as diabetic treatments, diet, exercise, smoking cessation, and HPV vaccination (Denman et al., 2016; Levesque et al., 2007; Williams et al., 1998, 2004). According to SDT, autonomy is conceptualised on a motivation continuum of six regulations: amotivation, external, introjected, identified, integrated and intrinsic. *Intrinsic* regulation is the most internalised, referring to behaviours initiated out of interest or pleasure. The remaining five regulations relate to extrinsic motivation which overall refers to engaging with behaviour for external reasons such as completing a work task to avoid sanctions or to satisfy the request of workplace policies and guidelines (Deci & Ryan, 1985). As extrinsic motivation becomes more internalised, moving from the least internalised regulation of *amotivation* to the most internalised regulation of *integrated*, behavioural outcomes become more autonomously motivated as they align more closely with internal beliefs and values (Deci & Ryan, 2000; Ünlü & Dettweiler, 2015).

Amotivation refers to the lack of willingness to act and is associated with an absence of self-determined behaviour, and is assumed to result from a lack of perceived value, a sense of incompetence, or a belief that the desired outcome is not achievable. Next is the external and introjected regulations, which in some TSRQ measures form two separate latent constructs (Denman et al., 2016; Levesque et al., 2007), and in others form one construct reflecting controlled regulation (Williams et al., 1998, 2004). *External regulation* refers to the perception that external demands are controlling, therefore the behavioural action seeks only to satisfy the external demand or imposed reward. *Introjected regulation* refers to behaviours associated with the avoidance of guilt or attainment of pride, serving to maintain or enhance self-esteem. Finally, identification and integrated regulation are the most autonomous and internalised forms of extrinsic motivation. *Identification* occurs when the individual recognises the importance of the behaviour, which results in an action in accordance with the self or free choice. *Integrated* regulation is similar to intrinsic motivation, as the associated behaviours are autonomous and self-determined although they continue to be motivated by an external outcome (Deci & Ryan, 2000). Often these two constructs can form together to create autonomous regulation (Denman et al., 2016; Levesque et al., 2007).

Occasionally, introjection may be more associated with autonomous regulation as it is considered 'somewhat internal' and the extent to which this regulation is more internalised than externalised remains undetermined within SDT (Deci & Ryan, 2000). However, analytical tools are available to provide a quantifiable understanding of the shared internalisation and externalisation of introjection (Ünlü & Dettweiler, 2015). Using such methodological approaches, we report on the exploratory analysis determining the extent of the overlap of introjection with autonomous regulation across the samples used in this study. Understanding the full extent to which these behavioural regulations drive healthcare professionals' decisions to vaccinate, or not vaccinate, against the flu may be useful for developing targeted flu-campaigns aimed at facilitating improved vaccination uptake (Moon et al., 2021).

The aim of this study is to provide initial evidence for the modification of the TSRQ assessing healthcare professionals' motivation to receive the flu vaccination. Previously, measures of autonomous motivation for flu vaccine uptake have used ad-hoc adaptations of items (Chan et al., 2015; Fall et al., 2018), yet the reliability of these items has not yet been formally validated. Moreover, to the best of our knowledge items have not yet been developed to assess the motivations of healthcare professionals. While healthcare professionals' feelings towards the flu vaccination may be considered similar to that of the general population (Brewer et al., 2017), the general population in the UK are not urgently advised to get the flu vaccination unless categorised as at-risk (NHS, 2019). Further, healthcare professionals' have an expectation to satisfy the request of policies and workplace guidelines placed by organisations such as the NHS, Public Health England and the World Health Organisation. As such, we use healthcare professionals in our samples.

Following the approach to scale validation outlined by Van den Broeck et al. (2010) and Boateng et al. (2018), we formally validate the TSRQ-Flu scale across five phases, using four samples. In Phase 1, items were generated. In Phase 2, items were selected using exploratory factor analysis (EFA). In Phase 3, the factorial structure was established using confirmatory factor analysis (CFA) and we tested factorial invariance by past vaccination status. In Phase 4, we assessed the internal consistency, reliability and validity of the scale, and responses were examined for social desirability contamination. In Phase 5, we examined the concurrent, predictive and incremental validity. Specifically, it was hypothesised that (a) autonomous motivation would predict vaccination intention, (b) past behaviour would be positively associated with autonomous regulation for vaccinators while (c) controlled regulation would be negatively associated. As a final step in Phase 5, we explored the extent to which introjection regulation was more internalised than externalised across samples.

Method

Participant overview

A total of 718 healthcare professionals and healthcare students participated in this study. Most participants specialised in acute care (34%), worked within an NHS Hospital setting (64%), were Nurses (34%), and 79% had direct patient contact (see Table 1 for demographics).

Sampling

Participants were invited to complete an online Qualtrics questionnaire. Convenience sampling was used whereby participation was voluntary and self-selected. Participants were informed that the study was anonymous and that there was no employment-related, or other obligation to participate, and informed consent was obtained. Where necessary, data categories were collapsed to safeguard anonymity (de Vaus, 2001). Approval from the Research Ethics Committee of Kingston University London was granted prior to data collections (application: #1724 and #1828).

Sample 1 (pilot) were recruited from a healthcare organisation specialising in mental health. Although the invitation was sent to 4,600 healthcare professionals the response rate was low (1.43%), therefore remaining samples were recruited using online panels and social media. As such, further response rates are not available. *Sample 2* were recruited from Facebook and a London based University. An invitation to participate was posted on Nursing-related Facebook groups and the University's School of Nursing internal communications. *Sample 3* were recruited via Prolific Academic whereby participation was financially compensated £2.00. *Sample 4* were student nurses recruited from a London based University, and full participation was compensated with the chance to win a £50 Amazon voucher.

Table 1. Participant Demographic Information across Four Samples (N = 718).

	Pilot		Sample 2		Sample 3		Sample 4		Grand Total	
	(*N* = 66)		(*N* = 412)		(*N* = 152)		(*N* = 88)		(*N* = 718)	
Gender, *N* (%) Female	49	(74%)	305	(74%)	142	(93%)	68	(77%)	564	(79%)
Age in years, Mean (*SD*)	46.5	(10.03)	38.0	(11.48)	38.4	(10.24)	28.0	(8.28)	38	(10.01)
Direct Patient Contact, Yes (%)	49	(74%)	317	(77%)	124	(82%)	80	(91%)	570	(79%)
Place of Work, *N* (%)										
NHS Hospital	47	(71%)	224	(54%)	86	(54%)	75	(71%)	432	(64%)
Community based	11	(17%)	123	(30%)	49	(31%)	11	(10%)	194	(29%)
Private Hospital			7	(2%)	5	(3%)	5	(5%)	17	(3%)
Care Home			6	(1%)	13	(8%)	8	(8%)	27	(4%)
Hospice			3	(1%)	3	(2%)	4	(4%)	10	(1%)
Other	3	(5%)	4	(1%)	2	(1%)	3	(3%)	12	(2%)
Occupation, *N* (%)										
Doctor	5	(8%)	8	(2%)	4	(3%)			17	(2%)
Nurse	14	(21%)	185	(45%)	46	(30%)			245	(34%)
Midwife			14	(3%)	5	(3%)			19	(3%)
Clinical Specialist	4	(6%)	17	(4%)	6	(4%)			27	(4%)
Allied Healthcare Professional	12	(18%)	23	(6%)	47	(31%)			82	(11%)
Admin and clerical	20	(30%)	4	(1%)	30	(20%)			54	(8%)
Volunteer	1	(2%)	1	(0%)	1	(1%)			3	(0%)
Student	1	(2%)	67	(16%)	7	(5%)	88	(100%)	163	(23%)
Other	7	(11%)	16	(4%)	5	(3%)			28	(4%)
Specialism, *N* (%)										
Acute Care	7	(11%)	151	(37%)	55	(36%)	32	(36%)	245	(34%)
Adult Mental Health	40	(61%)	63	(15%)	17	(11%)	11	(13%)	131	(18%)
Child and Adolescent Mental Health	4	(6%)	11	(3%)	3	(2%)			18	(3%)
General Practitioners (GPs) Services			41	(10%)	10	(7%)			51	(7%)
Learning Disability Care			4	(1%)	1	(1%)	3	(3%)	8	(1%)
Paediatric Care			16	(4%)	13	(9%)	18	(20%)	47	(7%)
Elderly Care			26	(6%)	21	(14%)	5	(6%)	52	(7%)
Other			20	(5%)	29	(19%)	8	(9%)	57	(8%)

Note. Participants were able to select more than one main place of work therefore % is calculated against the total number of responses.

Data screening

Participants were excluded if they left the questionnaire before completing the TSRQ-Flu items. To overcome the potential confound of variation within governmental regulations (e.g., condition-of-service policies, see Gruben et al., 2014) only UK workers were included. Missing data and missing data patterns were examined in each sample. If data were considered missing at random (Fox-Wasylyshyn & El-Masri, 2005) and the proportion of missingness was < 5%, cases were removed listwise (as implications of removal are considered inconsequential, see Schafer, 1997). In addition, straightliners were excluded (i.e., identical responses for a set of items, see Kim et al., 2019). Multivariate outliers were removed if they violated three indicators of unusual score combinations: Malahanobis distance ($p < .001$), leverage (calculated as $3(k+1)/n$, where k represents the number of items) and the critical Cook's distance ratio < 1 (Fidell & Tabachnick, 2003; Field, 2013). For data screening of each sample see Supplementary Materials.

Measures

In addition to the measures reported below, participants were asked to provide demographic information. For an overview of how the samples and measures were used across each phase see Table 2.

Table 2. Overview of the Samples and Measures used across the Five Phases (adapted from Van den Broeck et al., 2010).

	Sample 1	Sample 2	Sample 3	Sample 4
Phase 1: Item Development	X			
Phase 2: Item Selection		X		
Phase 3: Factor Structure and Measurement Invariance				
Factor Structure		X	X	
Measurement Invariance		X		
Phase 4: Model Reliability and Validity				
Common method bias				
Self-Deceptive Enhancement				X
Impression Management				X
Intercorrelations		X	X	X
Convergent and discriminant validity		X	X	
Phase 5: Criterion-related Validity				
Concurrent Validity				
Cognitive Empowerment		X	X	X
Vaccine Attitudes			X	
Predictive validity				
Vaccination Intention		X	X	X
Incremental validity				
Cognitive Empowerment		X		
Past Vaccination Behaviour		X		
Line Manager Vaccination status		X		

Common method bias

To check that responses were not confounded by social desirability bias the Balanced Inventory of Desirable Responding (BIDR-16) scale (Hart et al., 2015) was used. The 16-item scale captures Self Deceptive Enhancement (SDE), reflecting honest but overly positive responding (α = .697), and Impression Management (IM), reflecting the conscious presentation of a favourable public image (α = .657). Responses were rated on 7-point Likert scale ranging from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*).

Discriminant and criterion-related validity

Cognitive empowerment was assessed using the MoVAc-flu Scale (Vallée-Tourangeau et al., 2018). The 9-item scale captures the cognitive empowerment of healthcare professionals to get the flu vaccine, and measures sentiments of impact, value, autonomy and knowledge. Responses were measured on a 7-point Likert scale ranging from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*); α = .929.

Vaccine attitudes were assessed using a shortened version of the pH1N1 Vaccine Attitude Scale (Corace et al., 2013). The 11-item scale captures sentiments related to perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and cues to action which are internal and external stimuli that motivate vaccine uptake. The word 'pH1N1' was substituted for the word 'flu' Responses were measured on a 5-point Likert scale ranging from 1 (*Strongly Agree*) to 5 (*Strongly Disagree*); α = .832.

Behavioural measures. Participants were asked if they had been vaccinated during the current flu season (e.g., 2016/2017 or 2017/2018): measured using *Yes* = 1, *No* = 0. If they intended to vaccinate during the next flu season (e.g., 2017/2018 or 2018/2019): measured using *Yes* = 1, *Don't Know* = 0.5, *No* = 0, and whether they knew if their line manager gets vaccinated against the flu: measured using *Yes* = 1, *No* = 0.5, *Don't know* = 0.

Phase 1: Pilot study

Item development

Items were developed using the TSRQ diabetes scale (Williams et al., 1998); as this 20-item scale concerns medication it was considered a closer resemblance to vaccination than diet and exercise behaviour. Nine items were formulated under the stem "I [do not] have the flu vaccine because:" and 11 items were formulated under the stem "The reason I [do not] get vaccinated against the flu:" We added one item related to protective behaviours "It's [not] important to get the jab to protect my colleagues and patients from the flu." Items were discussed and approved by healthcare managers from the pilot organisation in conjunction with experts from the field of behavioural decision-making psychology. In addition, demographic items such as place of work, occupation and specialism were guided and approved by the healthcare managers prior to dissemination. These user feedback and acceptability checks resulted in adaptations to reflect the familiar language used by healthcare professionals, such as using the word "Flu Jab" instead of "Influenza vaccine". In total, nine items related to autonomous regulation, and 11 items related to controlled regulation. Responses were rated on a 7-point Likert scale ranging from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*). Past behaviour determined which scale participants would receive and items were randomised under the appropriate stem.

Sampling and results

The pilot sample tested the consistency between the two 20-item scales which aimed to capture opposing sentiments of vaccination uptake ($N = 42$ Vaccinated; $N = 24$ Not-vaccinated). Examination of data distributions and item correlations revealed inconsistencies between the two scales (see Supplementary Materials Table S1). Consequently, a universal scale was developed to assess the motivation regulations for both those who do and do not vaccinate. Items were reformulated under the stem indicative of an intended behaviour *"If I were to have the flu jab next season it would be because*:", and remained consistent to other versions of the TSRQ (Levesque et al., 2007). Accounting for the distribution of data observed 18 items were retained. The final item pool included eight items for autonomous regulation, three items for introjected regulation, five items for external regulation, and two items for amotivation (for reformulated items see Supplementary Materials Table S2).

Phase 2: Item selection

Using *Sample 2* ($N = 412$), the final set of items were selected based on exploratory factor analysis (EFA) and item-total correlations. Statistical analysis was conducted using IBM SPSS Statistics for Macintosh (version 24.0). Of the 18 TSRQ-Flu items, two items representing amotivation suggested a tendency for low scores ($M = 1.83$, 1.70; $SD = 1.48$, 1.43), for data distributions see Supplementary Materials Table S3. As low scores for amotivation are prevalent among TSRQ measures (Levesque et al., 2007) both items were retained. An initial parallel analysis, using a Monte Carlo approach (O'Connor, 2000), suggested two significant factors, corresponding to the underlying theoretical components of autonomous and controlled regulation (see Supplementary Materials Figure S1). The correlation matrix indicated a presence of multicollinearity, therefore item 6 which had the lowest tolerance value (0.11) was removed. Item 7 and 8 were then removed respectively as the communalities did not meet the minimum threshold, .40 (Field, 2013).

Results

A principal component analysis with an oblique rotation (direct oblimin) was conducted on the remaining 11 items. Two factors were extracted based on eigenvalues > 1, accounting for 63.96% of the explained variance. However, visual inspection of the scree plot (Cattell, 1966) indicated that a two or possible four-factor solution could be retained. Additionally, cross-loadings on the items relating to introjection were revealed. As introjection and autonomous regulation are closest on the motivation continuum and the extent of the overlap remains undetermined in SDT (see Ünlü & Dettweiler, 2015), a decision was made to extract a four-factor solution. Previous TSRQ scales have revealed a four-factor structure (see Levesque et al., 2007), and separate sub-scales of external, introjection and autonomous regulation were present in the TSRQ assessing HPV vaccination (Denman et al., 2016). Next, item 16 did not load on an expected factor, and three items (15, 10 and 12) did not contribute to a simple structure; these were removed respectively.

The final four-factor solution (see Table 3) explained 83.16% of the variance with 12% nonredundant residuals with absolute values > .05, suggesting a good factor model (Field, 2013). The Kaiser-Meyer-Olkin sampling of adequacy remained meritorious (KMO = .862). Bartlett's test of sphericity was statically significant, $\chi^2(55) = 3097.17$, $p < .001$. All items had a minimum loading of .760 with no cross loading above .249.

Phase 3: Factor structure and measurement invariance

Using *Sample 2* and *Sample 3*, we first examined the hypothesised four-factor structure using a confirmatory factor analysis (CFA). Analysis of the sample from which the EFA was derived (*Sample 2*), allows for a more accurate assessment of potential methodological explanations should the CFA fail within the new data set (Van den Broeck et al., 2010). We also examined the dimensionality of the model across groups. Second, using *Sample 2* we examined the incremental levels of measurement invariance across groups of past vaccination uptake behaviour (e.g., those who did, or did not get the flu vaccination last flu season). The decision to test this group was two-fold: first, past behaviour for flu vaccination uptake is considered a strong indicator of intention formation (Ernsting et al., 2011), and second, the TSRQ-Flu scale aims to understand the underlying motivation driving vaccination decisions among both vaccinated and not-vaccinated healthcare professionals. Statistical analyses were conducted using RStudio (2020) version 1.2.5019, for a list of R packages used see Supplementary Materials.

Table 3. Summary of Exploratory Factor Analysis (N = 412).

Item	*M*	*SD*	Skewness (*SE* = 0.12)	Kurtosis (*SE* = 0.24)	Communalities	Factor Loadings 1	2	3	4
Autonomous regulation									
It's important to get vaccinated to protect myself from the flu virus.	4.65	2.07	−0.44	−1.05	.873	**.972**	.023	.013	.064
I personally believe that having the flu vaccine will protect my health.	4.60	2.17	−0.39	−1.24	.889	**.968**	−.023	.019	.091
I personally believe it's important to do so in order to stay healthy.	5.08	2.01	−0.79	−0.62	.794	**.933**	−.026	.049	.016
I've carefully thought about flu vaccination and believe it's the right thing to do.	4.18	2.22	−0.15	−1.40	.847	**.783**	−.032	−.157	−.140
It's important to get the jab to protect my colleagues and patients from the flu.	4.71	2.24	−0.49	−1.23	.795	**.781**	.037	.007	−.219
Introjection regulation									
I'd feel guilty if I didn't get the flu jab.	3.22	2.09	0.44	−1.09	.809	−.085	.008	.033	**−.961**
I would feel bad about myself if I didn't get the flu jab.	2.79	2.04	0.74	−0.79	.885	.249	.039	.002	**−.760**
External regulation									
I want my line-manager to think I'm a good employee.	3.17	2.09	0.43	−1.12	.859	.040	**.970**	−.044	.086
I don't want other people to be disappointed in me.	2.42	1.80	1.05	0.03	.766	−.085	**.763**	.101	−.150
Amotivation regulation									
I just do it because my line-manager recommends to.	1.83	1.48	1.89	2.91	.805	−.023	−.045	**.923**	−.004
It is easier to do what I'm told than to think about it.	1.70	1.43	2.29	4.64	.827	.037	.065	**.871**	−.009
Eigenvalue						4.73	2.77	.87	.79
% of variance						42.97	25.16	7.87	7.16
α						.946	.742	.774	.803

Note. Extraction Method: Principal Component Analysis; Rotation Method: Oblimin with Kaiser Normalization; Factor Loadings > (−).40 are in bold; *SE* = standard error.

Results of factor structure

In both *Sample 2* and *Sample 3*, Mardia's (1970) multivariate normality (MVN) test indicated that data was non-normal ($p < .001$). Multivariate normality is an assumption of the Maximum Likelihood (ML) estimation method applied in CFA, and violations may lead to bias within the fit indices (Hu & Bentler, 1999). As such, analyses were conducted using the diagonally weighted least squares (WLSMV) estimation. This robust distribution-free estimator demonstrates less bias and increased accuracy within the factor loading estimates, particularly in the presence of non-normal distributions (Li, 2016). Four goodness-of-fit indices are reported, comparative fit index (CFI), root mean squared error of approximation (RMSEA), standardized root mean square residual (SRMR), and the Satorra-Bentler scaled chi-square test statistic. The Satorra-Bentler test statistic provides robust estimates for non-normal data derived from small and medium sample sizes (Satorra & Bentler, 2001). Adequate model fit is achieved when CFI values ≥ 0.90 and the RMSEA and SRMR values < 0.08 (Hair et al., 2013). Scaling

Table 4. Fit indices for the Measurement Models of Extrinsic Motivation Regulations in Samples 2 and 3.

	SB- χ^2	df	*p*	*Sc*	RMSEA	90% CI	CFI	SRMR	Comparison	SB Δ-χ^2	df	*p*
Sample 2												
Model A	235.22	38	.000	.332	.065	[.057, .073]	.985	.050				
Model B	1230.03	43	.000	.497	.183	[.174, .192]	.868	.168	A	304.99	5	.000
Model C	1542.97	44	.000	.414	.185	[.177, .193]	.861	.170	A	601.55	6	.000
Sample 3												
Model A	108.42	38	.000	.331	.064	[.050, .078]	.986	.054				
Model B	641.77	43	.000	.402	.193	[.180, .206]	.857	.153	A	235.22	5	.000
Model C	660.81	44	.000	.395	.192	[.179, .205]	.855	.154	A	280.69	6	.000

Note. Computation of Satorra-Bentler (SB Δ-χ^2) test in RStudio uses the estimated scaled SB- χ^2 value; therefore, SB- χ^2 is reported as such with *Sc* representing the scaled-correction factor. Robust estimands for all other fit indices are reported.

was fixed to one on the latent factors enabling all parameters to be freely estimated. Thus, the covariance structures and variance contribution of each observed item could be examined (Little et al., 2006).

The hypothesized four-factor model (Model A) was compared to a two-factor model (Model B) whereby Introjection, External and Amotivation were combined to reflect controlled regulation. Both models were compared to a unidimensional model (Model C). The fit indices indicated adequate fit, and in both samples the hypothesised four-factor solution (Model A) achieved superior fit to Model B and Model C (see Table 4 for fit measures of the models). All items loaded significantly onto their respective factors (*Sample 2*: ranging from .677 to .991, $p < .001$; *Sample 3*: ranging from .691 to .950, $p < .001$), exceeding the minimum threshold of .50 for standardized parameter estimates (Hair et al., 2013). The average loadings were superior or equal to .777 (*Sample 2*) and .748 (*Sample 3*), thus exceeding the ideal threshold of .70 (Hair et al., 2013). See Supplementary Materials Table S4 for data distributions, Figure S2 to S3 for assumption checks, and Table S5 for parameter estimates.

Results of measurement invariance

As the R package used for analyses required a minimum sample size of 100 per group, *Sample 2* was used to test measurement invariance. We report four levels of invariance: configural, metric, scalar and strict (although the latter is not fundamental to testing mean differences between groups at the CFA level, see Putnick & Bornstein, 2016). To evaluate the fit of metric invariance model, we applied the change in the ΔCFI < .02 criterion, and for the scalar invariance model we used ΔCFI < .01 criterion (Rutkowski & Svetina, 2014). For group comparison of the TSRQ-Flu item loadings, see Figure 1.

The configural model fit indices indicated a favourable fit, CFI = .956, RMSEA = .076 [90% CI: .068, .085], SRMR = .066. Metric invariance was achieved, ΔCFI < .02, CFI = .942, RMSEA = .083 [90% CI: .075, .092], SRMR = .077. Finally, invariance at the scalar level was achieved, ΔCFI < .01, CFI = .938, RMSEA = .083 [90% CI: .075, .091], SRMR = .081. Items were examined to establish which may be problematic

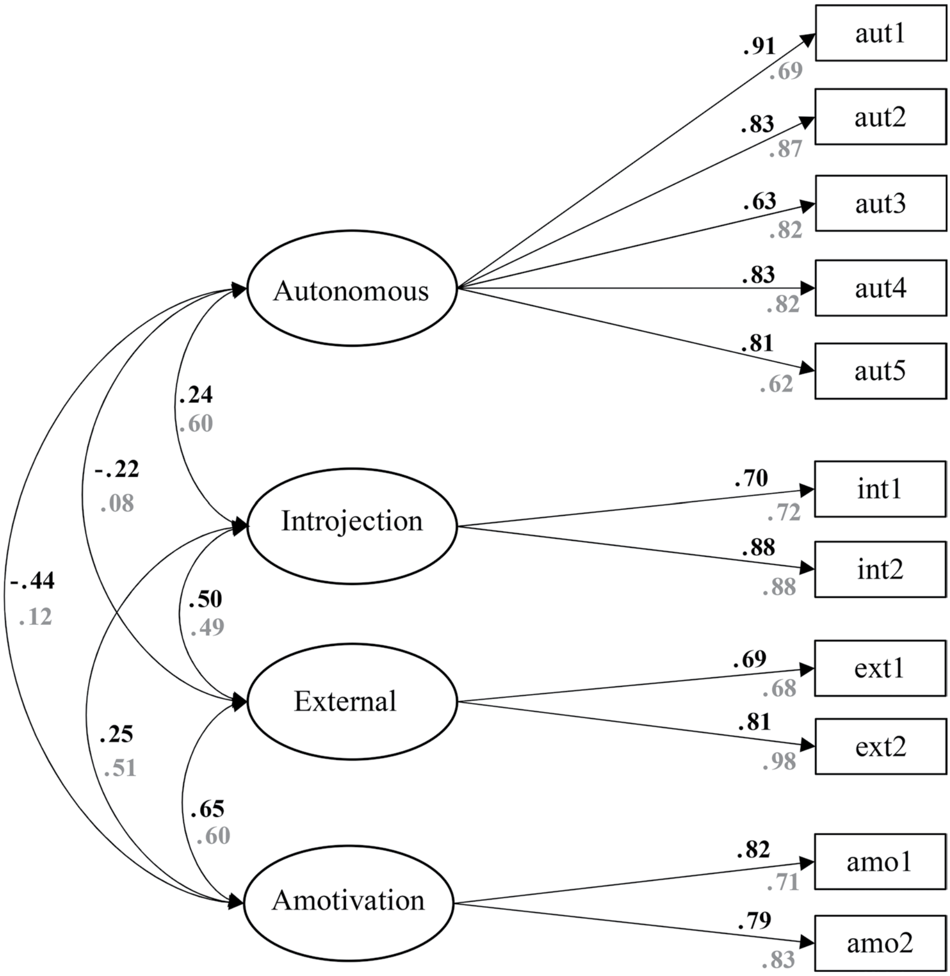

Figure 1. Four-Factor Model Loadings and Covariances as a Function of Past Vaccination Behaviour. *Note*. Vaccinated in black, Not-vaccinated in grey.

for achieving the conservative ΔCFI < .01 at the metric level. Item 3, *"It's important to get the jab to protect my colleagues and patients from the flu"*, indicated lower loadings in the Not-vaccinated group (β = .578), compared to the vaccinated group (β = .781). This item was developed for the TSRQ-Flu scale, and it is plausible that at the group level the importance of protecting patients and colleagues could convey a stronger internalised belief (autonomous regulation) for those who vaccinate compared to those who do not. Subsequently, we conducted exploratory partial invariance for item 3 and achieved conservative metric and scalar invariance ΔCFI < .01. Partial invariance relaxes imposed constraints on specified items across groups and is acceptable at the metric level when two or more indicators are equal across groups (Vandenberg & Lance, 2000). As both full metric invariance (ΔCFI < .02) and scalar invariance (ΔCFI < .01) were achieved, item 3 was retained. As such, the mean scores of the groups may be interpreted equally.

Phase 4: Model reliability and validity

First, to check whether responses were influenced by social desirability bias we computed partial zero-order correlations using *Sample 4*. Next, the internal consistency of each subscale was assessed using Cronbach's (1951) alpha (α) and the Spearman-Brown measure of reliability (ρ). As coefficient alpha may underestimate the true reliability of a two-item scale, reporting both measures are recommended (see Raykov & Marcoulides, 2011). Lastly, we examined construct, convergent and discriminant validity using *Sample 2* and *Sample 3*. The R package used to conduct the statistical analysis required a minimum sample size of 100, therefore *Sample 4* was not included in this analysis. Validity was assessed using four indicators: factor loadings, average variance extracted (AVE), composite reliability (CR) and maximum shared variance (MSV). The AVE uses the standardised item loading to calculate the mean variance extracted for a given construct. Values exceeding .50 indicate adequate convergent validity and all factor loadings should be statistically significant and ideally exceed .70 (Hair et al., 2013). While Cronbach's coefficient alpha may be considered an estimate of CR, it does not account for correlated errors (Raykov & Marcoulides, 2011). As such, to examine CR we used Raykov's (1997) rho which serves to correct positive bias within the α estimation (Macdougall, 2011). Lastly, we computed the Fornell-Larcker criterion (Fornell & Larcker, 1981), considered a rigorous indicator for assessment of discriminant validity, in which the AVE for two constructs is larger than the squared correlation estimates between two constructs (MSV), and the square root of the AVE on each construct is larger than the correlations of other constructs. Statistical analyses were conducted using RStudio (2020) version 1.2.5019. For a list of packages used, assumption checks, and data distributions see Supplementary Materials.

Results of common method bias

The potential confounds for socially desirable responses were examined using *Sample 4*. Six participants did not respond to the BIDR-16 scale (Hart et al., 2015) and were omitted from analysis listwise ($n = 82$). Self-Deception Enhancement (SDE) demonstrated a significant correlation with External regulation ($r = -.283$, $p = .010$). The squared correlation coefficient between SDE and external regulation was $R^2 = .07$, suggesting a limited impact of socially desirable responses on the TSRQ-Flu scores (Hair et al., 2013). See Supplementary Materials Table S6 for data distributions and Table S7 for social desirability zero-order correlations.

Results of reliability and validity

For a summary of the convergent and discriminant validity see Table 5. Overall, the four factors were discriminant and the observed variables adequately explained the latent variables. On average, the TSRQ-Flu scale demonstrated acceptable reliability: autonomous, α = .947; introjection, α = .794; external, α = .808; amotivation, α = .745. The average Spearman-Brown reliabilities for the two-item latent variables were favourable: introjection, ρ = .885; external, ρ = .880; amotivation, ρ = .853. The AVE for

Table 5. Four-factor Model Reliability and Validity Estimates for Sample 2 and 3.

	α	ρ	CR	AVE	MSV	Correlations 1	2	3	4
Sample 2									
Autonomous	.95		.95	.78	.31	**.88**			
Introjection	.80	.89	.84	.73	.31	.56	**.85**		
External	.78	.85	.74	.59	.40	−.12	.36	**.77**	
Amotivation	.77	.87	.77	.63	.40	−.22	.22	.63	**.79**
Sample 3									
Autonomous	.95		.95	.80	.47	**.90**			
Introjection	.79	.88	.80	.68	.47	.69	**.82**		
External	.83	.91	.83	.71	.23	−.11	.30	**.84**	
Amotivation	.72	.83	.72	.56	.23	−.21	.15	.48	**.75**

Note. α = Cronbach's alpha. ρ = Spearman Brown Split half reliability. CR = Composite reliability. AVE = Average Variance Extracted. MSV (Maximum Shared Variance) = maximum standardised correlation^2. Square root of the AVE is shown on the diagonal in bold.

each latent variable exceeded .50, and the Raykov's (1997) rho CR exceeded .70, suggesting adequate convergent validity and construct reliability. Good evidence for discriminant validity was established, as the AVE was greater than the maximum shared variance (MSV) between each latent construct. In addition, the square root of the AVE was greater than inter-construct correlations, providing further evidence of discriminant validity (Fornell & Larcker, 1981).

Phase 5: Criterion-related validity

First, using *Sample 2*, *3* and *4* we report concurrent validity which refers to the strength of the relationship between the criterion (a 'gold-standard' measure) and the new measure (Boateng et al., 2018). Pearson's correlation coefficients between the four TSRQ-Flu constructs and the criterion-related variables (Cognitive Empowerment and Vaccine Attitudes), were computed. Second, using multinomial logistic regression as a function of future vaccination behaviour we report predictive validity, which refers to the new measure's ability to predict future outcomes (Boateng et al., 2018). Third, using *Sample 2,* a hierarchical binary logistic regression analysis assessed the incremental validity of the TSRQ-Flu scale above and beyond the criterion measure Cognitive Empowerment. Statistical analyses were conducted using *RStudio* (version 1.2.1335). See Supplementary Materials Phase 5 for data distributions (Table S8), assumption checks (Figure S5, Table S10, Table S12), and a commentary on data preparation for both predictive and incremental validity.

Results of concurrent validity

Validity coefficients demonstrated consistency across the three samples (for a summary see Supplementary Materials, Table S9). Across all samples, Introjection was positively correlated with both Cognitive Empowerment and Vaccine Attitudes. This finding was not surprising given the item loadings observed during Phase 2. Introjection may 'somewhat' relate to internalised forms of motivation (i.e., autonomous regulation) and externalized forms of motivation (i.e., external regulation), and the extent of this overlap remains undetermined (Dettweiler et al., 2015). For the reporting of the strength of association using the procedure outlined by Meng et al. (1992) see Supplementary Materials: Strength of Association.

Results of predictive validity

For a summary see Supplementary Materials, Table S11. As increasing vaccination uptake rates would be the desirable outcome, 'Vaccinated' was used as the reference category in the multinomial logistic regression. Table S11 presents results as 'Hesitant' relative to 'Vaccinated', and 'Not-vaccinated' relative to 'Vaccinated'. However, to ease interpretation the inverse of the odds ratios (OR) (calculated as 1/OR, see Field & Miles, 2010) are summarised next in relation to getting 'vaccinated' relative to either 'not-vaccinating' or 'hesitancy'. Across the three samples, Autonomous regulation was positively associated with the likelihood to get vaccinated, compared to those who would not vaccinate ($OR_{Sample2}$ = 8.91, $p < .001$; $OR_{Sample3}$ = 7.28, $p < .001$; $OR_{Sample4}$ = 5.77, $p < .001$), or were hesitant ($OR_{Sample2}$ = 3.35, $p < .001$; $OR_{Sample3}$ = 2.71, $p < .001$; $OR_{Sample4}$ = 2.96, $p = .037$). Thus hypothesis (a) was supported. Introjection was positively associated with the likelihood to get vaccinated, compared to those who would not get vaccinated ($OR_{Sample2}$ = 1.54, $p = .030$) or were hesitant ($OR_{Sample2}$ = 1.36, $p = .040$); no significant associations of introjection were found in *Sample 3* and *Sample 4*. External regulation was negatively associated with the likelihood to get vaccinated, compared to those who were uncertain to vaccinate ($OR_{Sample2}$ = 0.70, $p = .021$); no significant associations of External regulation were found in *Sample 3* and *Sample 4*. No significant associations of Amotivation were found across the three samples.

Results of incremental validity

For a summary see Table 6. At step 1, demographics did not significantly predict past vaccination behaviour. At step 2, knowing a line manager's flu vaccination status significantly predicted vaccination behaviour over and above demographic variables. Knowing that a line manager had received the flu vaccination increased the odds of being vaccinated (OR = 2.57, 95% CI [1.55, 4.33], Wald $\chi^2(1) = 3.59$, $p < .001$).[1] Knowing that a line manager had not been vaccinated decreased the odds of vaccination (OR = 0.35, 95% CI [0.12, 0.94], Wald $\chi^2(1) = -2.01$, $p = .044$.) At step 3, adding Cognitive Empowerment improved the predictability of vaccination behaviour, and was the strongest predictor increasing the odds of vaccination (OR = 3.54, 95% CI [2.74, 4.74], Wald $\chi^2(1) = 9.07$, $p < .001$). At step 4, adding the four TSRQ-Flu constructs improved predictability of flu vaccination behaviour with autonomous and introjection regulation being the strongest predictors (see Table 6 for OR). The final model provided a good fit to the data and contributed to the predictability of vaccination behaviour beyond the baseline model, Model LR $\chi^2(10) = 241.26$, $p < .001$. Past behaviour was positively associated with autonomous regulation for vaccinators ($b = 0.99$, $p < .001$), thus Hypothesis (b) was supported. External regulation was negativity associated ($b = -0.27$, $p = .071$), whereas Introjection

Table 6. Hierarchical Binary Logistic Regression Results Predicting Past Flu Vaccination Behaviour.

	Step 1			*Step 2*			*Step 3*			*Step 4*			*Step 4*		
														95% CI for OR	
	b	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*	OR	*LL*	*UL*
Demographics variables															
Gender (self-describe)	−1.73	1.31	.189	−1.18	1.35	.383	−1.11	1.96	.571	0.02	2.08	.993	1.02	0.02	42.67
Gender (female)	−0.54	0.49	.273	−0.62	0.51	.217	−1.20	0.69	.083	−1.61	0.89	.070	0.20	0.03	1.11
Age	0.00	0.01	.846	−0.01	0.01	.587	0.01	0.02	.400	0.02	0.02	.345	1.02	0.98	1.06
Social variable															
Line manager not vaccinated				−1.04	0.52	**.044**	−0.27	0.70	.696	−0.76	0.92	.407	0.47	0.08	2.78
Line manager vaccinated				0.94	0.26	***	0.91	0.35	**.009**	0.91	0.42	**.031**	2.50	1.10	5.88
Criterion-related variable															
Cognitive Empowerment							1.27	0.14	***	0.36	0.25	.156	1.43	0.85	2.33
Motivation regulations															
Autonomous										0.99	0.22	***	2.69	1.79	4.33
Introjection										0.41	0.17	**.014**	1.51	1.10	2.13
External										−0.27	0.15	.071	0.77	0.57	1.02
Amotivation										0.21	0.16	.199	1.23	0.90	1.71
Model fit															
Hosmer and Lemeshow test			13.62			9.23			8.16			6.89			
p-value			.092			.323			.418			.548			
Nagelkerke R^2			.01			.10			.57			.73			

Note. 0 = Not vaccinated ($n = 116$), 1 = Vaccinated ($n = 198$). For Step 1, Step LR χ^2 (3) = 2.39, p = .496, −2LL = −411.24, percent correct = 63.38%. For Step 2, Step LR χ^2 (5) = 24.64, $p < .001$, −2LL = −388.99, percent correct = 65.61%. For Step 3, Step LR χ^2 (6) = 170.52, $p < .001$, −2LL = −243.11, percent correct = 83.44%. For Step 4, Step LR χ^2 (10) = 241.26, $p < .001$, −2LL = −85.8, percent correct = 89.17%. Gender is compared to males; Line manager is compared to not knowing line manager vaccination status; OR = Odds Ratio. Bold denotes significance $p < .05$; *** $p < .001$.

($b = 0.41$, p = .014) and Amotivation ($b = 0.21$, p = .199) were positively associated. Thus hypothesis (c) was not supported. To understand the positive association of Introjection regulation, an exploratory analysis was conducted and is described in the Supplementary Materials, Phase 5 and Table S13.

Discussion

The primary objective was to establish the initial reliability and validity for an adapted version of the Treatment Self-Regulation Questionnaire (TSRQ) assessing healthcare professionals' motivations of flu vaccination uptake. The underlying four-factor structure was supported through CFA analyses across two independent samples and reflected outcomes similar to that of other TSRQ measures within health behaviours (Levesque et al., 2007). Invariance analyses indicated that the factor structure could be considered equivalent for groups of healthcare professionals' who did vaccinate against the flu (vaccinated) and who did not get vaccinated against (not-vaccinated). One new item, "It's important to get the jab to protect my colleagues and patients from the flu", had a stronger factor loading within the vaccinated group, suggesting a stronger internalised motivation to protect patients and colleagues against the flu. Factors were discriminant, with directional correlations and associations consistent with SDT and other TSRQ measures (Denman et al., 2016; Levesque et al., 2007). Additionally, the scale demonstrated good reliability, and responses were not found to be significantly affected by social desirability biases. The four factors were distinct from, and contributed over and beyond, other psychosocial measures of flu vaccination behaviour.

Cognitive Empowerment and Vaccine Attitudes were most strongly related to autonomous motivation. Correlations among external regulation and vaccine attitudes were low, but consistent with other TSRQ validations (Denman et al., 2016). Thus, we support previous recommendations that autonomous regulation may be of particular importance for drivers of vaccination decisions (Denman et al., 2016), adding that introjection and external regulation may also be of importance for understanding healthcare professionals' decisions to vaccinate against the flu.

Exploratory analysis for the extent of internalisation of introjection revealed consistent differences between those who stated that they previously were or were not vaccinated against the flu, suggesting introjection could be considered 'somewhat internal' for those who do not vaccinate against the flu. Future research could investigate the role of introjection regulation in healthcare professionals' decisions to vaccinate against the flu, particularly within communication campaigns. However, as the items measuring introjection are framed in accordance with guilt avoidance (i.e., internal punishment), we advise a cautionary approach. Attempts to increase perceived feelings of guilt may be met with backfire effects, increased negative perceptions, higher feelings of anger and rejection of the target behaviour (Coulter & Pinto, 1995; Miller et al., 2007). Such rejection may be a result of psychological attempts to restore threats to perceived freedoms (Brehm & Brehm, 1981).

Limitations

The TSRQ-Flu scale provides a useful and valid tool to assess healthcare professionals' flu vaccination decision-making, and is suitable to evaluate those who do and do not vaccinate against the flu. However, there are limitations. First, data was based on convenience sampling of healthcare professionals, and the majority of participants across all samples stated having received the flu vaccination in the past. Flu vaccine coverage rates vary across different care settings (Public Health England, 2019) and possibly between different occupational roles. Thus, to strengthen the generalisability of the TSRQ-Flu scale, future studies could use a randomised selection of healthcare professionals from various healthcare settings and care, to assess if the role of autonomy differs between occupational roles or types of care offered. Second, group invariance analysis was conducted in the largest sample only as the R package *semTools* required a minimum group membership of $n = 100$. Therefore, measurement invariance could not be corroborated against additional samples. Third, we cannot be certain of the strength of evidence for predictive validity, particularly as group membership for hesitant vaccinators was disproportionate. To strengthen reliability and validity, future research could corroborate findings using organisation-specific populations whereby actual vaccination uptake rates are available. Fourth, item reduction resulted in two-item subscales for introjection, external and motivation, which may be considered problematic in securely assessing latent constructs (Eisinga et al., 2013). However, our findings demonstrated good reliability, and are in-line with other TSRQ scales whereby two-item scales are used (Denman et al., 2016; Levesque et al., 2007). Fifth, we did not test the scale's test–retest reliability, which could be explored in future studies.

Implications for policy and practice

The TSRQ-Flu scale provides a tool to investigate healthcare professionals' motivations to get vaccinated, extending beyond typical determinations of perceived benefits and risks. A recent study showed healthcare professionals' prior motivation regulations, measured with the TSRQ-Flu scale, moderated the impact of communication encouraging flu vaccine uptake (Moon et al., 2021). Thus, the TSRQ-Flu may aid in the development of tailored interventions to prevent infection and increase vaccine uptake.

Note

1. Odds ratios reported in the manuscript reflect each individual step. For the odds ratio of the final model see Table 6.

Disclosure statement

The authors report no conflict of interest.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author, K.M. The data are not publicly available due to restrictions from Kingston University Research Ethic Committee.

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