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A brief measure of reactance to health warnings

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Abstract Reactance to persuasive messages involves perceived threat to freedom, anger, and counterarguing that may undermine the impact of health warnings. To understand reactance's effects, reliable and valid assessment is critical. We sought to develop and validate a brief Reactance to Health Warnings Scale (RHWS). Two independent samples of US adults completed the brief RHWS in studies that presented warnings on cigarette packs that smokers carried with them for 4 weeks (Study 1; $n = 2149$) or as digital images of cigarette packs that participants viewed briefly (Study 2; $n = 1413$). The three-item Brief RHWS had good internal consistency and test–retest reliability. The scale correlated with higher trait reactance and exposure to pictorial warnings, supporting its convergent validity. With respect to predictive validity, the Brief RHWS predicted perceived message effectiveness, quit intentions, avoidance of the warnings, and number of cigarettes smoked per day. The Brief RHWS can serve as an efficient adjunct to the development of persuasive messages.

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Introduction

Health messages aim to encourage people to engage in healthier behaviors, such as quitting smoking or getting vaccinated. However, these messages sometimes elicit opposition due to feelings that one's autonomy is being threatened. Termed *reactance*, theorists suggest that this negative reaction to persuasive messages can reduce message effectiveness (Brehm, 1966; Brehm & Brehm, 1981; Witte, 1992). Drawing on the rich body of empirical and conceptual work on reactance (Dillard and Shen, 2005; LaVail et al., 2010; Quick, 2012; Quick & Stephenson, 2007; Rains, 2013; Witte, 1992, 1994), we define reactance as an emotional and cognitive resistance to a message, characterized by (1) perceived threat to freedom, (2) anger toward the message, and (3) counterarguments against the message, such as denial or derogation. Based on this definition, we developed and evaluated the validity of a 9-factor, 27-item Reactance to Health Warnings Scale (RHWS; Hall et al., 2016) in the context of pictorial cigarette pack warnings. We found that the RHWS had high reliability and good construct validity (Hall et al., 2016). As expected, reactance factors were positively correlated with trait reactance (i.e., a personality characteristic reflecting a predisposition to reactance), being a smoker, and exposure to pictorial cigarette pack warnings (vs. a text-only warning control).

Although the RHWS exhibits strong psychometric properties, its length may pose a challenge in many research contexts. For instance, researchers evaluating

multiple candidate messages or images may wish to assess reactance, but administering 27 items for each of multiple messages would be overly burdensome and repetitive for study participants. Moreover, many studies of tobacco product warnings, disclosures, and public media campaigns are currently underway to assess their viability and effectiveness for communicating the risks of tobacco use; administration of a short measure of reactance could help researchers to select effective messages that elicit minimal reactance and thereby have a greater impact on tobacco-related beliefs and behaviors. Given these considerations, the current study describes the development and validation of a short reactance scale that could be used not only in the context of anti-tobacco messaging, but also for assessing reactance in other health messaging domains.

Methods

Study 1

Participants

From September 2014 to August 2015, we recruited a convenience sample of adult smokers in North Carolina and California, US to participate in a trial comparing the impact of pictorial versus text-only warnings (Brewer et al., 2016). Participants were 18 years of age or older, proficient in English, and current smokers, defined as having smoked at least 100 cigarettes during their lifetime and now smoking every day or some days. Exclusion criteria included pregnancy, current enrollment in a smoking cessation trial, smoking only roll-your-own cigarettes, smoking fewer than seven cigarettes per week, and living in the same household as another study participant. Details regarding recruitment, design, and methods can be found in Brewer et al. (2016).

Procedures

Smokers received warnings on their own cigarette packs for four weeks (Brewer et al., 2015). Participants brought in an 8-day supply of cigarettes weekly. They were randomly assigned to have one of four pictorial warnings applied to the top half of the front and back panels of their cigarettes packs (Fig. 1), or one of four text-only warnings applied to the side of their cigarette packs, for the duration of the study. Randomization created groups that did not differ on demographics assessed (all $p > .05$) (Brewer et al., 2016). Participants completed two computer surveys at the first study visit (i.e., baseline and immediately after seeing their assigned warning, or immediate post-test), and

Fig. 1 Pictorial warnings used in Studies 1 and 2

Panel A. Study 1 warnings (applied to smokers' cigarette packs)

Panel B. Study 2 warnings (viewed on a computer screen)

Table 1 Reactance items selected for item response theory testing, Study 1

Subscale	Item	Factor loading	Readabiliy
Anger	This warning makes me feel aggravated	0.95	8.8
Anger	This warning irritates me	0.76	9.4
Anger	*This warning annoys me*	*0.77*	*4.4*
Exaggeration	This warning is misleading	0.59	10.0
Exaggeration	This warning exaggerates the health effects of smoking	0.61	10.3
Exaggeration	*The health effect on this warning is overblown*	*0.63*	*7.6*
Government	The government shouldn't require warnings like this on packs	0.71	10.6
Government	Smoking is legal, so the government should stop interfering with smokers' freedom	0.90	11.7
Government	*It's not the government's job to warn me about the risks of smoking*	*0.71*	*5.5*
Manipulation	This warning is trying to boss me around	0.34	3.9
Manipulation	*This warning is trying to manipulate me*	*0.53*	*7.6*
Manipulation	This warning is manipulating smokers	0.45	12.3
Personal attack	*This warning tells me I'm bad because I smoke*	*0.53*	*2.8*
Personal attack	This warning tells me that I'm stupid	0.45	2.8
Personal attack	I am being told that I am a fool by this warning	0.34	2.2
Common knowledge	I've heard the information in this warning a million times	0.71	6.9
Common knowledge	The information in this warning is common knowledge	0.73	9.5
Common knowledge	*I already knew about the harms in this warning*	*0.67*	*6.2*
Denial	*I'll quit long before I suffer the health effect in this warning*	*0.55*	*4.7*
Denial	The health effect in this warning won't catch up to me for a long time	0.48	3.9
Denial	I would worry more about this warning if I expected to smoke for many years	0.40	7.0
Derogation	*This warning is stupid*	*0.62*	*4.4*
Derogation	This warning is useless	0.67	8.4
Derogation	This warning is pointless	0.58	6.0
Self-relevance	*This warning is meant for other smokers, not me*	*0.74*	*4.2*
Self-relevance	This warning is only meant for hard-core smokers	0.69	4.7
Self-relevance	This warning is not relevant to me	0.71	5.4

Italicized rows depict items selected for item reponse theory model. Readability is the reading grade level of the message, calcluated as an average of five readability scores, obtained from readability-score.com. Factor loadings from previously-reported data in Hall et al. (2016)

one survey at each visit thereafter. Participants received a cash incentive at the end of each visit, up to $185 in North Carolina and $200 in California. At the end of the final follow-up appointment, participants received information about local smoking cessation programs.

Measures

The immediate post-test survey at the first study visit assessed demographic characteristics, trait reactance [11 items, $\alpha = .87$, with response options ranging from strongly disagree (coded as 1) to strongly agree (coded as 5)] (Hong & Page, 1989), and positive smoker prototypes (4 items, $\alpha = .84$) (Gerrard et al., 2008; McCool et al., 2011). We assessed message reactance using the 27-item RHWS (Hall et al., 2016) at the immediate post-test survey, the week 1 follow-up survey, and the week 4 follow-up survey. The outcome variables used to assess predictive validity were obtained at the week 4 follow-up survey, and comprised perceived effectiveness of the warning (six items, $\alpha = .90$, "How much did having this warning on your cigarette packs make you want to quit smoking? How much did having this warning on your cigarette packs make you concerned about the health effects of smoking? How much would having this warning on cigarette packs…Make other smokers concerned about the health effects of smoking? Make other smokers want to quit smoking? Make non-smokers concerned about the health effects of smoking? Discourage non-smokers from starting to smoke?"), support for requiring pictorial warnings on cigarette packs (one item: "If the US required that graphic warnings covered the top half of the front and back of cigarette packs, would you… strongly oppose this policy, somewhat oppose this policy, somewhat support this policy, or strongly support this policy?"), quit intentions (three items, $\alpha = .94$, e.g., "How interested are you in quitting smoking in the next month?") (Klein et al., 2009), avoidance of the warning (three items, $\alpha = .90$, e.g., "In

Table 2 Participant characteristics at baseline

	Study 1				Study 2			
	Text-only warnings ($n = 1078$)		Pictorial warnings ($n = 1071$)		Text-only warnings ($n = 209$)		Pictorial warnings ($n = 1204$)	
	n	(%)	*n*	(%)	*n*	(%)	*n*	(%)
Smoker								
No	0	(0.0)	0	(0.0)	122	(58.4)	694	(57.6)
Yes	1078	(100.0)	1071	(100.0)	87	(41.6)	510	(42.4)
Age								
18–24 years	171	(16.1)	152	(14.5)	42	(20.1)	257	(21.3)
25–39 years	377	(35.5)	398	(37.9)	113	(54.1)	659	(54.7)
40–54 years	338	(31.8)	304	(29.0)	40	(19.1)	200	(16.6)
55+ years	176	(16.6)	195	(18.6)	14	(6.7)	88	(7.3)
Mean years (SD)	39.7	(13.4)	39.8	(13.7)	34.1	10.9	33.5	11.4
Gender								
Male	507	(47.4)	532	(50.0)	102	(48.8)	565	(47.0)
Female	548	(51.2)	512	(48.2)	107	(51.2)	632	(52.6)
Transgender	15	(1.4)	19	(1.8)	0	(0.0)	4	(0.3)
Gay, lesbian, or bisexual	173	(16.3)	195	(18.8)	28	(13.4)	120	(10.0)
Hispanic	92	(8.6)	89	(8.5)	16	(7.7)	85	(7.1)
Race								
Black or African American	484	(45.8)	510	(48.9)	17	(8.1)	80	(6.6)
White	393	(37.2)	358	(34.3)	155	(74.2)	958	(79.6)
Other/multiracial	134	(12.7)	117	(11.2)	18	(8.6)	78	(6.5)
Asian	28	(2.7)	42	(4.0)	17	(8.1)	77	(6.4)
Native Hawaiian/other Pacific Islander	11	(1.0)	6	(0.6)	0	(0.0)	2	(0.2)
American Indian or Alaska Native	7	(0.6)	11	(1.0)	2	(1.0)	9	(0.7)
Education								
High school degree or less	333	(31.1)	344	(32.5)	35	(16.8)	124	(10.3)
Some college	519	(48.5)	502	(47.4)	80	(38.5)	534	(44.4)
College graduate	156	(14.6)	156	(14.7)	77	(37.0)	433	(36.0)
Graduate degree	63	(5.9)	58	(5.5)	16	(7.7)	112	(9.3)
Low income (≤150% of federal poverty level)								
No	506	(47.0)	477	(44.8)	–	–	–	–
Yes	570	(53.0)	589	(55.2)	–	–	–	–
Household income, annual								
$0–$24,999	566	(53.3)	589	(55.8)	66	(31.6)	333	(27.7)
$25,000–$49,999	272	(25.6)	266	(25.2)	64	(30.6)	381	(31.7)
$50,000–$74,999	110	(10.3)	92	(8.7)	32	(15.3)	236	(19.6)
$75,000+	115	(10.8)	109	(10.3)	47	(22.5)	252	(21.0)
Study site								
California	594	(55.1)	592	(55.3)	–	–	–	–
North Carolina	484	(44.9)	479	(44.7)	–	–	–	–
Cigarettes smoked per day, mean (SD)	9.1	(6.5)	9.0	(7.2)	–	–	–	–
Trait reactance, mean (SD)	2.86	(0.7)	2.89	(0.7)	2.93	(0.7)	2.97	(0.7)

– Not assessed. Missing demographic data range from 0.0% to 2.2%. Demographics did not differ by trial arm in Study 1. Demographics did not differ by trial arm in Study 2, except for education ($p < .05$)

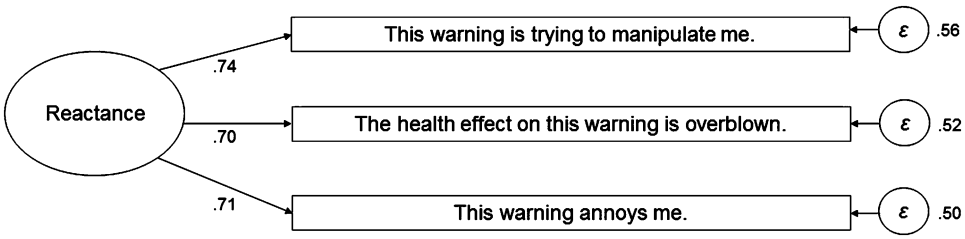

Fig. 2 Confirmatory factor analysis for Brief Reactance to Health Warnings Scale, Study 1

the last week, how often have you tried to avoid looking at the warning label on your cigarette packs?") (Population Assessment of Tobacco and Health Study, 2014), and forgoing a cigarette (one item: "In the last week, how often have you stopped yourself from having a cigarette because you wanted to smoke less?") (Li et al., 2014). We also assessed the number of cigarettes smoked per day.

Data analysis

Analyses used Stata/SE version 14.1 with two-tailed tests and a critical alpha of 0.05. In Study 1, reactance at immediate post-test did not differ among the four text-only warnings ($F < 1$) or among the four pictorial warnings ($F < 1$). For Study 2, we previously reported that comparisons of the five warnings in the pictorial condition revealed few differences in reactance (Hall et al., 2016). Thus, in both studies, we combined the warnings into two groups (text-only vs. pictorial) for all analyses.

To prioritize items for the brief measure, we used item response theory (IRT)-based modeling (De Ayala, 2013; Embretson & Reise, 2013) with immediate post-test data from Study 1. For each of the nine reactance subscales, we selected the item with the highest factor loading from our previous validation study (Hall et al., 2016) that was at or below an eighth-grade reading level (Table 1). Then, we entered these nine items into a graded-response IRT model. After testing IRT assumptions, we eliminated two items that violated the assumption of local dependence and one that violated the assumption of monotonicity (De Ayala, 2013; Embretson & Reise, 2013). Then, we ran a second IRT model with the remaining six items, ultimately selecting the three items for the Brief RHWS that contributed the most information about the underlying latent construct of reactance based on the item information curves (the items are listed in Table 3).

We ran a confirmatory factor analysis with the three Brief RHWS items at immediate post-test to evaluate factor loadings, although we could not determine model fit because the model was just-identified (Bollen, 1998). We then calculated mean scores and assessed internal consistency using Cronbach's alpha. We also assessed test–retest reliability for reactance between immediate post-test, week 1, and week 4. For convergent validity, we derived our predictions from the Theory of Psychological Reactance (Brehm, 1966; Brehm & Brehm, 1981), anticipating that higher Brief RHWS scores would be correlated with the RHWS long form, higher trait reactance, greater positive smoker prototypes, and exposure to pictorial warnings (i.e., random assignment to the pictorial condition). In terms of predictive validity, we drew upon the fear appeals literature (Witte, 1992; Witte & Allen, 2000), expecting that higher Brief RHWS scores at immediate post-test would be correlated with several deleterious consequences including lower perceived effectiveness, less support for pictorial warning policy, lower quit intentions, greater avoidance of warnings, a lower likelihood of forgoing a cigarette at the week 4 follow-up survey, and smoking more cigarettes per day. Finally, we ran these validity analyses using the RHWS long form in order to compare the validity of the long form to the Brief RHWS.

Validity analyses controlled for study arm and used pairwise deletion for missing data, using cases with complete data on the variables of interest for each model. Convergent validity analyses treated reactance as the outcome and thus used linear regression with standardized coefficients. For predictive validity analyses, we present standardized regression coefficients for continuous outcomes and odds ratios and 95% confidence intervals for dichotomous outcomes.

Study 2

Participants

In May 2014, we used Amazon Mechanical Turk (MTurk) to recruit a convenience sample of 1500 US smokers and non-smokers 18 years of age or older. MTurk is a web-based crowd-sourcing platform that is widely used for social science research and shown to generate reliable and valid data (Buhrmester et al., 2011; Paolacci & Chandler, 2014; Peer et al., 2014). We excluded 87 respondents who failed standard procedures for ensuring data quality, resulting in a final sample size of 1413 respondents. While we used this sample to validate the long form of the scale, we use it here to test the psychometric properties of the

Table 3 Brief Reactance to Health Warnings Scale

	Study 1			Study 2
	Immediate post-test (n = 2149) Mean (SD)	Week 1 (n = 1854) Mean (SD)	Week 4 (n = 1901) Mean (SD)	(n = 1413) Mean (SD)
Item 1. This warning is trying to manipulate me	2.16 (1.15)	2.01 (1.07)	2.03 (1.04)	3.02 (1.30)
Item 2. The health effect on this warning is overblown	1.96 (1.01)	1.90 (0.95)	1.90 (0.93)	2.08 (1.05)
Item 3. This warning annoys me	2.14 (1.10)	2.03 (1.04)	2.02 (1.00)	2.36 (1.25)
Brief RHWS	2.08 (0.89)	1.98 (0.85)	1.98 (0.84)	2.49 (0.93)
Cronbach's alpha, Brief RHWS	0.75	0.77	0.80	0.65

Response scale ranged from 1 (strongly disagree) to 5 (strongly agree). Missing data range from 0.0% to 0.7%

brief measure. The University of North Carolina Institutional Review Board approved the procedures for both studies.

Procedures

Smokers viewed the warnings on a computer screen. Participants took a survey while viewing an image of an unbranded cigarette pack with a randomly assigned warning on the top half. They viewed one of five warnings with an image depicting the health consequences of smoking and related text (n = 1204, Fig. 1) or one of the same five warnings without the image (n = 209). Randomization to pictorial or text condition yielded equivalent groups on eight of nine demographic variables; participants had lower levels of education in the text than in the pictorial condition ($p < .05$). Participants received $3 for completing the online survey.

Measures

The survey assessed demographics, the 27-item RHWS, and trait reactance using the same measures as Study 1. The survey also assessed positive smoker prototypes using an expanded 6-item version of the scale ($\alpha = .86$) (Gerrard et al., 2008; McCool et al., 2011). Among smokers, the survey assessed perceived effectiveness of the warning (four items, $\alpha = .85$, "How much would having this warning on your cigarette packs… Make you concerned about the health effects of smoking? Make you concerned about the health effects of smoking? Discourage non-smokers from smoking? Make non-smokers concerned about the health effects of smoking?") and avoidance (ten items, $\alpha = .89$, e.g., "Imagine that all cigarette packs had this warning. How likely is it that you would try to avoid looking at the warning on your cigarette packs?") (Population Assessment of Tobacco and Health Study, 2014). A more detailed description of Study 2 measures can be found in Hall et al. (2016). Survey items for both studies are available upon request.

Data analysis

We calculated mean scores of the Brief RHWS and internal consistency using Cronbach's alpha. We calculated the same correlational coefficients examined in Study 1 to assess convergent validity, expecting that the Brief RHWS would be correlated with the RHWS long form, higher trait reactance, higher positive smoker prototypes, and exposure to pictorial warnings. We also predicted that smokers would exhibit more reactance than non-smokers because warnings may more directly threaten smokers' perceived freedom to use cigarettes. For concurrent criterion validity, we expected that reactance would be associated with lower perceived effectiveness and greater avoidance of the warnings, as in Study 1. As in Study 1, we ran these validity analyses using the RHWS long form. Validity analyses controlled for study arm and education.

Results

About half (48%) of the 2149 Study 1 participants were male, with a mean age of 40 years (Table 2). Study 1 participants were diverse, including a substantial number of sexual minority, African American, low-education, and low-income smokers. About half (47%) of the 1413 Study 2 participants were male, with a mean age of 34 years. Ten percent were gay, lesbian, or bisexual, and 55% had less than a college education.

Scale psychometrics

The three items in the Brief RHWS each had a strong association with the underlying latent construct of reactance, as demonstrated by the high factor loadings from confirmatory factor analysis (Fig. 2). The Brief RHWS exhibited acceptable reliability in Study 1 ($\alpha = .75$ at immediate post-test, 0.77 at Week 1, and 0.80 at Week 4; Table 3) and Study 2 ($\alpha = .65$). In Study 1, the measure

Table 4 Correlates of reactance to health warnings (brief form)

	Range	Study 1			Study 2—smokers			Study 2—non-smokers		
		n	Mean (SD)	*β*	*n*	Mean (SD)	*β*	*n*	Mean (SD)	*β*
Convergent validity (correlates at immediate post-test)										
Reactance long form	1–5	2106	2.30 (0.63)	0.85**	594	2.87 (0.69)	0.88**	–	–	–
Trait reactance	1–5	2043	2.87 (0.70)	0.32**	594	3.05 (0.72)	0.37**	808	2.90 (0.67)	0.27**
Positive smoker prototypes	1–5	2122	1.76 (0.86)	0.19**	594	2.42 (0.90)	0.15**	808	1.87 (0.76)	0.09*
Exposure to pictorial warning	–	2135	–	0.21**	594	–	0.20**	808	–	0.18**
Other validity		Predictive validity			Concurrent criterion validity					
Perceived message effectiveness	1–4	1882	2.66 (0.86)	−0.15**	592	2.70 (0.85)	−0.36**	–	–	–
Support for pictorial warning policy	1–4	1887	3.30 (0.84)	−0.30**	–	–	–	–	–	–
Quit intentions	1–4	1890	2.63 (1.09)	−0.18**	–	–	–	–	–	–
Avoidance of warning	1–5	1847	2.02 (1.14)	0.09**	594	2.74 (0.93)	0.30**	–	–	–
Forgoing a cigarette	–	1889	–	OR = 0.82*[a]	–	–	–	–	–	–
Cigarettes per day	1–60	1890	7.34 (6.78)	0.07*	–	–	–	–	–	–

For predictive validity analyses, we assessed predictors at immediate post-test and the outcome at week 4

*β*s are standardized regression coefficients. – not assessed. Study 1 analyses controlled for study condition. Study 2 analyses controlled for study condition and education

* $p < .05$; ** $p < .001$

[a] 95% confidence interval [.73, .92]

had good test–retest reliability at one week ($r = .70$), three weeks ($r = .68$), and four weeks ($r = .59$).

Convergent validity

Analyses supported the convergent validity of the Brief RHWS. The brief scale was highly correlated with the long form in Study 1 ($\beta = 0.85$, $p < .001$; Table 4), a finding replicated in Study 2 ($\beta = 0.88$, $p < .001$). In Study 1, the Brief RHWS was correlated with higher trait reactance, greater positive smoker prototypes, and exposure to pictorial warnings cigarette packs (all $p < .001$; Table 4). Again, Study 2 replicated these findings, and also demonstrated that reactance was higher among smokers than non-smokers ($\beta = 0.23$, $p < .001$, data not shown). The brief form and the long form performed similarly in terms of convergent validity in both studies (Table 5).

Predictive validity

The Brief RHWS also exhibited predictive validity. Longitudinal analyses indicated that Brief RHWS scores at immediate post-test predicted lower perceived effectiveness of the warnings at the week 4 follow-up survey in Study 1, controlling for study arm ($\beta = -0.15$, $p < .001$; Table 4). In these same analyses, Brief RHWS scores were associated with less support for requiring pictorial warnings on cigarette packs ($\beta = -0.30$, $p < .001$) and lower intentions to quit smoking at the end of the trial ($\beta = -0.18$, $p < .001$). These results were similar when controlling for baseline levels of support for requiring pictorial warnings and quit intentions. Brief RHWS scores were associated with greater avoidance of the warnings ($\beta = 0.09$, $p < .001$) and lower odds of forgoing a cigarette (OR = 0.82, 95% CI = .73–.92). The Brief RHWS was also associated with smoking more cigarettes per day ($\beta = 0.07$, $p < .05$).

Concurrent criterion validity analyses in Study 2 followed a very similar pattern to Study 1. Among smokers, Brief RHWS scores were associated with lower perceived effectiveness of the warnings ($\beta = -0.36$, $p < .001$) and greater avoidance of the warning ($\beta = 0.30$, $p < .001$), controlling for study arm and education. The Brief RHWS and the long form performed comparably in terms of predictive validity in both studies (Table 5).

Discussion

Our brief scale is an efficient and psychometrically strong measure of reactance to health messages. The three items in the Brief RHWS reflect the conceptualization of reactance as an amalgam of perceived threat to freedom, anger in response to the warning, and counterarguing against the warning. The scale exhibited good test–retest reliability and acceptable internal consistency reliability among US adults exposed to pictorial cigarette pack warnings. The internal consistency reliability was lower in Study 2 than Study 1; future studies should evaluate the reliability of the Brief RHWS to ensure that it is adequate. The brief mea-

Table 5 Correlates of reactance to health warnings (long form)

	Range	Study 1		Study 2—smokers	
		n	*β*	*n*	*β*
Convergent validity (correlates at immediate post-test)					
Trait reactance	1–5	2020	0.37**	596	0.46**
Positive smoker prototypes	1–5	2096	0.23**	596	0.12*
Exposure to pictorial warning	–	2106	0.15**	596	0.09*
Other validity		Predictive validity		Concurrent criterion validity	
Perceived message effectiveness	1–4	1856	−0.19**	596	−0.43**
Support for pictorial warning policy	1–4	1860	−0.31**	–	–
Quit intentions	1–4	1863	−0.17**	–	–
Avoidance of warning	1–5	1824	0.09**	596	0.32**
Forgoing a cigarette	–	1889	OR = 0.75*[a]	–	–
Cigarettes per day	1–60	1863	0.06*	–	–

For predictive validity analyses, we assessed predictors at immediate post-test and the outcome at week 4

*β*s are standardized regression coefficients. – not assessed. Study 1 analyses controlled for study condition. Study 2 analyses controlled for study condition and education

* $p < .05$, ** $p < .001$

[a] 95% confidence interval [.73, .92]

sure correlated with its long form, higher trait reactance, higher positive smoker prototypes, exposure to pictorial warnings, and being a smoker, supporting the measure's convergent validity. In support of predictive validity, the brief measure correlated with greater avoidance of warnings, lower perceived effectiveness warnings, less support for requiring pictorial warnings on cigarette packs, lower quit intentions, a lower likelihood of forgoing a cigarette, and smoking more cigarettes per day. The Brief RHWS exhibited comparable validity to the long form, indicating that researchers can use the brief form without sacrificing construct validity.

The brief form builds on the strengths of several distinct reactance measurement approaches. A widely-used measure, developed by Dillard and Shen (2005), assesses anger toward and counterarguments against a message, using four close-ended questions assessing anger and an open-ended thought-listing task to assess counterarguments about the warning (Dillard & Shen, 2005; Gollust & Cappella, 2014; Quick, 2012; Rains, 2013; Rains & Turner, 2007). Some prior studies on pictorial warnings have often focused on the emotional element of reactance (Cho et al., 2016; Erceg-Hurn & Steed, 2011). Other researchers testing Extended Parallel Process Model have measured reactance as a combination of perceived manipulation, message minimization, and message derogation (Witte, 1994). Organ donation researchers have assessed reactance with a four-item scale assessing frustration toward being told how to feel (LaVail et al., 2010; Lindsey, 2005; Reinhart et al., 2007). Our measure builds on this work by incorporating the key affective and cognitive components of reactance, and by including a close-ended measure of counterarguing that may be less burdensome for participants and researchers.

Design and development of health warnings may benefit from taking message reactance into account in order to potentially maximize the beneficial impact of the warnings. In the early stages of developing warnings and campaigns, evaluators commonly use perceived effectiveness as a metric for identifying effective messages (Davis et al., 2013). We propose reactance as a useful adjunct to perceived effectiveness. Measuring reactance could identify outlier messages that elicit particularly high amounts of reactance and therefore may be likely to be ineffective or lead to unintended consequences. Looking at reactance alone is likely not the best way to narrow down a list of candidate messages because effective messages often simultaneously elicit reactance, as is the case for pictorial warnings (Hall et al., 2016). Furthermore, in our own work, we have found little variation in message reactance among pictorial warnings (Hall et al., 2016), perhaps because we looked at a small number of warnings that had already been pre-tested by other researchers (Cameron et al., 2015). Thus, assessing message reactance may offer less useful information at later stages of message development after messages have already been refined.

Pictorial cigarette pack warnings cause greater message reactance than text warnings, as several studies and a recent meta-analysis have demonstrated (Erceg-Hurn & Steed, 2011; Hall et al., 2016; LaVoie et al., 2015; Noar et al., 2016). However, given the large body of research indicating the effectiveness of pictorial warnings, it would

be unwise to conclude that pictorial warnings are counterproductive because they produce reactance, as others have asserted (LaVoie et al., 2015). Experimental and observational evidence supports the superiority of pictorial warnings over text warnings on numerous outcomes, including quit intentions (Noar et al., 2016), quit attempts (Brewer et al., 2016), knowledge about smoking risks (Brennan et al., 2011), and foregoing cigarettes (Yong et al., 2013). Moreover, pictorial warning implementation is associated with decreases in the number of cigarettes smoked and may have played a role in the reductions in smoking prevalence that we have seen in many countries (Noar et al., 2016). Despite the role reactance may play in weakening the warnings' impact, pictorial warnings remain a promising strategy for reducing smoking, far better than text-only warnings at changing attitudes, intentions, and behavior (Brewer et al., 2016; Noar et al., 2016).

Reactance could undermine the political will to implement pictorial warnings on cigarette packs or other policy changes. Public support can influence the ability of policymakers to successfully advocate for, enact, and enforce health policies as well as the effectiveness of the new policies (Diepeveen et al., 2013). The relationship between reactance and support for public health policies remains an important area for future research.

Strengths of our studies include consistent validity findings across both studies, the use of an experimental design in both studies, naturalistic exposure to warnings on smokers' actual packs (Study 1), the longitudinal follow-up assessment (Study 1), and the inclusion of both smokers and nonsmokers (Study 2). However, our use of convenience samples may limit the generalizability of our findings to other populations. The magnitude of some of the correlations in our validity analyses was modest. Although we followed smokers for four weeks in Study 1, the impact of reactance on attitudes and behavior over a longer period of time remains unknown. Finally, we did not include previously validated reactance scales in our surveys due to space constraints.

Conclusions

The Brief Reactance to Health Warnings Scale captures the construct well while maintaining good reliability and validity among smokers exposed to pictorial warnings. We encourage researchers to measure reactance when developing and evaluating health messages in order to understand whether reactance weakens the effects of those messages. Researchers could use this scale as one of a battery of measures to help develop and select pictorial warnings for implementation. The scale may also hold utility beyond the context of pictorial cigarette pack warnings, for example, in evaluating health warnings and other messages for other tobacco products, alcohol, risky sex, exercise, or food and beverages. The scale could also be used or adapted for different types of health communication message formats, such as mass media campaigns.

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Compliance with ethical standards

Conflict of interest Marissa G. Hall, Paschal Sheeran, Seth M. Noar, Kurt M. Ribisl, Marcella H. Boynton and Noel T. Brewer declare that they have no conflict of interest.

Human and animal rights and Informed consent Study procedures were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments. Researchers obtained informed consent from study participants.

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