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The Function Acquisition Speed Test (FAST) as a Measure of Verbal Stimulus Relations in the Context of Condom Use

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Abstract
The Function Acquisition Speed Test (FAST) has shown recent evidence as an effective tool for the quantification of stimulus relatedness. The current study assessed the potential of the FAST in measuring the effects of the presentation of positively or negatively valenced messages on relatedness between stimulus relations with regard to safe-sex behavior, namely condom use. Fifty-one participants were assigned to one of three conditions comprised of valenced message interventions regarding the impact of condom use on the enjoyment of sexual behavior (each condition $n = 17$): a positive-message condition, a negative-message condition, or a no-message control condition. A significant Strength of Relation (SoR) score was found across positive and negative FAST test trials in the positive-message condition only, with no significant differences in SoR scores observed for either the Negative-message or Control conditions. These data suggest that the FAST may have utility as a sensitive behavioral tool for measuring changes in stimulus relations concerning safe-sex behavior on the basis of brief message interventions.

Keywords Function acquisition speed test (FAST) · Condom use · Implicit attitudes · Stimulus relations · Safe-sex behavior

Individuals typically become sexually active in adolescence, meaning that this is a vital period to teach sexual health knowledge and practice to young adults (Boyce, Doherty, Fortin, & MacKinnon, 2003). Safer sex practices are taught to promote positive outcomes, such as rewarding sexual relationships, prevention of unintended pregnancy, and the reduction in the spread of sexually transmitted infections (STIs; Fullerton, Rye, Meaney, & Loomis, 2013). In particular, an estimated 499 million new cases of STIs occur every year, which can have a serious impact on both sexual and reproductive health (World Health Organization, 2013). Although most STIs are easily treated, the failure of participants during sex to engage in prevention behaviors, such as use of condoms, is a well-known facilitator of STI spread (Warner, Clay-Warner, Boles, & Williamson, 1998; Warner et al., 2008). A common

method of assessing the likelihood of engaging in safe-sex behavior can be through the utilization of attitudinal evaluation measures (e.g., Tucker et al., 2012). The most common approach for assessing attitudes in research is through the administration of questionnaires regarding general evaluations towards an object or concept (Fazio, Eiser, & Shook, 2004). It is traditional that research examining the motivational components of an individual's sex-related behavior has implemented this explicit, self-report approach (Newton, Newton, Windisch, & Ewing, 2013; Riggio, Galaz, & Garcia, 2014; Wang, 2013; DiLorio, Parsons, Lehr, Adame, & Carlone, 1992).

It is important to note that the ontological basis of explicit measures assumes, first, that behavioral engagement relies on conscious and controlled mental processes, and second, that the verbal reporting of participants corresponds directly to these processes (Chassin, Presson, Sherman, Seo, & Macy, 2010; Keatley, Clarke, & Hagger, 2012; Smith & Nosek, 2011; Wiers & Stacy, 2006). However, in refutation of this latter point, researchers have identified that such measures of attitudes are not always accurate predictors of behavior, due to the direct influence of deliberate processing (Herring et al., 2013; Noel & Thomson, 2012; Wiers & Stacy, 2010). That is, such mental processing is greatly influenced by the tendency of participants to respond based on what they consider to be

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socially desirable, rather than their true beliefs (Noel & Thomson, 2012; Rüsch, Todd, Bodenhausen, Weiden, & Corrigan, 2009). This greatly lowers the validity of self-report methodologies for assessing attitudes, with measures of sexual behaviors in particular susceptible to unique challenges (Fenton, Johnson, McManus, & Erens, 2001; Van den Mortel, 2008).

It has been suggested that an attitudinal construct that circumvents the problem of social desirability responding is that of "implicit attitudes." "Implicit attitudes" are described as automatic evaluations which influence an individual's behavior, but that are not necessarily accessible to that individual (De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009). Indeed, the position that implicit attitudes are inaccessible to their possessor has been a relatively robust finding (Hahn, Judd, Hirsh, & Blair, 2014; Heiphetz, Spelke, & Banaji, 2013; Marhe, Waters, Wetering, & Franken, 2013; Noel & Thomson, 2012; Smith & Nosek, 2011). Implicit attitudes are typically quantified through the use of indirect, performance-based procedures (known as "implicit measures"; Gawronski & Houwer, 2014) such as the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). The IAT is a computer-based categorization task that requires participants to respond under time pressure with differential key presses to stimuli that are presented on-screen, based on rules provided to the participant that vary across blocks (Randall, Rowe, Dong, Nock, & Colman, 2013). Standardized reaction time scores based on the variance in response latencies across test blocks are of interest in the IAT, because it is assumed that placing participants under time pressure facilitates the capture of their implicit (or "automatic") cognitions. It is assumed that faster responses during one block (e.g., insects-bad/flowers-good) compared to the other (e.g., insects-good/flowers-bad) indicate associations that are indicative of the participant's "attitudes" (see Greenwald & Banaji, 1995). An advantage of the IAT and implicit measures in general is that they likely minimize susceptibility to self-presentational strategies that confound the veracity of explicit measures (Rüsch et al., 2009), particularly in research on topics of a socially or personally sensitive nature (see Greenwald, Poehlman, Uhlmann, & Banaji, 2009).

Previous research has illustrated that implicit measures have predictive validity for socially stigmatized health-related behaviors such as smoking (Chassin et al., 2010; McCarthy & Thompsen, 2006), drug relapse (Marhe et al., 2013), suicide and self-harm (Randall et al., 2013), alcohol use (Burton, Pedersen, & McCarthy, 2012; McCarthy & Thompsen, 2006), and (of particular relevance to the present study) condom use (Czopp, Monteith, Zimmerman, & Lynam, 2004). Although findings regarding the predictive validity of implicit measures towards condom use are not entirely clear (e.g., see Keatley et al., 2012), it can be argued that implicit measures at least provide information about the evaluations of

individuals towards condom use that explicit measures do not provide (Garcia-Retamero & Cokely, 2011; Hill, Amick, & Sanders, 2011; MacDonald, MacDonald, Zanna, & Fong, 2000; Van der Drift, Agnew, Harvey, & Warren, 2013).

The use of behavior-analytic implicit measures may be preferable to traditional social-cognitive implicit measures such as the IAT, because behavior-analytic (functional) accounts of implicit effects tend to avoid the conceptual opacity that is prevalent in social-cognitive accounts of these measures (Cartwright, Roche, Gogarty, O'Reilly, & Stewart, 2016; Cummins, Roche, Tyndall, & Cartwright, 2018). One such behavior-analytic alternative to the IAT is the Function Acquisition Speed Test (FAST; O'Reilly, Roche, Ruiz, Tyndall, & Gavin, 2012). In essence, the FAST serves as a measure of "stimulus relatedness" (Cummins et al., 2018), which simply refers to the degree to which stimuli have been trained (either directly or through derivation) as being paired in the previous history of the individual (Cartwright et al., 2016; O'Reilly et al., 2012; O'Reilly et al., 2012; O'Reilly et al., 2013). Although "stimulus relatedness" may initially appear to be a functionally phrased variant of the "stimulus associations in memory" account of the IAT (Greenwald et al., 1998), there is an important distinction between the two that should be noted. In particular, a stimulus relatedness account of the FAST allows for the falsifiability of the FAST's rationale: that is, if the FAST fails to measure stimulus relations that are trained through experimental contrivance, then the FAST can be argued as incapable of measuring stimulus relatedness. However, if experimental contrivance does not produce effects in an implicit measure, then this does not refute the "associations in memory" account. Rather, it can simply be argued that the training did not serve to sufficiently induce the relevant memory associations. As such, the "associations in memory" account can be susceptible to a kind of tautological reasoning, whereby the associations are only inferred to exist on the basis of presence of effects in the measure; effects that are then used to affirm the efficacy of the measure in quantifying such associations. By contrast, the stimulus relatedness account occasions an empirical testing ground for its assumptions.

The FAST requires participants to complete two critical blocks, referred to as the "consistent" block, and the "inconsistent" block. Two pairs of experimental stimulus classes (e.g., positive evaluative words and pictures of flowers, and negative evaluative words and pictures of insects) are used throughout the procedure in both blocks. For all blocks, each trial consists of the presentation of a single stimulus in the middle of the screen, with participants having the option to press either the "z" or "m" key on the computer keyboard in response to the stimulus. Upon responding, participants are provided feedback on-screen indicating whether the response was "correct" or "wrong."

In the consistent block, the "correct" response options involve coordinating responses for stimuli that are assumed to

be consistent with the participant's learning history sharing a response (e.g., press the "z" key when "flowers" or "good" stimuli appear on screen, and press the "m" when "insect" or "bad" stimuli appear). Likewise, in the inconsistent block, the correct response options involve responding in a manner inconsistent to the participant's assumed history (e.g., "flower" and "bad" share a response, and "insect" and "good" share a response). Blocks terminate after the participant achieves 10 correct responses in a row, or until 200 trials have passed (O'Reilly et al., 2012, 2013; but see Cartwright et al., 2016, for an alternative procedure format). It is assumed that the acquisition rates for learning how to respond will differ across blocks, because participants should achieve the designated correct-in-a-row criterion in fewer trials on blocks that are consistent with that participant's learning history (O'Reilly et al., 2013). The outcome measure is referred to as the Strength of Relation (SoR) index.

The FAST has shown initial promise as a useful tool to assess sensitive sexual behavior-related topics. For example, Roche, O'Reilly, Gavin, Ruiz, and Arancibia (2012) aimed to assess learned stimulus relations of participants between sexual imagery and images of semi-clothed females. Findings indicated a negative effect for prepubertal images and sexual imagery (i.e., these pairs of stimuli were not related), whereas a positive FAST effect was observed when the female images were postpubertal (i.e., these stimuli pairs were related). These findings suggest that subject's histories enabled the formation of a response class for postpubertal female images and generic sexual images, but inhibited the formation of such a response class for prepubertal female images and generic sexual images (Roche et al., 2012). These findings can be supported by O'Reilly et al., (2013), who also found that on average participants had a quicker rate of acquisition for response classes that was consistent with a prior learning history compared to those which were inconsistent. Based on this evidence, it appears that the FAST may be a useful tool for quantifying stimulus relatedness (Cummins et al., 2018; Roche et al., 2012). However, the FAST has not previously been used to assess relatedness in the domain of stimuli related to safe sexual practices.

The ability to effectively assess learning histories relating to safe sexual practices could have practical implications for researchers. That is, previous research has demonstrated that influencing the history of learning of individuals towards safe-sex practices through brief interventions can subsequently lead to increases in the safe-sex behaviors of those individuals (Garcia-Retamero & Cokely, 2011, 2013; see also Gallagher & Updegraff, 2012, in terms of a review of health-related behaviors in general). As such, a measure that can quantify differences in learning histories may prove useful in the prediction of safe-sex–related behaviors. A first step towards this would be to investigate the ability of the FAST to detect changes in learning on the basis of immediately presented

information relating to safe-sex behaviors. Although the brief presentation of information relating to safe-sex behaviors may not be expected to influence significantly stimulus relatedness relative to a history of learning across decades, it should be noted that other work has found brief interventions similar to these to be effective in manipulating well-established evaluations at the implicit level. For example, Van Dessel, Ye, and De Houwer (2018) found that the presentation of brief vignettes with negative information about the positively evaluated historical figure Mahatma Gandhi lead to changes in implicit liking of Gandhi commensurate to the negative information presented, in spite of the fact that this information was exceedingly brief and acute, relative to the long history of positive evaluations around Gandhi in the wider social context. Of course, single instances of presented information are unlikely to change behavior in the long term. However, demonstrating the FAST's ability to measure changes in relatedness in terms of safe-sex behavior stimuli in the short term would provide an important first step in terms of advancing its potential for prediction in a more temporally distal sense.

The current study intended to assess the utility of the FAST in measuring differences in relatedness between condom stimuli and positive/negative evaluative terms on the basis of a brief verbal manipulation. Relatedness was manipulated through the brief presentation of a message regarding condom use, which described condom use in either a positive or a negative light. In order to thoroughly investigate the specific dynamics of the potential effects at play, the current study employed a two-phase FAST design. This simply involved the presentation of two FASTs: a "positive-FAST" that measured rates of learning when condom stimuli and positive words shared a response key (with two neutral stimuli as contrasts), and a "negative-FAST" that measured learning rates when condom stimuli and negative words shared a response key (with neutral stimuli as contrasts). This differs from other, single-phase FAST procedures (e.g., O'Reilly et al., 2013) in that it allows for the quantification of degrees of both condom-positive *and* condom-negative relatedness (relative to neutral stimulus pairings).

Participants were assigned to one of three conditions (negative message, positive message, or control). Participants in the negative-message condition were presented with a negative message regarding condom use prior to completion of the FAST. Positive message participants, by contrast, were presented with a positive message regarding condom use prior to testing on the implicit measure (i.e., FAST). Control participants simply completed the measures without any evaluative message presented. It was conjectured that the FAST would be sensitive to subtle differences in stimulus relatedness caused by the evaluative messages. In particular, it was expected that between the two phases of the FAST, participants in the positive-message condition would show larger SoR scores in the positive-FAST relative to the negative-FAST, whereas

participants in the negative-message condition would show greater effects in the negative-FAST relative to the positive-FAST, with the control condition showing no difference between the two.

Method

Participants

Participants were recruited through convenience sampling at the University of Chichester by advertisement through the social media website, Facebook. Advertisements were posted on the private Facebook page of the third author, as well as on the undergraduate Facebook group page of the University. The advertisement stated that the study involved measures attitudes about health beliefs, with specific reference to safe-sex practices. Participants were not compensated for their participation. The mean age of participants was 20.92 years ($SD = 1.11$). Females ($n = 23$) accounted for 45% of the sample and males ($n = 28$) accounted for 55% of the sample. All participants, apart from two who were nonstudents, were undergraduate students at the University of Chichester (total study $n = 51$, with $n = 17$ across each of the three conditions; see Procedure)

Materials and Apparatus

The experiment was completed by all participants in a quiet experimental cubicle in the Department of Psychology in the University of Chichester. The message presented to subjects at the beginning of the experiment relating to condom use (whose content varied based on the condition subjects were allocated to) was presented to subjects on a 5 in. x 3 in. white laminated card. The FAST was administered to all subjects using a Dell Inspiron laptop with a screen resolution of 1024 x 768 pixels. The FAST was delivered using proprietary software programmed using Livecode. All responses in the FAST consisted of key-presses, and response accuracy and timings were recorded by the FAST software.

Procedure

Overview Participants were recruited through the online social media platform, Facebook. The study was carried out in small, private study rooms in the university library. Participants were randomly assigned to one of three conditions by the experimenter prior to experimentation: the positive-message condition, the negative-message condition, or the control condition. Following signing a consent form, subjects were presented with one of three 5 in. x 3 in. white laminated cards for 30s that had one of the following interventions: (1) no message (i.e., the control condition); (2) a positive message regarding

condom use; or (3) a negative message regarding condom use. The positive message read "using condoms will increase pleasure and relaxation during sexual encounters" and the negative message read "using condoms will take away pleasure and relaxation during sexual encounters." Following the presentation of the message, participants completed the FAST. The presentation of the critical phases of the FAST (i.e., Phase 3 and Phase 4) were randomized across participants. When the full FAST (i.e., all five phases) was completed, the subject was informed that the experiment was finished and invited to ask the experimenter any questions that they may have had about the study.

Function Acquisition Speed Test (FAST)

Overview The FAST required subjects to learn on the basis of feedback (i.e., either "correct" or "wrong") how to respond (i.e., press the "z" or "m" key) when a stimulus was presented on screen. No instructions are presented at any point with the procedure. Rather, subjects are required to learn the appropriate responses to each stimulus on the basis of the contingencies present within each FAST block. In effect, participants are required to form two functional response classes, where stimulus items serve to discriminate specific responses (O'Reilly et al., 2012). The rate of acquisition of the learning of these response classes serves as an index of the degree of relatedness of the stimuli. The procedure consisted of five phases. Phases 1, 2, and 5 each consisted of a single block of trials, whereas Phases 3 and 4 (i.e., the critical FAST phases) consisted of two blocks each, with one designated a "consistent" block and the other an "inconsistent" block in each case.

With the exception of Phase 1, the number of trials in FAST blocks in each phase varied depending on how quickly subjects could achieve a preset criterion (i.e., 10 responses in a row correct). The presentation of stimuli was quasi-randomized, insofar as no stimulus would appear more than twice in any run of eight trials. At the beginning of each trial at all phases of the FAST, a single stimulus was presented in the center of the screen. Upon the presentation of the stimulus, the subject was required to press either the "z" or "m" key. On recording the subject's response, the stimulus was removed from the screen, and feedback was presented (either the word "correct" or "wrong" in large red 48-point Times New Roman font) for 1s. A 500ms intertrial interval (ITI) followed, at the end of which the next trial commenced. If subjects failed to respond on a given trial within 3s, then the stimulus was removed from the screen, and feedback (i.e., "wrong") was subsequently presented on screen. All images that were used in all phases were 150 x 150 pixels and were presented on screen for 3 s until the response was emitted. All word stimuli were presented in 48-point black Times New Roman font. All images were obtained from the International Affective Picture Database (Lang, Bradley, & Cuthbert, 2008), with the

exception of the condom images, which were extracted from the Guardian.com website (Rogers, 2009).

Phase 1 The first phase of the FAST exposed participants to a practice block that required participants to acquire shared response functions for neutral stimulus categories (i.e., responding by pressing the one key on the keyboard when the presented stimulus was from one of two categories, and pressing the other key when the presented stimulus was from one of two other categories). The categories of pictures in the practice block were circles and squares, and the categories of words were body parts and items of clothing. Participants were required to learn that images of circles and clothing words shared the response function of an "m" key press, and images of squares and body part words shared the response function of a "z" key press. The number of trials in this practice block was fixed at 10. As such, this phase was simply to get subjects used to the format and layout of the procedure.

Phase 2 Phase 2 of the FAST procedure exposed participants to an initial baseline block. A baseline block was also administered in the final phase, Phase 5. The main purpose of administering baseline blocks before and after the critical FAST blocks is to establish a baseline level of response class acquisition using novel and previously unrelated stimuli, which is then used in the calculation of the overall SoR index in the FAST (see Results section for further information; O'Reilly et al., 2012). The administration of a baseline block after the critical blocks (i.e., phase 5) allows for the effect of practice to also be considered in terms of baseline acquisition rates relative to neutral stimulus categories. In Phase 2, the block involved learning that words relating to different types of birds and images of vehicles shared a response function, and images of mushrooms and occupation names shared another response function.

Phase 3 This phase of the FAST consisted of two testing blocks, a consistent and an inconsistent block. This phase assessed relatedness between images of condoms and positive words (though note that Phase 3 and Phase 4 were randomized in terms of order of presentation in order to avoid any potential effects of order of presentation). The order of FAST block presentation within this phase was randomized across subjects. The consistent block involved condom images and positive words sharing a response function of an "m" key press, and sky images and number words sharing the response function of a "z" key press. The inconsistent block involved an orthogonal configuration (i.e., positive words and sky images shared a response function, and condom images and number words shared a response function). Such a configuration can be seen as similar (though not identical) to the single-target IAT (ST-IAT; Bluemke & Friese, 2008) in that it attempts to measure the relatedness between only one target (i.e., condom

images) and one of two valences (either positive or neutral valence). The presence of the neutral images (which diverges from the ST-IAT's layout) is to ensure that subjects do not simply adopt a heuristic response pattern wherein they learn to press a specific key whenever they see a stimulus that is not a word. That is, the presence of the neutral images ensures that the condom aspect of the image is the salient discriminative feature of the stimulus.

Phase 4 This phase was similar to Phase 3 in that consistent and inconsistent FAST blocks were administered. This phase assessed relatedness between images of condoms and negative words. The consistent block involved condom images and negative words sharing the response function of an "m" key press, and sky images and number words sharing the response function of a "z" key press. The inconsistent block involved a converse configuration (i.e., condom-number and sky-negative).

Phase 5 In Phase 5, the block involved learning that images of babies and words for items of clothing shared a response function, and images of scenery and words for different forms of crockery shared another response function.

Results

Strength of Relation Index

The FAST data were scored using a Strength of Relation (SoR) index score (O'Reilly et al., 2012). This score is calculated by dividing each raw trial difference score (i.e., total trials needed on the inconsistent block to reach criterion minus total trials needed on the consistent block to reach criterion) by the mean trial requirement to reach criterion on baseline blocks (i.e., phases 2 and 5). A separate SoR score was calculated for both the Phase 3 and Phase 4 FASTs. A positive SoR score indicates that the response acquisition on the inconsistent block took more trials than the response acquisition on the consistent block, whereas a negative SoR score indicates that response acquisition for the consistent block took more trials compared to the inconsistent block (see O'Reilly et al., 2012, 2013] for greater discussion on this scoring method). The median SoR scores for each FAST are shown in Table 1. We present median, rather than mean, scores here because the data were not normally distributed.

Fast

We expected that differences between the SoR scores in the positive and negative FASTs would differ in accordance with the condition to which participants were assigned, with the positive-message condition showing a greater effect on the

Table 1 Median SoR scores for Control Condition (Control Cdn), Negative Message Condition (Negative Cdn), and Positive Message Condition (Positive Cdn)

Condition	Median SoR	N
Control Cdn SoR Positive	.164	17
SoR Negative	0	17
Negative Cdn SoR Positive	-.037	17
SoR Negative	.0517	17
Positive Cdn SoR Positive	.534	17
SoR Negative	0	17

positive- compared to the negative-FAST, the negative-message condition showing a greater effect on the negative-compared to the positive-FAST, and the control condition showing no difference between the two FASTs. The SoR scores for both the positive and negative FASTs across the three conditions overall were not normally distributed. Hence, in order to assess the differences in SoR scores within subjects across the three conditions, three Wilcoxon signed-rank tests were conducted. The first of these tests revealed that there was a statistically significant difference between SoR scores in the positive-message condition between positive-FAST and negative-FAST SoR scores, $z = 3.290$, $p = .001$, $r = .56$. The median score decreased significantly from the positive ($Md = .534$) to negative ($Md = 0$) FAST SoR score. There was no statistically significant difference between SoR scores on the positive FAST compared to the negative FAST for the control condition, $z = 1.138$, $p = .255$, $r = .19$. The median SoR score decreased from the positive ($Md = .164$) to negative ($Md = 0$) FAST, but not significantly. Finally, for the negative-message condition, there was also no statistically significant difference between positive FAST compared to negative FAST SoR indices, $z = -1.034$, $p = .301$, $r = .17$. The median SoR score increased nonsignificantly from the positive ($Md = -.037$) to negative ($Md = .0517$) FAST.

In light of the expected trend mentioned above, a further analysis was run in order to determine whether differences between SoR scores were affected by the experimental condition of subjects. Given that the data were not normally distributed, a Kruskal-Wallis test was run using the difference between positive-FAST and negative-FAST SoR indices (referred to herein as "SoR differences") as the DV, and experimental condition as the IV. There was a statistically significant difference among SoR differences across the experimental conditions, $\chi^2 (2, n = 51) = 9.747$, $p = .008$. The largest median SoR difference score was for the positive-message condition ($Md = .396$), with the lowest median SoR difference score being for the negative-message condition ($Md = -.0345$). The median SoR difference score for the control condition fell between these two values ($Md = .0952$).

Discussion

The aim of the current study was to investigate the utility of the FAST in measuring subtle changes in the relatedness between condoms and evaluative stimuli, manipulated through the use of a brief message presentation. The results indicated that differences between the phase-positive and phase-negative SoR scores were largest and significantly different for the positive-message condition, not significantly different for the control condition, and not significantly different for the negative-message condition. Furthermore, analyses indicated that these differences were significant between subjects. That is, the difference between the SoR scores varied significantly across conditions, with the largest difference noted for the positive-message condition. Overall, the current results support the expected outcomes of the study, i.e., scores in the phase-positive and phase-negative FASTs changed in accordance with the relevant manipulation of relatedness.

Although it is notable that the current findings were not in line entirely with the expected outcome (i.e., the negative-message condition did not show a significantly greater effect in the negative-phase FAST compared to the positive-phase FAST), it could be that this may have been due to the preexperimental histories of the subjects. In particular, the difference between SoR indices in the control condition showed a slight skew towards the positive-phase FAST compared to the negative-phase FAST. Although this difference was not significant, it may be the case that subjects in general in the control condition had a preestablished history of relatedness between condoms and positive words that was slightly greater than that of relatedness between condoms and negative words. By contrast, the negative-message condition showed a greater SoR score for the negative-phase FAST compared to the positive-phase FAST. Although this score was close to zero, a potential preestablished condom-positive history (as exemplified by the control condition) would suggest that the (nonsignificant) difference between SoR scores in the negative-message condition should be measured against the control condition (which shows a nonsignificant positive skew), rather than against some zero baseline value. Although such a comparison still suggests no significant change, the qualitative shift in the direction of SoR differences in this negative-message condition may be seen as more impactful than if it were measured against a zero baseline.

It should be noted that the intervention messages provided to subjects were relatively brief in nature. In spite of this, the FAST scores changed commensurate to the specific message presented, indicating that the FAST was quantifying the subtle changes in learning that were the consequence of the intervention. This is particularly interesting, given that a meta-analytic review of the literature regarding the effect of similar message-presentation interventions on condom use and other health-related behaviors indicated that typically such message

interventions do not affect scores in explicit attitudinal measures towards these behaviors (Gallagher & Updegraff, 2012). Even more interesting, the aforementioned meta-analysis indicated that such message-presentation interventions tend to lead to behavioral change towards health-related stimuli (e.g., condoms) based on these messages. As formerly mentioned, explicit measures may exhibit poor predictive validity due to biases that prevent subjects from responding honestly (Fenton et al., 2001; Van den Mortel, 2008). The corresponding changes in both the FAST scores in the current study and behavioral outcomes towards health-related stimuli (including condom stimuli) in other studies based on message interventions, coupled with the lack of effect noted on explicit measures based on these interventions (and the general ineffectiveness of self-report measures in predicting behavior), may be argued as illustrating the potential of the FAST in predicting condom-related behaviors.

Of course, the above assertion should be regarded as highly tentative, and such an inference cannot be made in any concrete terms based on a single study. Future studies using the FAST therefore should seek to replicate the current experiment using both the same condom stimuli as the current experiment, and other health-related stimuli more generally. In addition, future studies should also incorporate a behavioral outcome involving the specific stimuli that are being investigated in order to determine whether FAST scores can reliably predict behavioral outcomes as the above-mentioned argument may suggest. At the very least, the current findings add to the growing body of research that suggests that the FAST is capable of measuring relations between stimuli, as well as being capable of parsing differences in relatedness between those stimuli across groups of individuals (Cartwright et al., 2016; Cummins et al., 2018; O'Reilly et al., 2012; 2013; Roche et al., 2012).

It should be noted that a number of elements relating to the message intervention employed in the current study are unclear. In particular, the specific learning dynamics on which the intervention affected the learning history of subjects is unclear. For example, although the intervention may be effective in manipulating learning histories in the short term, the effect of the intervention may not be pervasive across time. Although (as mentioned) similar interventions have proven effective in changing behavior (implying some degree of influence in the long-term history of subjects), the specific messages presented in the current study have not been validated in such a way. This limits the specificity of inferences that can be made about the FAST from the current data. In particular, if the current messages are only influential in the short-term history of the subject, then the current data may in fact be suggestive of a confound of the FAST, in the sense that short-term learning may have more of an impact than the more

long-term history of the subject in terms of FAST scores. Although future studies should seek to implement the current paradigm with interventions whose impact on learning is more well-known, it should be noted that (regardless of the specific dynamics of learning involved), the current data suggest that the FAST is capable of quantifying differences in learning in at least some capacity.

Overall, the current findings were in line with the expected outcome of the experiment; that is, FAST scores varied in accordance with the specific message intervention presented to subjects prior to exposure to the procedure. The current findings suggest that the FAST may be sensitive to slight differences in the learning history of individuals towards condom-related stimuli. As such, the FAST may show potential as a tool for predicting likelihood of engaging in safe-sex behavior. Although this latter claim requires significantly more empirical investigation in order to assess its veracity, these data show initial promise in this regard, and add to the growing body of research that suggests that the FAST is effective in measuring differences in learning across individuals.

Compliance with Ethical Standards

Disclosure of Conflicts of Interest On behalf of all the authors the corresponding author confirms that no author has a conflict of interest to declare.

Ethical Approval All procedures performed in this study with human participants were in accordance with the ethical standards of the institutional and national research committees.

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