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Assessment of Appeal-Aversion Response among US Smokers Following Exposure to Graphic Warning Labels on their Cigarette Packages

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy

in

Public Health (Health Behavior)

by

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The dissertation of Matthew David Stone is approved, and it is acceptable in quality and form for publication on microfilm and electronically.

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EPIGRAPH

The true face of smoking is disease, death, and horror –
not the glamour and sophistication the pushers in the tobacco industry try to portray.

David Byrne

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ABSTRACT OF THE DISSERTATION

Assessment of Appeal-Aversion Response among US Smokers Following Exposure to Graphic Warning Labels on their Cigarette Packages

by

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Doctor of Philosophy in Public Health (Health Behavior)

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Background: The United States (US) is the only high-income country that has not mandated Graphic Warning Labels (GWLs) on cigarette packaging. Pack imagery is a key element of tobacco marketing aimed at generating brand appeal to encourage continued smoking. Removing industry imagery should neutralize reactions to packaging thus lessening appeal and weakening the product's perceived value. Adding GWLs should go further and replace appeal with aversion thus generating negative responses and subtracting from perceived valuations.

Methods: This dissertation consists of three studies using data from the CASA randomized controlled trial examining the effects of cigarette packaging on smoking cognitions and behavior. Study 1 quantified smokers' initial reactions as they examined packaging design options (i.e., own US pack, Blank pack devoid of industry imagery, and three GWL plain packs). Study 2 evaluated the psychometric properties of a 6-item measure of brand appeal for cigarette packaging. Study 3 identified the change in

smokers' appeal-aversion valuations via a willingness-to-pay assessment of packaging options after randomization to a 3-month intervention involving smokers purchasing their cigarettes repackaged into one of three pack options.

Results: Smokers had largely positive reactions to their own packs, neutral reactions to the blank pack, and graded negative reactions to GWL packs that aligned with expressions of disgust, anger, fear, and sadness. Strong scalability, internal consistency, concurrent validity, and predictive validity was found for the brand appeal measure. We found upfront positive valuations (i.e., appeal) for smokers' Own Packs, weakened yet still positive valuations for the Blank Pack, and negative valuations (i.e., aversion) for GWLs. After 3-month exposure, minimal change in willingness-to-pay was observed: appeal-aversion valuations did not change among those randomized to use their own packs, while those randomized to use Blank and GWL packs were less price aversive to GWL imagery that provoked high negative affect.

Conclusion: The findings indicate that industry-designed packaging generates appeal and positive affect among adult US daily smokers. Removing industry imagery temporarily neutralizes this response and adding GWLs engenders aversion and negative affect which may decrease following repeated exposure. Plain GWL packaging would seem to be an important component of an effective tobacco control strategy.

CHAPTER 1: INTRODUCTION

Tobacco use is the single greatest cause of preventable death and disease in the world. Use of tobacco is causally linked to six of the eight leading causes of death and kills roughly 6 million of its users annually.[1] In the United States (US), more than 480,000 deaths per year are attributed to cigarette smoking.[2] Meanwhile, the tobacco industry spends tens of billions of dollars annually on global marketing and advertising to make their products as appealing as possible in order to retain users and recruit new populations of smokers.[3] As voluntary marketing restrictions have been ineffective and the tobacco industry has demonstrated a willingness to circumvent most constraints, thus governments have needed to enact intervening legislation.[1]

While the US requires surgeon general warnings be printed on all tobacco packaging, these warning labels have had minimal impact on knowledge and attitudes about smoking.[4] Unfortunately, there has been little meaningful change in these text-only messages since 1965.[5] Further, the current placement on many cigarette packs make the warnings easy to miss and difficult to read.[4] In 2003, in an effort to combat the tobacco epidemic and guided by early reports on the effectiveness of graphic warning labels (GWLs),[6] 168 countries signed The World Health Organization Framework Convention on Tobacco Control (FCTC) treaty[7] to ensure that "*every person be informed of the health consequences, addictive nature and mortal threat posed by tobacco consumption and exposure to tobacco smoke.*" Article 11 of this treaty recommended that large health warning labels be placed on all tobacco products and strongly recommended the use of pictorial health warnings. Since this time, over 127 other countries,[8] <u>not</u> including the US, have implemented GWL policies that meet the minimum standards outlined in the FCTC.[7] Presently, 17 countries have gone further, following Australia's 2012 introduction of plain packaging, which removes all branding and adds large GWLs.[8] The US, however, has not been without effort. In 2009, congress passed the Family Smoking Prevention and Tobacco Control Act[9] which empowered the Food and Drug Administration (FDA) to regulate tobacco and specified that GWLs be required on cigarette packaging and advertisement. Though, after litigation by the tobacco industry, the DC Circuit Court blocked the graphic warning requirement, concluding that the packaging proposed by the FDA was unconstitutional on the grounds of the violation of commercial free speech.[10] FDA elected not to appeal the decision and instead sought to conduct more research on this topic. FDA has since

issued a revised rule in March 2020 which was immediately met with new litigation attempting to strike down the GWL mandate and the Tobacco Control Act itself.

This dissertation seeks to advance the research on the role of cigarette packaging on smoking behavior. Current US packaging is a platform for Tobacco Industry marketing. The CASA randomized trial[11] manufactured cigarette packs that were devoid of all Tobacco Industry marketing as well as GWL plain packs that were manufactured to be very similar to those in use in Australia and for which UC Regents obtained a license from the Commonwealth of Australia. We leverage data from this trial which examined a real-world experience where US daily smokers purchase their cigarettes repackaged into specially manufactured packs for three months. In chapter 2, we psychometrically validate a 6-item measure of brand appeal that smokers have for their own US cigarette brand. We also examine how this construct is related to other brand perceptions and demographics. In chapter 3, we evaluate a “Think aloud” verbalized response to initial presentation of the different study packs during a formal pack handling task. We measure affective reactions in two ways and quantify emotional utterances. In chapter 4, we examine a smoker’s willingness to pay for differing packaging designs using a pair of discrete-choice purchase tasks performed before and after 3-month of the study intervention in which smokers were randomized to receive their cigarettes in the different study packaging. Taken together, these series of studies provide data on the appeal response to industry branded packaging designed to recruit and maintain its users and the aversion response to GWLs designed to inform and remind smokers of associated risks. The result of these three studies are relevant to the ongoing US litigation on cigarette packaging which focuses on the rights of the Tobacco Industry to use appealing packs and the rights of governments to convince smokers of the harmful consequences of smoking.

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CHAPTER 2: THE ROLE OF AFFECTIVE REACTIVITY INDUCED BY CIGARETTE PACKAGING INCLUDING GRAPHIC WARNING LABELS: THE CASA STUDY

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ABSTRACT

Objective: To identify whether three types of cigarette pack designs (Graphic Warning Label [GWL] packs, Blank packs, Current US packs) differentially elicit the type of affect necessary to study how packaging influences cognitions and behavior among US smokers.

Design: During one-on-one meetings, 324 daily smokers from San Diego, California were asked to handle a randomized presentation of packs (3 GWLs, 1 Blank, and 1 US) and "Think Aloud" their reactions as they examined each design. Participant thoughts were recorded and transcribed. Six trained coders scored these transcriptions on a 7-point reactivity scale (-3 to +3) and natural language processing software quantified the text for speech polarity (-1 to +1) and emotive word frequency.

Results: Reactivity scores had excellent inter-rater reliability (agreement≥86%; ICC≥.89) and were correlated with speech polarity (*rho*'s=.21-.37, *p*-values<.001). When considering their own US pack, approximately two-thirds of smokers had a low (31.5%) to medium (34.6%) positive response (reactivity=1.29; polarity=0.14) with expressed feelings of joy and trust. Blank packaging prompted a largely (65.4%) neutral response (reactivity=0.03; polarity=0.00). The gangrenous foot GWL provoked mostly medium (46.9%) to high (48.1%) negative responses (reactivity=-2.44; polarity=-0.20), followed by neonatal baby (reactivity=-1.85; polarity = -0.10) and throat cancer (reactivity=-1.76; polarity=-0.08) warnings. GWLs varied in their elicitation of disgust, anger, fear, and sadness.

Conclusion: Initial reactions to three GWL packs, a blank pack, and smokers' current US pack reflected the targeted range of positive, neutral, or negative affect enabling tests of the role of packaging on smoking cognitions and behavior in a real-world randomized trial.

INTRODUCTION

Cigarette packaging offers a point-of-use marketing opportunity to influence both a smoker's behavior and the perceptions of observers, particularly young people.[1-3] Branded marketing on cigarette packages is associated with positive affect that supports the decision to smoke another cigarette.[4-6] Completely removing industry marketing from the packaging may not be sufficient to counteract positive affect[7] and inhibit incentive salience attribution.[8,9] Graphic warning labels (GWLs) of the health consequences of smoking aim to introduce negative affect with the goal of having the smoker reconsider the decision to smoke. As of January 2021, 127 countries have mandated GWLs on all cigarette packaging,[10] and 17 countries have mandated plain packaging pioneered by Australia,[11] which includes removal of all industry branding as well as GWLs on 75% of the pack.[12,13] The United States is the only high income country that has not yet mandated GWLs on cigarette packs.

While there have been multiple studies showing that GWL packaging is associated with negative affect,[14-19] the valid measurement of affective response to emotion-evocative stimuli is complicated, frequently requiring information on the response to the targeted product when presented without the emotive stimulus.[20] The GWL literature mainly uses brief self-report paper and pencil measures of affect, resulting in a simple quantitative scale. Such a measure is best when complemented by additional research using observational methods that add rich context.[21]

The type of affect that cigarette packaging might induce is thought to be a minor "emotional episode".[22] Viewing a GWL package may elicit a minor positive or negative emotion that would not be strong enough to elicit any major physiological activation (such as fight or flight response), but is enough to have individuals think about their decision to smoke.[23] People are known to use emotive words to express the affect they feel when reacting to such an episode and the act of describing their response often helps them regulate their emotions.[24] The "think aloud" technique[25] poses a task to participants, such as to explore a pack, and asks them to express their thoughts and feelings as they undertake the exploration.[26] This approach elicits verbalized spontaneous thoughts[27] about the pack presented, that is often influenced by cognitions and emotions from previous experiences with the product.[28] This approach is most fruitful when different packaging options are compared and particularly when the overlearned

response to their usual pack is explored after they have been challenged with a pack featuring negative emotive stimuli.[29] When this observational methodology with multiple pack options is paired with multi-method measurement[30] of the responses, it measures immediate reactivity, as opposed to paper-pencil measures[31] which may promote evaluative reactions. We recorded and transcribed the "think aloud" when handling 5 different packaging options: GWL packs (3 different plain package choices), blank pack (devoid of both marketing and GWL imaging) and their usual pack after exposure to at least one GWL pack. After training, we used 6 coders to review the transcript and classify the immediate reactivity to each pack on a 7-point scale. We validated these coder classifications, by applying natural language processing to each transcript to identify the polarity of the speech used (i.e., positive, neutral, or negative words used) and characterize the frequency and types of emotional phrases uttered. All participants in this study were enrolled in a randomized trial where they received 3 months real world experience with their cigarettes repackaged into plain packs, blank packs or maintained their usual pack. While we hypothesize that the cognitive and behavioral responses in the trial will be determined by the immediate reactivity that the participants had to each of the study packs, this paper established and validates the measure.

METHODS

Study Population: This study uses cross-sectional data collected during the initial in-person visit (V1) for the CASA randomized trial of the effects cigarette packaging on smoking cognitions and behavior.[32] Volunteer daily smokers, aged 21-65 years from San Diego County, California, were enrolled using community advertising. All participants signed an informed consent (overseen by Institutional Review Boards at UC San Diego and Cal State San Marcos), completed questionnaires, and followed a protocol to think aloud their reactions as they explored study cigarette packaging.

Pack Handling Task: During V1, participants were handed one pack at a time and asked to verbalize what thoughts came to their mind as they explored each side of each pack. For each pack, verbalizations were timed, recorded, and transcribed. There were 5 study packs (**Supplementary Figure 1.1**) each labelled with the participant's brand and variant: three GWL plain packs; one blank pack (devoid of all marketing and messaging); and their current US pack. In a pre-test[32], we selected 3 of 8

plain pack images licensed from the Commonwealth of Australia using negative affect scores from the Positive and Negative Affect Scale.[33] To ensure that the "think aloud" response for their usual pack was more than mere overlearned responses, we required exposure to their own pack to be conditioned on exposure to at least one GWL plain pack. GWL packs were thus randomized to the 1st, 3rd, or 5th presentation and the blank pack and US pack to the 2nd or 4th presentation.

Coding Reactivity to Study Packaging: Using a multi-method qualitative approach,[30,34] two coders in consort with an anthropologist (SH) developed a coding manual[35] for a 7-point affect scale (high, medium, low for both negative and positive reactivity as well as a central neutral category; **Table 1.1**) using a training set of 30 transcriptions. Four additional coders were trained using this set until group concordance (±1) was reached on 80% of transcriptions. In total, six coders used the coding manual to independently rate each transcription for each pack The coders met weekly to discuss their scores and resolve instances of coding discordance. High reactivity was indicated by use of highly emotional words or amplified moderately emotional words that suggested a somewhat visceral reaction to the packaging. If moderately emotional words or highly emotional words were used and de-amplified (e.g., "*somewhat* disgusting") or emotional statements accompanied by qualifications (e.g., "that's disgusting but *it would not stop me from smoking*"), that indicated medium reactivity. A low level was a mild reaction followed by a rationalization. Neutral reactivity was when no emotional or reactive language was uttered. For each pack, reactivity scores were averaged, and categorical reactivity scores generated by rounding mean scores to their nearest integer.

Natural Language Processing of Initial Reactivity: Using R version 4.0.3 with the 'SentimentR' package,[36] we conducted natural language processing of the transcribed speech from the pack handling task to quantify the number of words uttered and polarity of word choice. Using the Jockers–Rinker sentiment lexicon of 11,710 polarized words,[37] sentences were classified according to their overall polarity (e.g., the degree to which the speech and its linguistic modifiers had a positive, neutral, or negative valence; **Supplementary Table 1.1**). To account for extreme negative words occurring more commonly in natural language,[38] polarity scores were scaled from -1 to +1 using a general rescaling function.[36] Linguistic modifiers were accounted for by examining the four words following, and two words

preceding, each polarized word and tagged as one of the following: neutral, negators (flip the ± polarity sign of a word, e.g., "I do *not* like it"), amplifiers or de-amplifiers (increase or decrease the impact of a word by multiplying polarity scores using standard preset weights.[37], e.g., "I *really* like it. I *hardly* like it"), or conjunctions (overrule previous clauses, e.g. "I like it *but it's not worth it*"). The sentiment lexicon was augmented to neutralize polarized words that had different connotations in our study (e.g., baby, child, surgeon). Sentence-level polarity scores were averaged to generate composite polarity scores per participant per pack. The prototypical emotions of fear, disgust, anger, sadness, anticipation, trust, joy, and surprise[39] were explored using 'SentimentR's' emotion function and the NRC Hashtag Emotion Lexicon look-up of 8265 emotion terms.[40,41] The rate of emotion expressed was evaluated as the number emotional words uttered relative to the total number of words spoken, with scores ranging between 0 (no emotional utterances) and 1 (all emotional utterances).

Study Covariates: Sociodemographics (age, sex, race/ethnicity, and educational attainment),[32] tobacco use (daily use frequency and primary brand smoked),[32] the Fagerström Test of Nicotine Dependence scale,[42] brand loyalty,[4] and health anxiety[43] were measured covariates. We assessed brand appeal using a 6-point Likert scale ('The design on the brand of cigarettes I currently smoke is…Stylish, Fashionable, Cool, High quality, Attractive, Appealing'; $\alpha = .92$).[44,45]

STATISTICAL ANALYSIS

Inter-rater reliability of the coded reactivity scores across the five pack conditions was evaluated in two ways:[46] a) by computing the percentage agreement across the scores while allowing for a tolerance of 1 in ratings, and b) by modeling the intraclass correlation coefficient (ICC) among the raters. With the goal of constructing composite scores, a two-way random effects (i.e., participants within pack type) ICC model was used[46] with raters' scores evaluated for consistency.[47] To examine patterns in highest levels of reactivity, quintile cut points were calculated. To examine differences in the time to explore packs, total words uttered, polarity of word choice and verbalized reactivity expressed, we conducted Kruskal-Wallis tests and post-hoc examination of pairwise comparisons using Dunn's tests. Spearman Rho correlation coefficients were used to evaluate construct validity between reactivity scores and word polarity. To explore differences in emotion expressed during pack handling, we plotted the

average rates of emotional utterances using a radar chart.[48] To explore the associations between sample characteristics and reactivity to cigarette packaging designs, we fit an intercept only conditional mixed-effects model with bootstrapped confidence intervals using the "Lme4" package. Reactivity scores were the outcome of interest, with package viewing order, age, gender, race/ethnicity, education, health anxiety, nicotine dependence, brand appeal, brand loyalty, and brand smoked included as fixed effects. All two-way interactions between pack condition and covariates were examined using the "LmerTest" package and significant terms (p<.05) retained using an omnibus F-test. Estimated marginal means were computed from model terms using the "effects" package and then plotted.

RESULTS

We obtained quality transcriptions from 324 of the 357 participants of the CASA trial (91%). The average age in our analytic sample was 39.3 years (SD=11.8), 47% were female, 68% were non-Hispanic White, with 41% having received a college degree. (**Supplementary Table 1.2**) Participants had low generalized health anxiety scores (Mean=1.1, SD=.09) and smoked 11.6 (SD=5.9) cigarettes/day (Mean=11.6, SD=5.9), with moderate levels of nicotine dependence (Mean=3.8, SD=2.3). The majority (77%) reported loyalty to a cigarette brand (Marlboro=43%; Camel= 26%; American Spirit=18%) as well as high levels of appeal towards their brand's packaging (Mean=3.7, SD=1.2).

Assessing the 'Think-Aloud' Pack Handling Task: Quality data on pack handling time was limited to 234 participants (72%). Average pack handling times were: Own pack (59.4 seconds), Blank pack (47.0 seconds) and GWL plain pack (80.2 seconds; **Table 1.2**). The average number of words in the "think aloud" were: Own pack (97 words), Blank pack (69 words) GWL plain pack (110 words). Inter-rater reliability (±1 tolerance) for reactivity scores of the six coders ranged from a low of 86.1 for their own US pack to a high of 97.8 for the foot gangrene GWL pack. The ICCs were also very high for all five reactivity scores (range: 0.89 to 0.95). Less than 2% of participants commented that they had previous experience with GWLs packs.

Three quarters of reactivity scores for participants' own packs were positive (high positive =9.2%; medium positive=34.6%; low positive=31.5%), for an overall mean reactivity score of 1.29 (95%CI=1.25, 1.34). Reactivity scores for the blank pack were mainly neutral (low positive=15%, neutral 65.4%, low

negative 15%) for an overall mean score of 0.03 (95%CI=0.00, 0.07). Reactivity scores for each of the 3 GWL plain packs were heavily negative: Throat cancer: high negative=8.6%. medium negative=64.5%, low negative=24.1% for an overall mean reactivity score of -1.76 (95%CI=-1.79, -1.73); Neonatal Baby: high negative=11.7%. medium negative=62.7%, low negative=21.3%, for an overall mean reactivity score of -1.85 (95%CI=-1.89,-1.82); Foot Gangrene: high negative=48.1%. medium negative=46.9%, low negative=4.6%, for an overall mean reactivity score of -2.44 (95%CI=-2.47,-2.41). When we examined quintiles of reactivity across the US and GWL packs, we found that 66.7% were highly reactive (top quintile) to at least one pack while 88.9% were moderately reactive (top two quintiles) to at least one pack. Only 8.3% of subjects were highly reactive to three or more packs.

The language processing analysis of the polarity of the words used in the “think aloud” task showed a pattern similar to the coded reactivity scores across design conditions: US pack, polarity mean=0.14 [95%CI=0.13, 0.15]; Throat cancer polarity mean =-0.08 [95% CI=-0.08, -0.07]; Neonatal baby, polarity mean=-0.10 [95% CI=-0.11, -0.09); Foot Gangrene, polarity mean= -0.20 [95% CI=-0.21, -0.19]). For each pack condition, polarity scores were correlated with mean reactivity scores (Spearman Rho’s range: 0.30-0.38, *p*-values <.001). Overall, both reactivity scores (*p*-values <.001) and polarity scores (*p*-values <.001) were significantly different across each packaging design condition.

The frequency of prototypical emotions expressed in the “think aloud” is presented in the radar chart **(Figure 1.1).** The foot gangrene pack elicited more emotions characterized as disgust, fear and, to a lesser extent, anger. A similar distribution of expressed emotions was seen in response to the throat cancer GWL pack, although at a lower frequency. The primary emotion elicited by the Neonatal Baby GWL pack was sadness. The two main emotions elicited by their own pack were trust and joy.

Predicting Reactivity to Cigarette Packaging Designs: The model of reactivity scores (**Table 1.3**) had main effects for pack type (F[4,1589]=59.76, *p*<.001), and health anxiety (F[1,1589]=12.14, *p*<.001), and interactions between pack type by viewing order (F[4,1589]=4.68, *p*<.001), gender (F[4,1589]=8.09, *p*<.001), and brand appeal (F[4,1589]=10.54, *p*<.001). Compared to the blank pack, reactivity scores for their US pack were significantly more positive for each increasing level of brand appeal (β=0.21 [95%CI=0.13, 0.29], *p* <.001). Those with greater brand appeal ratings expressed more

positive reactivity scores for their own packs (The 75th percentile level of brand appeal had a reactivity score of 1.45 [95%CI=1.37, 1.54] which was much higher than the 25th percentile level with a score of 1.16 [95%CI=1.08, 1.24]; **Figure 1.2**). No relationship was observed between ratings of brand appeal and reactivity scores for GWL or Blank packaging. More positive reactivity scores for the US pack were observed when the pack was viewed later in the pack handling task (4th position=1.43 [95%CI=1.33, 1.53]) compared to when it was viewed earlier in the task (2nd position=1.16 [95%CI=1.06, 1.26]).

DISCUSSION

US daily smokers, with minimal previous exposure to GWLs, demonstrated consistent negative reactions when they were exposed to the GWLs used as part of plain packaging licensed from the Commonwealth of Australia. While reactivity to GWL packaging was negative across the board, the level of reactivity appeared to align with the negative emotional response found in prior work.[32,49-52] Conversely, smokers' current branded cigarette pack was associated with positive reactivity which was higher when their branded pack occurred after exposure to two different GWL packs in the study's pack handling protocol. This finding supports previous research that found current cigarette packaging in the US to be associated with positive affect for smokers, which may promote more regular smoking behavior.[4] Blank packs, devoid of all marketing, drew a neutral response. Thus, the CASA randomized trial, has three pack conditions (GWL plain pack, Blank pack, US pack) which elicit markedly different initial participant reactions to the cigarette packaging. Accordingly, the selected pack designs should be able to provide an appropriate test of the effectiveness of pack induced reactivity on cigarette smoking cognitions and behavior.

A major objective of Australia's GWL health consequences messaging was to induce thoughts (e.g., "I cannot bear to think of that happening to me") that might be associated with future quitting behavior.[53] Notably, there was significant negative affect experienced by US smokers in response to the GWL packs, most markedly with the foot gangrene image. Both the images of the neonatal baby and throat cancer were associated with negative affect where the emotions appeared to be a mix of fear, disgust, anger, and sadness – which appear consistent with the goal of this health consequences messaging.[53] However, the foot gangrene image was associated with much stronger negative emotions that were more likely to be characterized as visceral. The emotions expressed appeared to be disgust,

fear, and anger much more than sadness. In future work, we will explore the directionality of anger emotions in the transcribed text as these could be focused on the tobacco industry [54] or perhaps at governmental regulations[55] or somewhere else. One of the strengths of our qualitative methodology is that it facilitates such further detailed analyses. In the CASA trial, we use ecological momentary assessment to test whether the high initial reactivity to the GWL packs images is associated with increased cognitions when participants reach for a cigarette. With twice daily measurement, we will be able to assess whether and how this reactivity is associated with avoidance and/or pack hiding behavior.[56] The detailed and frequent measurement of both cognitions and behavior in our CASA randomized trial is a major advance on most of the studies completed to date.[23,57]

GWLs may disrupt the incentive salience attributed to the cigarette packaging via the removal of industry marketing and inclusion of visceral imagery and aversive design characteristics (e.g., fonts and colors). Cue-learning models suggest that appealing design features on packaging capture attention, generate positive affective reactions, and motivate behavior that may facilitate a desire to smoke.[58,59] We found that the more brand appeal smokers reported for their own US marketed pack (e.g., cool, stylish, etc.), the more positive their reaction was when asked to express their thoughts and feelings about it. When appealing marketing cues are affixed to tobacco products and perceived immediately prior to use, the cues themselves can acquire similar motivational significance and evoke a desire to smoke.[8,60,61] Yet, levels of brand appeal did not influence the reactivity to the GWL packs, despite the packs being matched to the smoker's cigarette preference and clearly labeled with brand and variant name. Thus, plain GWL packaging may have the intended effect of inhibiting incentive salience attribution by quelling the appeal of the product, an effect consistent with prior research suggesting that plain GWL packaging impedes the product's ability to generate appeal.[62-64] Nevertheless, reactivity to the blank pack did not vary by levels of brand appeal, indicating that perhaps the appeal of the product may be suppressed by simply removing tobacco industry marketing.

There are a number of factors that limit the generalizability of these findings: a) the CASA study recruited volunteer smokers and the sample was not representative of the US population, or indeed, of smokers in other countries; b) under-representation of minorities in the study also resulted in a lower

proportion of menthol smokers; c) all participants were from San Diego, California which has stronger social norms against smoking than the rest of the US.[65] There were other limitations included the loss of < 10% (n=33) of the 'think aloud' data which was associated with a computer hardware failure at our storage facility. These file losses were few and the hardware event was unrelated to the trial, indicating that the data are most likely missing-at-random.[66] We used an exposure to GWL packs prior to assessing reactivity to their own pack which likely primed and influenced responses.[67] Indeed, a random subset of our sample had two such exposures and these had a higher positive reactivity to their own pack. It is likely that exposure to the GWL pack focused the participant's thinking on what they liked about their current pack, resulting in higher positive reactivity. The GWL packaging proposed for use in the US is not the plain packaging used in this study, but a hybrid packaging condition that includes reduced industry marketing with smaller graphic warning labels, a design quite common in many countries.[12] We would expect that such hybrid packaging would be associated with a lower level of initial reactivity to the GWLs than was observed in this assessment.

Despite limitations, the study had numerous strengths. It allowed smokers to openly express their thoughts and feelings about GWL packaging, thus resulting in more emotive details than structuring their response through a questionnaire. Further, we matched all study packs to the participants' preferred cigarette brand and variant in an effort to maintain cigarette expectancies and isolate the effects of the reactivity. We used observational measurement of reactions to the various pack designs with high-quality coding, which yielded a full range of valenced reactivity and was concurrently valid with the polarity of speech as identified by natural language processing.

CONCLUSION

GWLs are an integral part of the recommended suite of tobacco control strategies for governments to reduce the health costs associated with cigarette smoking,[13] but as yet, they have not been implemented in the US. In this study, we have demonstrated that US smokers have a wide range of emotive reactions to the cigarette packaging that is being studied in the CASA randomized trial; therefore, the trial will provide a good test of the role of GWLs on smoking related cognitions and behavior.

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Table 1.1 Coding System for Reactivity to Each Study Pack

Rating	Participant Reactions and Descriptions of Study Packs Include:
High Negative *Score: -3*	Highly emotional words or amplified moderately emotional words that are negatively valanced to describe pack aversion. Visceral reaction and repeated exclamations of aversion; might repeat emotional words. Language that indicates they do not want to handle the pack.
Medium Negative *Score: -2*	Moderately emotional words or de-amplified highly emotional words that are negatively valanced to describe pack aversion. No visceral reaction and a lower emotional response than high aversion. Strong initial negative reaction followed by rationalization (e.g., pack design would not modify behavior).
Low Negative *Score: -1*	Moderately emotional words that are negatively valanced followed by detracting statements or de-amplifiers that overrule the response. No visceral reaction or high/moderate negative emotional response. Mild reaction or acknowledgement of pack aversion followed by rationalization (e.g., pack design would not modify smoking behavior).
Neutral *Score: 0*	No emotional words to describe pack. No or little reaction to the pack and/or appear to be unaffected by the pack. Text on the pack may be read without saying how it makes them feel.
Low Positive *Score: +1*	Moderately emotional words that are positively valanced followed by detracting statements or de-amplifiers that overrule the response. No visceral reaction or high/moderate positive emotional response. Mild reaction or acknowledgement of pack appeal followed by rationalization (e.g., pack design would not modify smoking behavior).
Medium Positive *Score: +2*	Moderately emotional words or de-amplified highly emotional words that are positively valanced to describe pack appeal. No visceral reaction and a lower emotional response than high appeal. Strong initial positive reaction followed by rationalization (e.g., acknowledgement of the health consequences of smoking).
High Positive *Score: +3*	Highly emotional words or amplified moderately emotional words that are positively valanced to describe pack appeal. Visceral reaction and exclamations of appeal; might repeat emotional words. Language that indicates a desire to smoke a cigarette.

Table 1.2 Verbalized Response to Study Pack Designs during Initial Exposure using Coded Reactivity and Natural Language Processing

Characteristic	Cigarette Packaging Design (n=324)					*P*-value[7]
	Current US	Blank	Throat Cancer	Neonatal Baby	Foot Gangrene	
Seconds Held[1,2]	59.4 (56.1, 62.7)	47.0 (44.5, 49.6)	78.5 (74.7, 82.3)	78.5 (74.3, 82.8)	83.7 (79.4, 88.2)	<.001
Language Processing[1]						
Words uttered	96.6 (91.9, 101.4)	69.2 (65.6, 72.8)	109.7 (104.7, 114.7)	110.0 (103.9, 116.2)	104.8 (99.9, 109.6)	<.001
Speech polarity	0.14 (0.13, 0.15)	0.00 (-0.01, 0.01)	-0.08 (-0.08, -0.07)	-0.10 (-0.11, -0.09)	-0.20 (-0.21, -0.19)	<.001
Coded Reactivity						
Mean score[1]	1.29 (1.25, 1.34)	0.03 (0.00, 0.07)	-1.76 (-1.79, -1.73)	-1.85 (-1.89, -1.82)	-2.44 (-2.47, -2.41)	<.001
Categorical score[3,4]						
High negative	0 (0.0%)	0 (0.0%)	28 (8.6%)	38 (11.7%)	156 (48.1%)	
Medium negative	0 (0.0%)	2 (0.6%)	209 (64.5%)	203 (62.7%)	152 (46.9%)	
Low negative	1 (0.3%)	50 (15.4%)	78 (24.1%)	69 (21.3%)	15 (4.6%)	
Neutral	79 (24.4%)	212 (65.4%)	9 (2.8%)	14 (4.3%)	1 (0.3%)	
Low positive	102 (31.5%)	55 (17.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Medium positive	112 (34.6%)	5 (1.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
High positive	30 (9.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Inter-rater reliability[5,6]						
ICC	0.95 (0.94, 0.96)	0.93 (0.92, 0.95)	0.90 (0.89, 0.92)	0.93 (0.91, 0.94)	0.89 (0.87, 0.91)	
Agreement ± 1	86.1%	92.9%	93.8%	94.4%	97.8%	

[1] Statistics presented: mean (95% confidence interval)
[2] A subsample of cases were available for timing of the pack handling task (n=234).
[3] Statistics presented: n (%)
[4] Rounded rater coded reactivity score
[5] Intraclass Correlation Coefficient (95% confidence interval) for coded reactivity score across six independent raters
[6] Interrater agreements allowing for a tolerance of 1 in ratings.
[7] Statistical tests performed: Kruskal-Wallis Test.

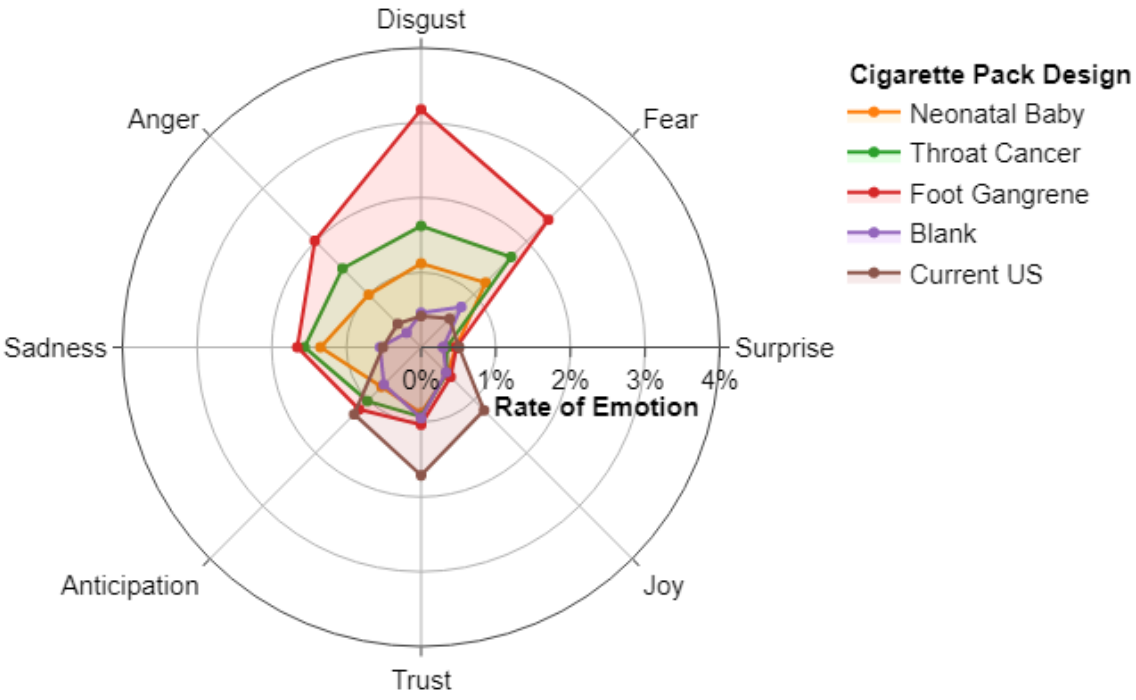

Figure 1.1 Average Rate of Emotive Words Spoken During Pack Exposure Period

Note. A sematic analysis of transcribed speech that was text mined for emotive utterances using an emotion word lexicon and computing the rate of emotive words expressed per sentence between 0% (no emotional utterances) and 100% (all emotional utterances).

Table 1.3 Associations between Sample Characteristics and Reactivity to Cigarette Packaging Designs

	Reactivity			
	Main Effects Model		Interaction Model	
Regressor	β (95%CI)	*P*-value	β (95%CI)	*P*-value
Main Effects				
Viewing order	0.01 (-0.02, 0.03)	.56	-0.02 (-0.09, 0.05)	.53
Pack				
Blank	*Ref*		*Ref*	
Current US	1.26 (1.15, 1.36)	<.001	-0.13 (-0.59, 0.34)	.57
Throat Cancer	-1.79 (-1.89, -1.69)	<.001	-1.74 (-2.16, -1.35)	<.001
Neonatal Baby	-1.89 (-2.00, -1.79)	<.001	-1.90 (-2.32, -1.47)	<.001
Foot Gangrene	-2.48 (-2.58, -2.38)	<.001	-2.24 (-2.69, -1.84)	<.001
Age (per 10 years)	0.01 (-0.02, 0.04)	.56	0.01 (-0.02, 0.04)	.61
Gender				
Male	*Ref*		*Ref*	
Female	-0.11 (-0.18, -0.04)	<.001	-0.05 (-0.18, 0.09)	.52
Race/Ethnicity				
Non-Hispanic White	*Ref*		*Ref*	
Hispanic	-0.05 (-0.15, 0.06)	.36	-0.04 (-0.14, 0.06)	.43
Other Non-Hispanic	0.04 (-0.05, 0.12)	.38	0.04 (-0.05, 0.12)	.36
Education				
College or advanced degree	*Ref*		*Ref*	
Some college	0.03 (-0.05, 0.09)	.47	0.02 (-0.05, 0.09)	.54
High school or less	-0.08 (-0.18, 0.03)	.17	-0.09 (-0.20, 0.02)	.10
Health anxiety	-0.07 (-0.11, -0.03)	<.001	-0.07 (-0.10, -0.03)	<.001
Nicotine dependence	-0.00 (-0.02, 0.01)	.53	-0.01 (-0.02, 0.01)	.51
Brand appeal	0.03 (0.00, 0.05)	.08	-0.01 (-0.07, 0.04)	.71
Brand smoked				
Marlboro	*Ref*		*Ref*	
American Spirit	-0.04 (-0.14, 0.05)	.37	-0.04 (-0.14, 0.05)	.35
Camel	0.05 (-0.03, 0.14)	.19	0.05 (-0.03, 0.13)	.22
Other	0.01 (-0.09, 0.12)	.79	0.01 (-0.09, 0.12)	.82
Brand loyalty				
No	*Ref*		*Ref*	
Yes	0.03 (-0.05, 0.12)	.42	0.03 (-0.05, 0.11)	.43
Interactions				
Pack × Viewing order				
Blank	--		*Ref*	
Current US	--		0.16 (0.06, 0.26)	.002
Throat Cancer	--		0.02 (-0.07, 0.10)	.68
Neonatal Baby	--		0.04 (-0.04, 0.13)	.30
Foot Gangrene	--		-0.01 (-0.09, 0.07)	.77
Pack × Gender (*Ref* = Male)				
Blank	--		*Ref*	
Current US	--		0.28 (0.08, 0.47)	.007
Throat Cancer	--		-0.13 (-0.32, 0.07)	.22
Neonatal Baby	--		-0.18 (-0.38, 0.02)	.08
Foot Gangrene	--		-0.24 (-0.44, -0.05)	.019
Pack × Brand appeal				
Blank	--		*Ref*	
Current US	--		0.21 (0.13, 0.29)	<.001
Throat Cancer	--		-0.01 (-0.10, 0.07)	.83
Neonatal Baby	--		-0.01 (-0.09, 0.08)	.87
Foot Gangrene	--		-0.02 (-0.10, 0.07)	.67

Note. From separate intercept only conditional mixed effects models with bootstrapped 95% confidence intervals (n=1000) predicting reactivity to cigarette packaging design.

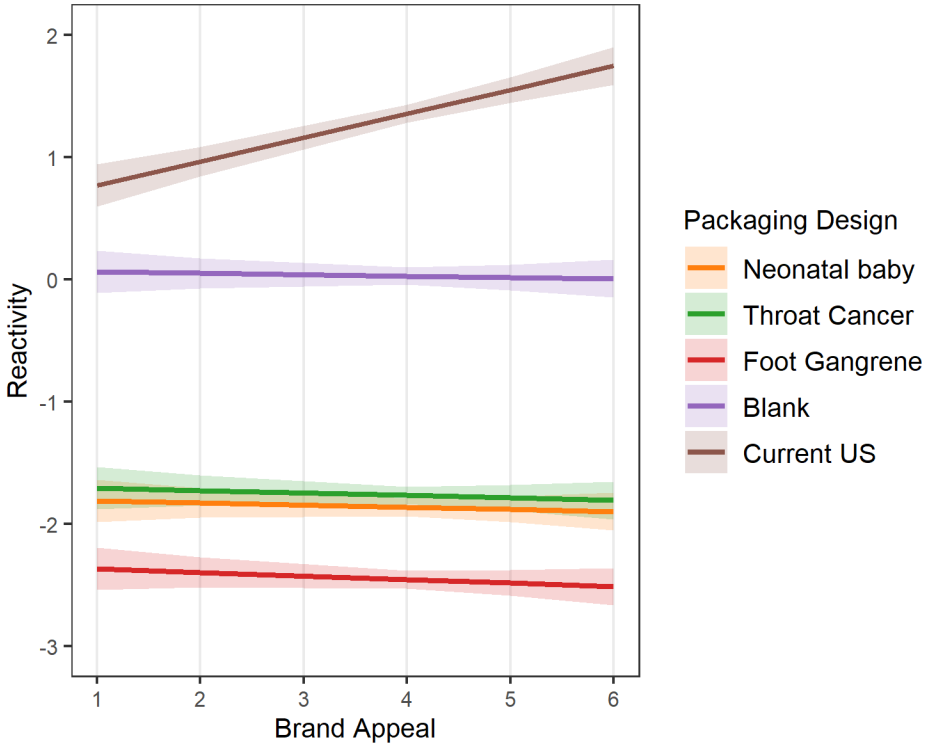

Figure 1.2 Relationship between Level of Brand Appeal and Affective Reactivity to Five Cigarette Pack Designs

Note. Estimated marginal means and 95% confidence interventions extracted from intercept only conditional mixed effects model predicting reactivity to cigarette packaging design with age, race/ethnicity, education, health anxiety, nicotine dependence, brand loyalty, and brand smoked included as fixed main effects and package viewing order, gender, and brand appeal as fixed interaction effects.

Supplementary Figure 1.1 Images of Manufactured Study Packs

Note. (A) Neonatal Baby*, (B) Foot Gangrene*, (C) Throat Cancer*, (D) Blank Pack. Reprinted from Contemporary Clinical Trials.[1]

* © Commonwealth of Australia

SUPPLEMENTAL REFERENCES

1. Pierce JP, Strong DR, Stone MD, et al. Real-world exposure to graphic warning labels on cigarette packages in US smokers: The CASA randomized trial protocol. Contemporary Clinical Trials. 2020;98:106152.

Supplementary Table 1.1 Examples of Natural Language Processing Estimates of Speech Polarity Uttered in Response to Viewing Study Packs

Quartile	Polarity	Example Text
Q1	-.461	Foot Gangrene Pack: *"Wow. That's gross. The foot, it catches my eye. It's disgusting looking. I've never seen anything like that. It's scary. Yeah. Just gross."*
	-.448	Neonatal Baby Pack: *"I think that would be very sad. I feel badly. Well, I suppose defensive because I smoked when I was pregnant, and my daughter was fine, I think. And hopefully I didn't cause any damage so maybe I'm feeling a little worried that I'm guilty of hurting her."*
	-.418	Throat Stoma Pack: *"It's scary. Painful. Devastating. No."*
Q2	-.183	Foot Gangrene Pack: *"So that's quite an unpleasant picture. Definitely wouldn't want to be in that situation. I imagine it has something to do with smoking, but I'm sure there's a whole lot more going on to get to this situation like that versus the other one that was, you know, more directly related."*
	-.169	Neonatal Baby Pack: *"Definitely the dying baby. Yeah, it makes me feel kind of guilty about smoking, but I mean I'm not pregnant, so it doesn't really affect me, I guess, but I don't know. It's kind of off-putting to know that my cigarettes are in here."*
	-.134	Throat Stoma Pack: *"Yeah. I mean, it's definitely something that, I'd rather quit before I get to that point. Yeah, it's a pretty unpleasant picture and, yeah, definitely doesn't look like a pleasant situation to be in."*
Q3	.000	Blank Pack: *"Plain. I don't really mind it so much. It's just a plain box. I actually almost kind of like it because it's plain, but it doesn't make me feel much. I don't really think of anything."*
	.000	Blank Pack: *"Nothing really on there, there's the warning label. Pretty much the warning label that catches your eye once you actually turn it over, assuming you actually turn it to the sides. Very plain."*
Q4	+.199	Own Pack: *"Kind of bright, pretty color. Really can't see the Surgeon's General Warning, silver kind of blends in with the packaging. Yeah, cool looking pack."*
	+.516	Own Pack: *"These feel very familiar, very attractive. It's got the nice little gold bronze going on that I'm very used to. The descriptive words on the front, like smooth, rich, mellow, it's just attractive and very comfortable and familiar to me."*

Note. Using SentimentR, average paragraph level polarity scores were generated using the 'sentiment' function and sentence level polarity characteristics were generated using the 'highlight' function (positive = green; neutral = gray; negative = red). Polarity scores across the five pack conditions were pooled and divided into four even quartiles. Example statements and polarity scores are presented for each quartile, with each study pack condition appearing two times.

Supplementary Table 1.2 Sample Characteristics

Variable	Total (N=324)
Age[1]	39.3 (11.8)
Gender[2]	
Male	152 (47%)
Female	172 (53%)
Race/Ethnicity[2]	
White, Non-Hispanic	219 (68%)
Hispanic	35 (11%)
Other, Non-Hispanic	70 (22%)
American Indian/Alaska Native	4 (1.2%)
Asian	24 (7.4%)
Black or African American	12 (3.7%)
Native Hawaiian or Pacific Islander	5 (1.5%)
Other	19 (5.9%)
Decline to answer	6 (1.9%)
Education[2]	
College or Advanced Degree	134 (41%)
High School or less	40 (12%)
Some college	150 (46%)
Cigarettes per day[1]	11.6 (5.9)
Nicotine dependence (range: 0-10)[1]	3.8 (2.3)
Primary brand smoked[2]	
Marlboro	138 (43%)
American Spirit	58 (18%)
Camel	83 (26%)
Other	45 (14%)
Cigarette type	
Menthol	92 (28%)
Non-Menthol	232 (72%)
Brand loyalty[2]	
No	75 (23%)
Yes	249 (77%)
Brand appeal (range: 1-6)[1]	3.7 (1.2)
Health anxiety (range: 0-4)[1]	1.1 (0.9)

Note. Data presented as: [1] Mean (SD) or [2] n (%).

CHAPTER 3: VALIDATION OF A MEASURE OF CIGARETTE PACKAGING BRAND APPEAL

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ABSTRACT

Background: Tobacco industry marketing is used to generate appeal for branded cigarettes. Assessing the effectiveness of Graphic Warning Labels (GWLs) that aim to reduce product appeal will require a measure with demonstrated reliability and validity to estimate the impact this regulatory action has on cognitions and smoking behavior.

Methods: Psychometric evaluations of a 6-item measure of cigarette brand appeal were conducted among 357 adult daily smokers. Differential item functioning was examined for biological sex. After viewing GWLs, smokers' reactivity to current US packaging and brand perceptions (i.e., harshness, healthiness, and affordability) were used to establish concurrent validity. Conditional mixed effects models assessed predictive associations with weekly ratings of appeal.

Results: Given factor analytic support for a single primary construct with no item-level differences for biological sex we describe effective option response characteristics using a graded item response model. The Omega-hierarchical reliability was 0.86 and coefficient alpha was 0.92. Concurrent validity regressions with covariate adjustment suggested positive reactivity to US branded packaging (β=0.32 [95%CI=0.19, 0.46], $p<.001$) and expected brand healthiness (β=-0.29 [95%CI=-0.39, -0.19], $p<.001$) maintained significant independent relationships with levels of brand appeal. Increasing levels of initial brand appeal were associated with subsequent ratings of appeal across 4 weeks of assessment (β=0.12 [95%CI=0.07, 0.16], $p<.001$).

Conclusions: We found strong scalability, reliability, and validity of a 6-item measure of brand appeal. Attractive packaging attributes may reinforce socially desirable characteristics and forecast subjective effects of smoking. Thus, branding that generates appeal may directly motivate persistent tobacco use behavior.

INTRODUCTION

Tobacco industry marketing is used to generate appeal for cigarette products among potential consumers.[1] While cigarette pack designs differentiate brands and their variants, appealing packaging designs are also likely to attract consumers, promote products, and cultivate and strengthen brand identity.[2] The perceived appeal of a product's brand may arise from pack designs crafted to convey socially desirable characteristics (e.g., stylish, fashionable, attractive) or intangible characteristics (e.g., quality, coolness). As such, when exposure to appealing brand attributes repeatedly precedes smoking, the marketing cues can evoke desires to use tobacco.[3-5] Thus, appealing packaging elements may directly motivate persistent smoking.[6] Understanding how smokers currently view their cigarette brand's packaging should provide insight into ways to disrupt the product's appeal. Combinations of plain packaging and graphic warning labels (GWLs) have been found to reduce appeal,[7] generate aversion,[8] and worsen the overall smoking experience.[7,9] Yet, few studies have assessed brand appeal directly, and rarely via psychometrically validated multiple-item measures.[10] This has resulted in mixed guidance on how best to counteract brand appeal, and literature reviews suggest the need for understanding how individual differences may influence it.[10,11]

Cigarette pack perceptions are likely to relate to how smokers view the appeal of the brand. The broader marketing literature indicates that appealing attributes conveyed by branded packaging are often reflected in the sensory perception of a product.[12,13] Packaging designs have even been shown to be associated with taste perceptions.[14,15] Further, branding may reinforce broad perceptions of product characteristics[14] that forecast subjective effects of smoking (e.g., expected harshness),[16] downplay deleterious outcomes (e.g., perceived healthiness), or convey the product's worth (e.g., affordability).[8] The tobacco industry documents include statements such as, "*the sensory experience of smoking a cigarette can be manipulated simply by changing the design elements of the pack, such as color, fonts and logos.*"[17] Philip Morris research reported the exact same Marlboro Ultra-Light cigarettes were perceived to have a "harsher" drag when placed in red packs while cigarettes from blue packs were considered "too mild."[18] Branding may directly generate perceptions of the product's healthiness or indirectly lower awareness of health risks by pulling the smokers' attention away from health warnings. For example, the "natural" descriptor for the tobacco used in American Spirit cigarettes creates

unwarranted perceptions that the brand has less harmful health effects than other cigarette brands.[19] Further, smokers with heightened brand appeal appraisals are willing to pay more for industry branded packs than for blank packs devoid of branded imagery and would need large discounts to willingly purchase packs with GWLs.[8,20]

Regulatory actions on tobacco product standards which address cigarette brand appeal will require a measure with demonstrated reliability and validity to estimate the range of potential impacts on product cognitions and smoking behavior. We aim to evaluate the factor structure of a series of items that have been used to measure brand appeal for cigarette packaging[7,21] and test the scale's concurrent and predictive validity. We hypothesize a scaleable unidimensional structure will emerge for the six-items that reflects the latent trait for brand appeal. We believe concurrent and predictive validity of this scale will be demonstrated via cross-sectional associations with branding perceptions (e.g., harshness, healthiness, and affordability) and positive longitudinal associations within four weeks of brand appeal assessment. We then describe how ratings on this appeal measure differ across demographics and cigarette brand preferences. Given previous associations,[8] we hypothesize that ratings of appeal will be greater for younger ages and for smokers who prefer popular cigarette brands, such as Marlboro.

METHODS

Participants and Procedures

Volunteer daily smokers aged 21–65-years-old from San Diego County, California were recruited using community advertising into the CASA randomized controlled trial to investigate the effects of cigarette packaging on smoking behavior.[22] Participants (N=357) who signed an informed consent (overseen by Institutional Review Boards at UC San Diego and Cal State San Marcos) and enrolled into the trial were included in this study. At the initial study visit, smokers participated in a cigarette pack handling task with a 'think aloud' cognitive interview,[23,24] completed a baseline study questionnaire, and responded to weekly questions for 4-weeks prior to randomization into the CASA trial.

Measures

Brand Appeal of Cigarette Packaging: Items collected from previous published reports[7,21] were used to construct three brand appeal measures. Each measure used six agreement anchors (i.e.,

'Strongly Agree', 'Agree Somewhat', 'Agree', 'Somewhat Disagree', 'Disagree', or 'Strongly Disagree') with higher scores reflecting greater levels of appeal. At baseline, participants were prompted with, 'The design on the brand of cigarettes I currently smoke is…' and rated their agreement with six-word characterizations of appeal (i.e., 'Appealing, Stylish, Fashionable, Cool, High Quality, Attractive'). Two measures were constructed: a 6-item measure and a single-item measure utilizing the 'Appealing' item. A second single-item appeal measure (i.e., 'The cigarettes I purchased from the study are appealing') was rated once a week for four weeks in response to US packs purchased during the pre-randomization period of the CASA trial.[22]

Comparative Brand Perceptions: Three comparative brand perceptions were assessed at baseline using the six 'strongly agree' to 'strongly disagree' anchors: 1) harshness ('The cigarettes aren't as harsh as other brands'), 2) healthiness ('They're healthier than other cigarettes, for example they have less tar'), and 3) affordability ('They cost less than other brands').[25,26]

Reactivity to Current US Packaging: To evaluate reactivity to cigarette packaging, participants completed a pack-handling task where they were asked to "think aloud"[27,28] verbalizing their thoughts and feelings as they explored five pack options matched to their preferred brand: 1) current US pack, 2) blank pack devoid of industry marketing, and 3) three GWL plain packs. In an effort to avoid outworn decisions,[29] the current US pack appeared after exposure to a GWL plain pack had challenged their perceptions of the usual pack design. A team of six coders rated the verbalized affect expressed in response to each pack using a 7-point reactivity scale (i.e., high, medium, low for both negative and positive reactivity as well as a central neutral category; reactivity to US pack range=-1 to +3; inter-rater agreement ±1=86.1%; intraclass correlation reliability coefficient=0.95).

Covariates**:** Sociodemographics included age, sex, race/ethnicity, and educational attainment. Tobacco use markers included cigarette brand preference and Fagerström Test for Nicotine Dependence (FTND; range=0–10, α=.67, omega hierarchical=.59).[30] Indicators of mental health included the Brief Sensation Seeking Scale (BSSS; range=0–3, α=.86, omega hierarchical=.70, coefficient H=.60)[31] and the non-specific psychological distress scale (K6; range=0–4, α=.80, omega hierarchical=.77, coefficient H=.57).[32]

Statistical Analysis

All analyses were carried out in R (version 4.0.3)[33] using the "psych',[34] 'KernSmoothIRT',[35] 'mokken',[36] 'ltm',[37] 'mirt',[38] 'lme4',[39] and 'lmerTest'[40] packages with statistical significance set at $p<.05$.

Dimensionality: Response frequencies, summary statistics, and corrected item-test correlations were examined. Exploratory factor analyses were used to evaluate assumptions of a single primary dimension underlying ratings of brand appeal (see Supplemental Materials). A full information maximum likelihood graded parametric item response model[41] was used to confirm the assumed unidimensional factor structure of the six brand appeal items. For each item, six parameters were estimated: a discrimination parameter ('a') which denoted the capability of an item to identify participants at differing points along the latent continuum, and five severity parameter thresholds ('b's) which denoted points on the latent continuum where the endorsement of a response option becomes more probable than the previous option.

Differential Item Functioning (DIF): To determine whether the individual brand appeal items had similar psychometric properties among males and females, we conducted a DIF analysis using multiple-group unidimensional Graded Response Models (GRMs). Likelihood Ratio Tests (LRTs) were used to select anchor items.[42] We tested group differences among item characteristics in a series of nested and constrained models by freeing the parameters of each item, one at a time in an all-others-as-anchors model. Prior to making final group comparisons, anchor items were selected by dropping items with significant LRTs and retaining the remaining items. A final invariance test was run to identify items with significant DIF by sex. To quantify the impact of observed DIF on total scores for the brand appeal by sex, we conducted differential test functioning (DTF) analyses to generate standardized effects reflecting mean difference in total scores attributable to observed DIF.

Reliability and Validity. Internal consistency reliability was assessed with Cronbach's coefficient alpha[43] and the amount of reliable variance (range=0.00–1.00) attributed to a single primary construct was assessed with coefficient omega-hierarchical.[44] Coefficient H was calculated (range=0.00–1.00) as an estimate of construct scalability[45] with coefficients considered 'weak' if less than 0.40, 'moderate' if between 0.41-0.50, and 'strong' if greater than 0.50.[45] Convergent validity of the scale was assessed by

calculating bivariate parametric and non-parametric correlations between mean brand appeal scores and ratings of reactivity to US packaging.[46] For concurrent validity, covariate adjusted regressions were run to examine the univariable association between validators (e.g., reactivity and comparative brand perceptions) and brand appeal. A parallel set of fully adjusted regressions were run to examine the strength of relationships between concurrent validators and brand appeal. Linear mixed effects models with planned covariates examined the predictive validity of initial brand appeal ratings (excluding item 'appealing' to avoid construct collinearity) regressed upon four repeated measures of the single-item appeal measure assessed weekly. The estimated slope was used to examine the stability of the repeated single-item measure over time.

Results

The sample consisted of adult (N=357, Mean age=39.3 years [SD=11.9], 54.6% female) daily smokers (FTND mean=3.84, SD=2.28) with differing racial-ethnic backgrounds (68.1% White; 11.2% Hispanic; 20.7% Other, Non-Hispanic), educational attainments (41.7% college degree; 47.1% some college; 11.5% high school or less) and varied cigarette brand preferences (41.5% Marlboro; 26.3% Camel; 18.2% American Spirit; 14.0% other). While all 357 participants completed the study, 35 were missing reactivity data due to a temporary computer hard-drive array failure, thus models utilizing this information were reduced to 322 participants (90% of sample). Descriptive statistics for the six brand appeal items can be found in **Table 2.1**. Overall, participants were found to have a moderate level of brand appeal for their preferred cigarette packs (M=3.72, SD=1.19). Each of the six items were highly correlated with one another (rs range=0.46–0.91) and with the average response used to reflect the total score (corrected polychoric correlation range=0.71–0.88).

Psychometric Evaluation of Brand Appeal: Assessment of a single construct underlying responses to the six brand appeal items using maximum likelihood exploratory factor analysis of polychoric correlations supported a single primary dimension (see Supplemental Materials). The Omega-hierarchical estimate of reliability and degree to which items share a single common source of variance was 0.84 and coefficient alpha was 0.92. Given support for a single dimension underlying the responses, we moved to a full information maximum likelihood graded item response model to confirm the factor

structure. All items loaded onto a single factor (λ range=0.75–0.90) and communality estimates supported each items contribution (h^2 range=0.56–0.89) combining to explain 77.2% of the common variance (**Table 2.2**).

We assessed option response characteristics using graded item response models to estimate separation of response options as monotone increasing functions of levels of brand appeal. **Figure 2.1a** displays expected item scores for increasing levels of brand appeal (standardized mean level of appeal; Mean=0, SD=1) and **Figure 2.1b** shows the amount of reliable information (inverse of measurement error) from each item across the range of brand appeal. The item reflecting agreement with the rating of 'appealing' had the highest level of information across a broad range of the measured level of brand appeal. Items 'attractive', 'stylish', 'cool' and 'fashionable' were reflective of higher levels of brand appeal than the 'high quality' item. Ratings of 'high quality' were unique in reflecting the lowest ranges (≤ -1.5 SD) of brand appeal and overall were less strongly related to overall levels of brand appeal than other items. Strong scalability was exhibited for the 6-items assessing brand appeal (coefficient H=0.70, se=0.03). With support for a single primary construct from factor analysis, strong reliability, strong scalability, and strong item-response relationships we generated a total score by averaging the 6 individual items.

After examination of Mead's Expected Score Standardized Difference (ESSD)[47] for the magnitude of any differences and corrected likelihood ratio tests, no statistically significant DIF in biological sex was found for five of the six appeal items (i.e., 'Stylish, Fashionable, Cool, Attractive, and Appealing'). Statistically significant non-uniform crossing DIF was observed in the 'High Quality' item. However, the corresponding effect size was small (ESSD=-0.04) and the magnitude of the effect at the scale level was not meaningfully (Expected Test Score Standardized Difference=-0.006).

Concurrent Validity: **Figure 2.2** includes parametric and non-parametric correlations between smokers' coded reactions to their own pack and the average of item responses to the 6-item brand appeal scale as well as the ordinal score for the single brand appeal item. Positive reactions to one's own cigarettes was associated with single-item (r=.31 [95%CI=0.21, 0.40], p<.001) and 6-item (r=.27 [95%CI=0.17, 0.40], p<.001) measures of appeal. Compared to the single-item appeal measure,

increased precision was seen in the 6-item measure as the less restricted non-parametric line of fit more closely resembled the linear parametric line of fit.

Associations between concurrent validating constructs and the 6-item measure of brand appeal are listed in **Table 2.3**. Reactivity to one's own cigarette pack (β=0.35 [95%CI=0.21, 0.49], *p*<.001), perceived brand harshness (β=-0.15 [95%CI=-0.25, -0.05], *p*=.003) and perceived brand healthiness (β=-0.32 [95%CI=-0.42, -0.21], *p*<.001) each were independently associated with levels of brand appeal. When examined in a simultaneous model, reactions to one's own branded pack (β=0.32 [95%CI=0.19, 0.46], *p*<.001) and perceived brand healthiness (β=-0.29 [95%CI=-0.39, -0.19], *p*<.001) maintained significant relationships with levels of brand appeal, while perceptions of brand harshness did not. Perception of own brand cost relative to other brands was not associated with levels of brand appeal. Parallel examinations using the single-item measure revealed the same pattern of associations but with slightly larger parameter estimates and wider confidence intervals (**Supplementary Table 2.2**).

Characteristics Associated with Appeal: Univariate models excluding concurrent validating constructs enabled independent examination of the relationships between demographic characteristics, levels of nicotine dependence, psychological distress, sensation seeking, and preferred brand on levels of brand appeal (**Table 2.3**). Older smokers reported lower ratings of product packaging appeal (β=-0.02 [95%CI=-0.03, -0.01], *p*<.001) than younger smokers. Hispanic smokers reported higher ratings of brand appeal (β=0.70 [95%CI=0.28, 1.12], *p*<.001) relative to non-Hispanic white smokers. Higher sensation seeking (BSSS) scores (β=0.32 [95%CI=0.13, 0.51], *p*<.001) were significantly associated with higher levels of brand appeal. Compared to Marlboro smokers, brand appeal was rated higher by both American Spirit (β=0.39 [95%CI=0.03, 0.76], *p*=.036) and Camel smokers (β=0.34 [95%CI=0.02, 0.67], *p*=.040). After including the concurrent validating constructs in a simultaneous model, associations between age (β=-0.02 [95%CI=-0.03, 0.00], *p*=.006), Hispanics vs. while non-Hispanics (β=0.66 [95%CI=0.28, 1.04], *p*<.001), psychological distress (β=0.16 [95%CI=0.00, 0.32], *p*=.049) and sensation seeking (β=0.26 [95%CI=0.07, 0.44], *p*=.006) each retained significant relationships to concurrent ratings of brand appeal.

Appeal Ratings Over Time: With adjustment for planned covariates (age, gender, race/ethnicity, education, primary brand, psychological distress, sensation seeking, and nicotine dependence), there

was no significant change in levels of appeal ratings over survey weeks (β=-0.000 [95%CI=-0.003, 0.003], *p*=0.83). In support of predictive validity hypotheses, there was a significant positive relationship between higher levels of initial averaged ratings of the 6-item brand appeal measure and ratings via the single-item measure of appeal over the four-weekly assessments (β=0.12 [95%CI=0.07, 0.16], *p*<.001).

DISCUSSION

The current study established a short measure of brand appeal for cigarette packaging among adult daily smokers. Psychometric assessment of scalability, reliability, construct validity, concurrent validity, and predictive validity supported six descriptors capturing the appeal of branding elements on cigarette packaging. Levels of reported brand appeal were characterized most strongly by ratings of the 'appeal' item, followed by ratings of 'attractiveness' and 'stylishness' relative to ratings of overall 'quality,' which was the least discriminating. This low discriminability for the 'quality' item may be due to differing interpretations of the descriptor (i.e., quality of the cigarettes contained within the packaging or quality of the branding used on the packaging, or both).[48] Nonetheless, item response modeling supported acceptable communalities, discrimination, thresholds, and, when averaged, provided information across ±3 standard deviations of standardized brand appeal scores. No meaningful differential item functioning by sex was found; thus, comparability of scores for males and females should be expected when using this measure.

Prior to the assessment of the brand appeal items, smokers were exposed to GWLs and then asked to express their thoughts and feelings about their own packs. Smokers who had more positive reactions to their current US pack also reported higher ratings of appeal for their brand. After covariate adjustment, the magnitude of this relationship remained unchanged, providing evidence of concurrent validity backed by a measure with a high degree of ecological validity.[27,28] Greater agreement with statements indicating that their preferred cigarettes are healthier was linked with higher ratings of brand appeal which align with reports showing that popular cigarette brands are perceived to be safer.[19,49] Perception that the smokers' preferred brand cost less was not associated with overall ratings of appeal. This finding was surprising, given that a product's price is often equated to its quality and that consumers are generally willing to pay more if they perceive a product to be superior to its competition.[50] Such is the

case with Marlboro packs (the most popular US brand), which elicit higher willingness to pay among smokers than American Spirit or Camel packs.[8] However, American Spirit and Camel smokers rated their brand as more appealing than Marlboro smokers, and these differences attenuated after covariate control.

Several associations between smoker characteristics and brand appeal were seen. Older smokers were found to report lower ratings of brand appeal. This was not surprising given that tobacco marketing strategies tend to be targeted at younger populations[51] and aim to generate socially desirable attributes[52] (e.g., 'cool', 'fashionable', 'stylish' etc.) which may not be as salient among older smokers. Ratings of brand appeal were stronger among Hispanic relative to non-Hispanic white smokers, which is supported by studies suggesting that Hispanic smokers are becoming increasingly targeted by, and more receptive to, tobacco marketing efforts.[53] Mental health distress and higher sensation seeking were related to higher levels of brand appeal. This finding is consistent with research linking sensation seeking to ratings of appeal of packaging elements[54] and tendencies to seek out of novel experiences.[55] The influence of sensation seeking on initiation of tobacco use among youth and dependent smoking among adults appears to be high.[56] Further, adolescents with higher sensation seeking report more exposure to, and may seek out, tobacco industry marketing.[57-59]

Much of the existing research examining brand appeal has been characterized by single-item measures which have not been psychometrically verified.[10] We evaluated a single-item measure of brand appeal and compared it to a 6-item measure. Equivalency was seen in the pattern, strength, and direction of correlations between smokers' reactivity to US packaging and both brand appeal measures. Yet, the 6-item measure captured more information and was better equipped to estimate differences among smokers than the single-item ratings. That said, among the 6 items the "appeal" item provided the most information across a wide range of the underlying latent trait. When reactivity scores were regressed upon the single- and 6-item appeal outcomes, the resulting parameter estimates from fully adjusted models were similar, but confidence intervals suggested increased precision when the 6-item measure was used. Further, mental health and sensation seeking were associated with the 6-item appeal measure, but not the single-item measure. Thus, when precision is needed, we recommend use of the 6-

item brand appeal measure, but when survey space or time is limited the single-item assessment may suffice.

One limitation of this study is that a portion of data assessing reactivity to cigarette packaging was missing (n=35), which potentially impacted our validity estimates. Differential item functioning was analyzed only using biological sex and did not account for the impact of gender identity on ratings of brand appeal. Brand appeal was only measured for current US cigarette packaging, and it is unclear if the psychometric properties of measure will be retained when evaluating aversive GWL packaging. It is also possible that brand appeal functions differently when used alongside other tobacco products with different branding elements and marketing strategies (e.g., e-cigarettes). Despite these limitations, the study had several strengths. We were able to validate single- and 6-item measures of brand appeal that cover considerable range of appeal across adult daily smokers of differing tobacco brands. We used a 'think aloud' cognitive interview which allowed smokers to verbalize spontaneous thoughts and feelings about their brand's packaging, which was used to validate the brand appeal measure and increase the study's ecological validity. We captured weekly data on a single measure of appeal for the smokers' preferred brand, which allowed us to assess reliability over time and the predictive validity of summed brand appeal composite scores.

CONCLUSION

The findings provide evidence of strong scalability, reliability, and validity, which warrants the use of the six-word characterizations to assess brand appeal among adult daily smokers. Appealing packaging elements may reinforce broad perceptions of tobacco branding, which may directly motivate persistent tobacco use behavior.

ACKNOWLEDGEMENTS

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Table 2.1 Descriptive Statistics, Distribution Properties, and Spearman Correlations for the Six Brand Appeal Items

							Spearman Correlation Coefficients and Alphas [b,c]						
Brand Appeal Item	Mean	SD	SE	Skew	Kurtosis	CPC[a]	Composite	1.	2.	3.	4.	5.	6.
Composite Score	3.70	1.20	0.06	-0.20	-0.39	**0.84**	(0.92)	***	***	***	***	***	***
1. Stylish	3.72	1.42	0.08	-0.37	-0.66	0.86	0.86	0.90	***	***	***	***	***
2. Fashionable	3.29	1.39	0.07	0.02	-0.74	0.83	0.83	0.75	0.90	***	***	***	***
3. Cool	3.33	1.48	0.08	0.02	-1.01	0.83	0.87	0.72	0.76	0.90	***	***	***
4. High quality	4.11	1.35	0.07	-0.52	-0.37	0.66	0.71	0.57	0.46	0.50	0.92	***	***
5. Attractive	3.77	1.44	0.08	-0.30	-0.77	0.88	0.88	0.70	0.65	0.70	0.57	0.90	***
6. Appealing	3.96	1.42	0.07	-0.53	-0.51	0.82	0.81	0.62	0.56	0.60	0.59	0.82	0.91

Note. Abbreviations: CPC, Corrected Polychoric Correlation of item to total score.
Each brand appeal item was rated in response to the prompt: 'The design on the brand of cigarettes I currently smoke is…'
Item anchors included: 'Strongly disagree' (1), 'Disagree' (2), 'Somewhat disagree' (3), 'Somewhat agree' (4), 'Agree' (5), and 'Strongly Agree' (6).
[a] Bolded value represents Omega Hierarchical.
[b] Underlined values represent Cronbach's alpha if item deleted.
[c] Items in the parentheticals represent overall Cronbach's alpha.
*** <0.001; ** <0.01; * <0.05.

Table 2.2 Full-Information Confirmatory Factor Loadings and Parameters, and Differential Item Functioning for Brand Appeal Items

	Factor Loadings, Communalities, and Item Parameters[a]								DIF[b]
Brand Appeal Item	λ	h^2	*a*	b_1	b_2	b_3	b_4	b_5	Female vs. Male
1. Stylish	0.90	0.81	3.56	-1.44	-0.80	-0.38	0.52	1.40	--
2. Fashionable	0.87	0.76	3.03	-1.31	-0.56	0.02	0.95	1.76	--
3. Cool	0.89	0.78	3.24	-1.26	-0.48	-0.06	0.76	1.63	--
4. High quality	0.75	0.56	1.94	-2.25	-1.26	-0.75	0.30	1.34	-0.04***
5. Attractive	0.94	0.89	4.85	-1.47	-0.72	-0.33	0.42	1.17	--
6. Appealing	0.90	0.82	3.59	-1.56	-0.88	-0.48	0.26	1.19	--

Note. Abbreviations: DIF = Differential Item Functioning.

[a] Proportion of variance accounted for by the confirmatory factor analysis was 77.2% with parameters that include:

λ = Factor loading.

h^2 = Factor communality estimates.

a = Discrimination, the rate at which the probability of endorsing a correct item changes given different levels of θ.

b = Severity, the cutoff of the standardized level of θ where subsequent response options become more probable than the previous option.

[b] Expected Score Standardized Difference (ESSD) and corresponding Likelihood-Ratio Significance Testing.

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

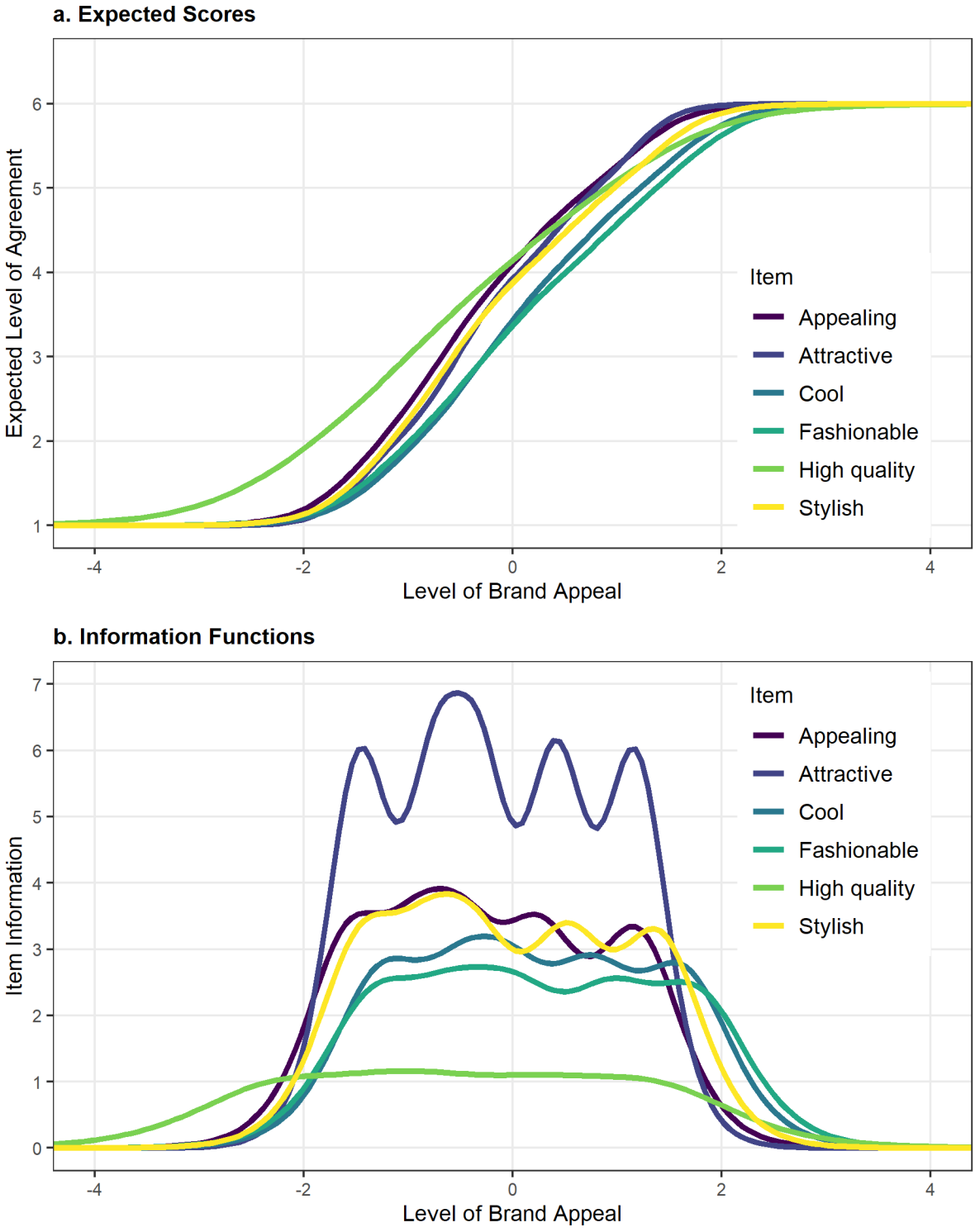

Figure 2.1 Expected Item Scores and Item Functions for Brand Appeal Items

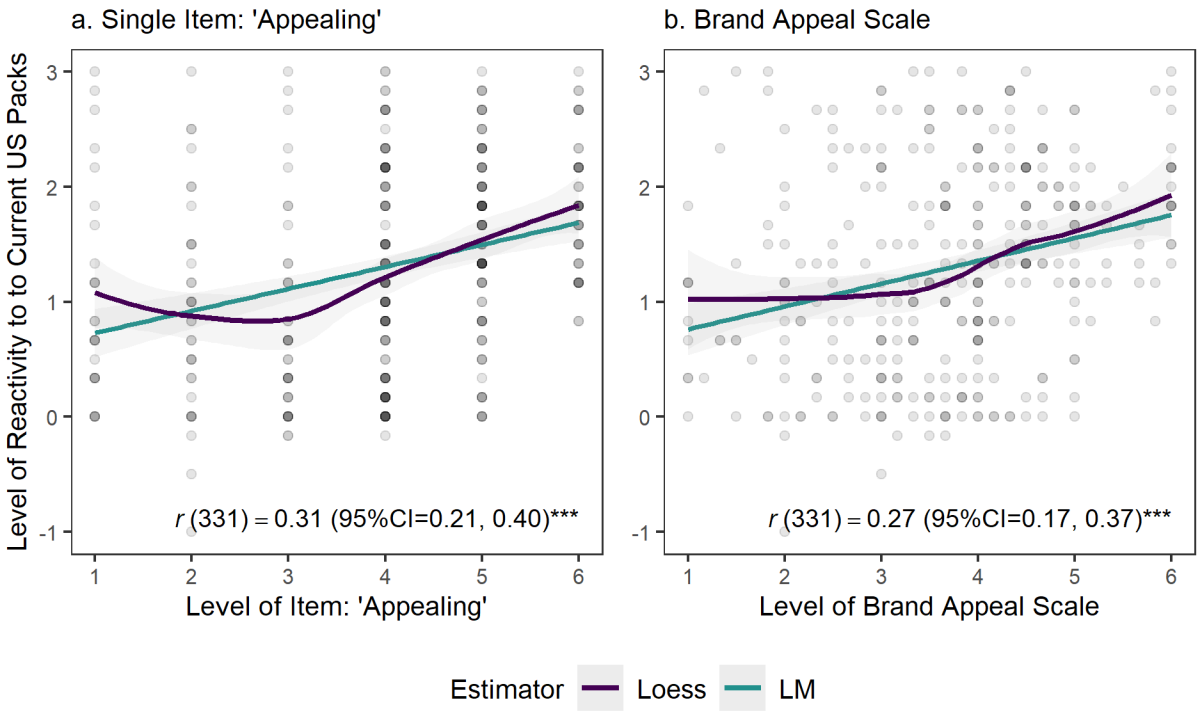

Figure 2.2 Correlation Between Brand Appeal Items and Coded Reactivity to Current US Pack

Note. Estimates from separate parametric and non-parametric correlations coefficients. Six coders rated smokers' level of positive and negative reactivity to current US packaging after exposure to a plain pack with a large Graphic Warning Label. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 2.3 Uni- and Multi-variable Associations with 6-item Brand Appeal Measure

	Outcome: 6-item Brand Appeal Measure	
Regressor	Univariable[1]	Multivariable[2]
Validating Constructs		
Reactivity to own cigarettes	0.35 (0.21, 0.49)***	0.32 (0.19, 0.46)***
Brand perceptions		
Harshness	-0.15 (-0.25, -0.05)**	-0.07 (-0.17, 0.02)
Healthiness	-0.32 (-0.42, -0.21)***	-0.29 (-0.39, -0.19)***
Cost	-0.05 (-0.13, 0.04)	-0.02 (-0.10, 0.06)
Covariates		
Age	-0.02 (-0.03, -0.01)***	-0.02 (-0.03, 0.00)**
Sex		
Male	*Ref*	*Ref*
Female	-0.20 (-0.46, 0.06)	-0.20 (-0.44, 0.04)
Race/Ethnicity		
White, non-hispanic	*Ref*	*Ref*
Hispanic	0.70 (0.28, 1.12)**	0.66 (0.28, 1.04)***
Other, non-hispanic	0.16 (-0.15, 0.48)	0.16 (-0.13, 0.44)
Education		
College or advanced degree	*Ref*	*Ref*
Some college	-0.14 (-0.41, 0.14)	-0.13 (-0.38, 0.11)
High School or less	0.15 (-0.27, 0.57)	0.11 (-0.27, 0.49)
Primary brand		
Marlboro	*Ref*	*Ref*
American Spirit	0.39 (0.03, 0.76)*	-0.12 (-0.53, 0.29)
Camel	0.34 (0.02, 0.67)*	0.19 (-0.11, 0.48)
Other	0.07 (-0.30, 0.45)	0.20 (-0.15, 0.56)
Nicotine dependence (FTND)	-0.01 (-0.06, 0.05)	0.04 (-0.02, 0.09)
Psychological distress (K6)	0.14 (-0.03, 0.32)	0.16 (0.00, 0.32)*
Sensation seeking (BSSS)	0.32 (0.13, 0.51)***	0.26 (0.07, 0.44)**

Note. Data expressed as β (95% Confidence interval).
[1]From separate linear regression models including each examined variable without inclusion of other examined variables plus covariate controls regressed upon the averaged 6-item brand appeal scores.
[2]Variables are evaluated for associations with brand appeal from a simultaneous model including covariates and examined variables.
*$p < .05$. **$p < .01$. ***$p < .001$.

SUPPLEMENTAL MATERIALS

STATISTICAL ANALYSIS

Exploratory Factor Analysis (EFA) was used to evaluate assumptions of a single primary dimension underlying ratings of brand appeal and scalability analysis to evaluate items prior to fitting graded response model. All models used polychoric correlations. Factor solutions used minres extraction and squared multiple correlations served as initial estimates of communalities. Estimated factor loadings of >.30 and communalities of >.25 were required to be included in a factor. To support our assumption of a single primary dimension, parallel Analysis of scree plots,[1] Velicer's minimum average partial criterion,[2] and the very simple structure criterion[3] were evaluated. Non-parametric kernel-smoothed[4] Option Characteristic Curves (OCCs) examined the distributional properties of responses to each six items relative to the standardized latent trait (i.e., brand appeal).

RESULTS

Results from the EFAs, Parallel Analysis, VSS, and MAP criterion provided support for a single unidimensional factor. The proportion of variance accounted for by one-factor model was 71.0% (**Supplementary Table 1.1**). Descriptive fit indices for the one-factor solution indicated good fit (RMSR=0.05; RMSEA=0.234 [95%CI=0.206, 0.265]; BIC=132.28, Tucker Lewis Index of factoring reliability=.845). Item scores were highly correlated with the one observed factor (r=.97). Parallel Analysis revealed eigen values > 4 for the first factor and values < 1 for subsequent factors. A VSS complexity of 0.96 and a Velicer MAP criterion of 0.08 were identified for a single factor solution. All six brand appeal items loaded onto a single factor (λ range=0.70–0.90) with acceptable communalities (h2 range=0.49–0.82) and, thus, were retained for subsequent analyses using one primary latent factor.

Examination of OCCs plots (**Supplementary Figure 1.1**) suggested that all but three items (‘Appealing’ and ‘High quality’) provided distinct separation among the six response options (Figure 1). For example, response options for the ‘Fashionable’ item were clearly demarcated across levels of brand appeal (M=0, SD=1), with each response more likely to be endorsed than all other options. In contrasts, the OCCs for the ‘High quality’ item illustrated that response option 3 (‘Somewhat disagree) was not more likely to be endorsed relative to the remaining options, suggesting that all six item options may not fully

separate across levels of brand appeal. However, given the relativity small sample and non-parametric nature of the analysis, larger samples are warranted to confirm this finding.

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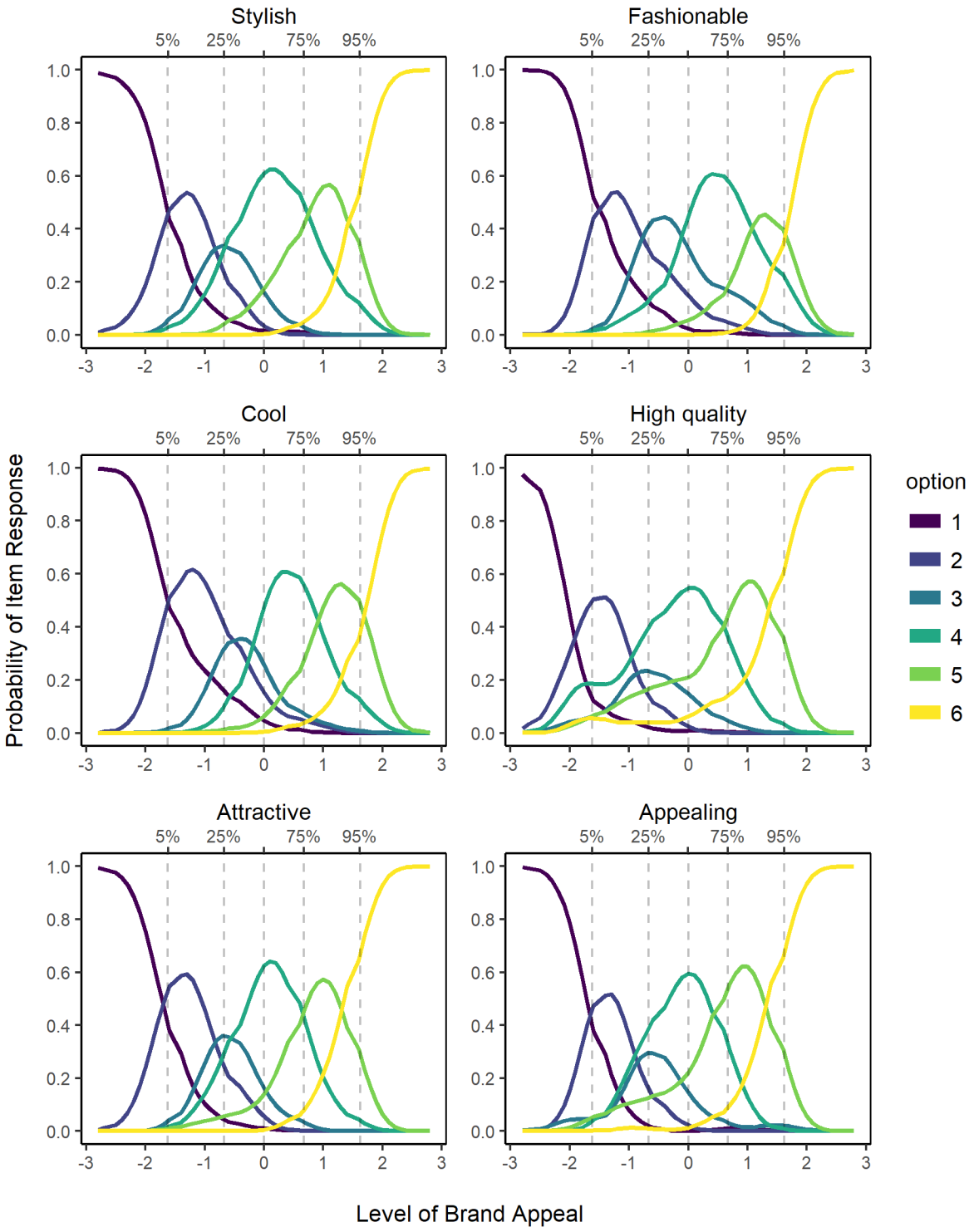
Supplementary Table 2.1 Exploratory Factor Loadings

Brand Appeal Item	λ	h^2
1. Stylish	0.89	0.79
2. Fashionable	0.85	0.72
3. Cool	0.87	0.75
4. High quality	0.70	0.49
5. Attractive	0.90	0.82
6. Appealing	0.84	0.70

Note. Proportion of variance accounted for by the exploratory factor analysis was 71.0%



Supplementary Figure 2.1 Kernel Smoothed Item Response Models for Brand Appeal Items

Note. Non-parametric kernel-smoothed option characteristic curves of the distributional properties for each brand appeal item relative to the standardized latent trait (Mean=0, SD=1). Scale Anchors include: 1-Strongly disagree; 2-Disagree; 3-Somewhat disagree; 4-Somewhat agree; 5-Agree; 6-Strongly Agree.

Supplementary Table 2.2 Uni- and Multi-variable Associations with Single-Item Appeal Measure

	Outcome: Single-item 'Appealing' Measure	
Regressor	Univariable[1]	Multivariable[2]
Validating Constructs		
Reactivity to own cigarettes	0.46 (0.30, 0.62)***	0.43 (0.27, 0.59)***
Brand perceptions		
Harshness	-0.16 (-0.27, -0.04)**	-0.08 (-0.19, 0.04)
Healthiness	-0.24 (-0.37, -0.12)***	-0.22 (-0.34, -0.10)***
Cost	-0.01 (-0.11, 0.09)	0.01 (-0.09, 0.10)
Covariates		
Age	-0.03 (-0.04, -0.02)***	-0.03 (-0.04, -0.01)***
Sex		
Male	*Ref*	*Ref*
Female	0.02 (-0.29, 0.33)	0.03 (-0.26, 0.32)
Race/Ethnicity		
White, non-hispanic	*Ref*	*Ref*
Hispanic	0.74 (0.24, 1.23)**	0.60 (0.14, 1.07)*
Other, non-hispanic	0.18 (-0.19, 0.56)	0.09 (-0.25, 0.44)
Education		
College or advanced degree	*Ref*	*Ref*
Some college	0.02 (-0.30, 0.35)	-0.00 (-0.30, 0.30)
High School or less	0.38 (-0.11, 0.87)	0.26 (-0.20, 0.72)
Primary brand		
Marlboro	*Ref*	*Ref*
American Spirit	0.35 (-0.08, 0.79)	0.03 (-0.47, 0.53)
Camel	0.34 (-0.05, 0.72)*	0.18 (-0.17, 0.54)
Other	0.00 (-0.45, 0.44)	0.24 (-0.19, 0.67)
Nicotine dependence (FTND)	0.01 (-0.06, 0.07)	0.06 (-0.01, 0.12)
Psychological distress (K6)	0.24 (0.04, 0.44)*	0.22 (0.03, 0.41)*
Sensation seeking (BSSS)	0.24 (0.02, 0.47)*	0.13 (-0.10, 0.35)

Note. Data expressed as β (95% Confidence interval).

[1]From separate linear regression models including each examined variable without inclusion of other examined variables plus covariate controls regressed upon the single-item (i.e., 'Appealing') measure.

[2]Variables are evaluated for associations with brand appeal from a simultaneous model including covariates and examined variables.

*p < .05. **p < .01. ***p < .001.

CHAPTER 4: EVALUATING US SMOKERS WILLINGNESS TO PAY FOR DIFFERENT CIGARETTE PACKAGING OPTIONS BEFORE AND AFTER REAL-WORLD EXPOSURE IN A RANDOMIZED TRIAL

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ABSTRACT

Introduction: Cigarette packaging containing tobacco industry imagery generates appeal to encourage smoking. Blank packaging devoid of industry imagery is thought to neutralize appeal. Graphic Warning Labels (GWLs), not yet implemented in the US, use aversive imagery of deleterious health outcomes to discourage smoking. We investigate whether change in willingness to pay for these pack designs is influenced by 3-months use of appealing-aversive cigarette pack options: 1) standard US packs, 2) blank packs, and 3) three GWL packs used in Australia.

Method: As part of the CASA trial, adult daily smokers in San Diego, California (N=287; 56% Female; Mean age=39.6) completed a price task after initial exposure and again after being randomized to use one of the three packaging options for 3-months. Conjoint analysis estimated the importance of pack attributes and participants' willingness to pay for pack designs. Mixed effect modeling examined change in willingness to pay for pack options and included gender, nicotine dependence, and brand appeal as regressors of interest**.**

Results: Price determined ~70% of purchase choices followed by the pack design at ~22%. At baseline, GWLs provoked price aversion over US packaging which generated appeal valuations that were slightly greater than blank packaging valuations; a consistent pattern that differed in magnitude across intervention arms. By intervention end, wear out effects were seen in the discount needed to willingly purchase the most aversive GWL image (i.e., 'Gangrene') among smokers randomized to use GWLs (β=0.41 [95%CI=0.06, 0.76]) and Blank packs (β=0.70 [95%CI=0.35, 1.04]) versus those randomized to US packs. Compared to the US arm, the blank pack arm decreased their willingness to pay for US packaging (β=-0.49 [95%CI=-0.87, -0.10]). For all designs, appeal-aversion valuations were more pronounced among females and smokers perceiving elevated brand appeal but less pronounced among more dependent smokers (*p*'s <.05).

Conclusion: US smokers indicate a need for significant price discounts to purchase packs labeled with GWLs compared to current US packs, an effect which decreased over time and was influenced by gender, dependence, and brand appeal. Should the US GWL mandate be finalized, then the perceived value of cigarette packs would be negatively impacted, which may deter purchasing.

INTRODUCTION

The United States (US) is the only high-income country that has not yet introduced Graphic Warning labels (GWLs) on cigarette packs.[1] Although a US mandate is scheduled to go into effect,[2] continued tobacco industry litigation seeks to stop such ruling. The purpose of GWLs is to use aversive imagery to remind smokers of the health consequences at the time they are reaching for a cigarette.[3] Plain packaging GWLs remove the industry's ability to use marketing to appeal to smokers as a means of encouraging continued smoking.[4] Thus, removing industry imagery from cigarette packaging should weaken the perceived value of the product. Adding aversive GWLs should go further and decrease the perceive value.[5] As such, the industry argues that a forced GWL requirement would be extremely burdensome and result in financial harm.[6] Thus, in this paper we will explore US smokers' willingness to pay for different cigarette packaging options following initial exposure and 3-month experience of having their cigarettes repackaged with these options.

Following an incentive salience model,[7] a smoker's willingness to pay for cigarettes packs is a measure of how the anticipatory drug reward combines with appealing product designs that capture attention and generate positive affect. Likewise, GWLs capture attention by provoking negative affect, reducing appeal, and increasing awareness of tobacco related health outcomes,[8] all of which are likely to influence the value smokers place on these products. Accordingly, initial exposure to GWLs appears to reduce a smoker's willingness to pay to purchase such products.[9] However, the role that this appeal-aversion response plays is likely to rely on effects from both acute and extended exposure to GWLs. Repeated exposure to GWLs may reduce the initial impact, leaving smokers emotionally and cognitively desensitized to the imagery,[10] which should be reflected in the price they are willing to pay for such products. Thus, we sought to examine if GWL packaging generates lasting price aversion valuations or if exposure to three months of consistent use of GWL plain packaging was associated with a moderation of willingness to pay.

The CASA randomized controlled trial, which examines the effects packaging has on smoking cognitions and behavior,[11] obtained license for eight images currently in use in Australia and selected three for re-packaging a smoker's own cigarettes. The 'Gangrene' image was selected for use in a

cigarette purchase task as well as the trial, as it provoked the greatest negative affect and was perceived to be the most effective at communicating health risks in a pre-test.[11,12] Two other GWLs were selected for use in trial, but not the purchase task. The 'Throat Cancer' image was selected as it ranked second on perceived effectiveness and first on perceived risk, as well as 'Neonatal Baby' image selected as smokers living with a child under 5 perceived this as most effective at communicating risk. Lastly, two additional images that were ranked similarly on perceived effectiveness (i.e., 'Blindness' and 'Teeth Damage') were selected [11] for use in the purchase task to explore whether any willingness to pay effects from 3-months exposure to the pack would generalize to other GWL images.

We sought to examine change in the perceived value of various cigarette packs options after three-month exposure to those packs and do so in a way that reflects the price smokers are willing to pay for the associated imagery. Using a discrete choice purchase task, we examine willingness to pay for five different packaging options: 1) a blank pack devoid of industry imagery; 2) three GWL plain packs; and 3) standard US packs. We hypothesize that 3-month exposure to aversiveness packs will result in amelioration of willingness to pay valuations. We do this by analyzing data from US smokers who completed the purchase task both before and after completing an intervention where they purchase their cigarettes re-packaged into the blank or GWL pack options. Evaluating choice preferences allowed us to determine the changes in price discount individual smokers would need to be willing to purchase GWLs as compared to blank and current US packaging.

METHODS

Study Population and Design**:** Participants were from the CASA study; a randomized controlled trial examining the effects cigarette packaging has on smoking behavior.[11] We use data from volunteer daily smokers aged 21-to-65-years-old from San Diego County, California who signed an informed consent (overseen by Institutional Review Boards at UC San Diego and Cal State San Marcos), completed the trial, and provided data on a conjoint task. At the initial study visit (V1), participants completed questionnaires, completed a "think-aloud" pack handling task where they explored study packs, and then completed a conjoint task designed to determine one's willingness to pay for various cigarette packaging designs (**Figure 3.1**). Following V1, participants completed a one-month run-in period

to assess compliance with study assessments prior to being enrolled and randomized into the CASA trial. Following allocation, participants began a 3-month intervention that involved purchasing cigarettes packaged from one of three conditions: 1) blank packs devoid of tobacco marketing; 2) GWL plain packs featuring 3 rotating images; and 3) standard US packs. Upon completion of the intervention, participants returned for a follow-up visit (V2) where they again completed the same conjoint task.

MEASURES

Willingness to Pay Purchase Task. At V1 and V2, an adaptive choice-based conjoint (ACBC) task,[13,14] matched to the participants' preferred cigarette brand, evaluated willingness to pay for various pack designs. These discrete choice tasks estimated the relative importance that smokers place on various attributes of cigarette packs and the part-worth valuations of attributes levels. During the task, participants indicated their willingness to pay for cigarettes with varying pack designs constructed from four attributes: (1) package design (five levels: industry design, blank design and three GWL designs); (2) tobacco origin (two levels: domestic or imported); (3) toll-free quitline number (two levels: absent or present); and (4) price (multiple levels, varied within ±33% of self-reported cigarette pack prices). The three GWL images selected for use covered a graded range of emotional responses (i.e., Foot Gangrene, Teeth Damage and Blindness; **Supplementary Figure 3.1**).[11] Using an orthogonally balanced adaptive fractional factorial design,[13] participants designed an ideal pack from the full list of product attribute options. Then, a series of nine choice tasks were presented, each assessing the possible purchase of three varied cigarette pack designs altered slightly from the ideal pack design. Finally, in a type of tournament of champions, up to 15 packs with purchase potential were pitted against one another until a single winner was identified. The trade-offs made across design choices reveal the amount of utility (e.g., willing to pay more) or disutility (e.g., willing to pay less) associated with each design.

Study Covariates: We assed sociodemographics (age, sex, race/ethnicity, and educational attainment),[11] tobacco use (daily use frequency and primary brand smoked),[11] the Fagerström Test of Nicotine Dependence scale,[15] and brand loyalty,[16] as planned covariates. Brand appeal[17,18] was measured by asking participants to rate their level of agreement with each of six-word characterizations

(e.g., ‘The design on the brand of cigarettes I currently smoke is…Stylish, Fashionable, Cool, High quality, Attractive, and Appealing’) using a 6-point Likert scale.

ANALYTIC PLAN

To determine differences in a willingness to pay for packaging options, conjoint analyses using hierarchical Bayesian (HB) estimations consisting of 40,000 iterations (20,000 for burn-in and 20,000 for parameter inference) were conducted in Lighthouse studio (version 9.10.1). Choice data from four brand specific conjoint tasks (i.e., American Spirit, Camel, Marlboro, or Newport) were pooled with brand preference (i.e., matches brand vs. else) included as a covariate. Estimated part-worth utilities are relative, sum to zero, and represent the preference for each level of the package design attribute, with higher values indicating greater preference. The valuation of attribute levels was determined by dividing the difference in price anchors ($3.00–$15.00, i.e., the spread in variation of reported cigarette pack prices) by the difference in part-worth utilities for these anchors and then multiplying the median of this calculation across each utility score. These price utility differences reflect the appeal valuation that participants would be willing to pay to keep the industry marketing on their pack and the aversion valuation that they would pay not to have each of the GWLs on their pack. Importance scores, reflecting the maximum effect an attribute has on product choice, were generated by dividing the range in utility scores for each attribute by the sum of the ranges of all attributes.

To investigate change in attribute importance and willingness to pay for each pack design, separate dependent samples t-tests bootstrapped using 10,000 replications were run using the “MKinfer” package.[19] To examine within subject variability on change in willingness to pay for each pack design, we fit five separate longitudinal, intercept only, conditional mixed-effects models with 95% confidence intervals bootstrapped using 10,000 replications in the “lme4” and “lmerTest” packages.[20,21] Main effects included the independent regressors of intervention arm, categorical time, gender, nicotine dependence and brand appeal. To examine intervention effects a study arm × categorical time interaction term was also included. Estimated marginal means of willingness to pay across intervention arms were computed from interaction model terms using the “effects” package[22] and then plotted. Models were run in R version 4.0.3[23] and adjusted for age, race/ethnicity, education, and cigarette brand preference.

RESULTS

Study Sample: A total of 357 smokers completed both study visits. Of these, 70 were excluded from the analysis: 40 had incomplete data, 12 had response categorized as likely not meaningful,[24] and 18 had response that were outliers[25] on the conjoint task (4+ standard deviations above the mean). Among the analytic sample (n=287, **Supplementary Table 3.1**), 160 (56%) were female with a mean age of 39.6 years (SD=11.8). Over two thirds were non-Hispanic White (69.3%) with the rest either Hispanic (10.5%) or other non-Hispanic race-ethnicities (20.2%). The majority of the sample received at least some college education (87.8%) with nearly half having earned a college degree (43.9%). Prior to the study, participants paid an average of $8.13 (SD=$1.48) per pack of cigarettes and smoked just over half-a-pack per day (Mean=11.8, SD=6.0). Just over a quarter (26.8%) had high levels of dependence (FTND score ≥ 6) and less than third (31.0%) had low dependence levels (FTND score ≤ 2). The highest proportion indicated that they were Marlboro smokers (42.5%) followed by Camel smokers (28.2%) and American Spirit smokers (16.7%).

Change in the Importance of Cigarette Packaging. Participants indicated price was the key determining factor in purchasing cigarette packs and this importance remained unchanged from the V1 to V2 session (69.4% → 71.0% of choice decisions, respectively; **Table 3.1**). Packaging design was the second most important determinant in purchasing decisions, although this declined over the course of the study (V1= 24%, mean change=-1.87 [95%CI=-3.61, -0.12]). Both the origin of the tobacco (3.8% → 4.3%) and the inclusion or exclusion of a quitline number (2.8% → 2.7%) were considered rarely, although the importance of the tobacco origin increased a little by the end of the study (Mean change=0.54% [95%CI=0.17%, 0.91%]).

Baseline Willingness to Pay for Cigarette Packaging. At V1 smokers were unaware to which arm they would be randomized in the trial. We hoped that the urn randomization procedure would lead to equivalence between groups on baseline willingness to pay estimates. However, those randomized to the Blank arm had more pronounced appeal-aversion valuations across the pack designs (**Table 3.2**). Appeal valuations for US packs varied by study group with those in the Blank arm willing to pay the most for these packs (US arm=$1.92; Blank arm=$2.22; GWL arm=$1.96). Additionally, blank packs devoid of

imagery had differential appeal valuations (US arm=$1.51; Blank arm=$1.81; GWL arm=$1.35), although these were marginally less than valuations added by industry imagery. GWL packs provoked aversion valuations at V1 along a graded continuum that appeared to align with the salience of the image (e.g., Gangrene < Teeth damage < Blindness). These pre-randomization aversion valuations also varied by study arm for the 'Gangrene' (US arm=-$1.60; Blank arm=-$2.06; GWL arm=-$1.52) and 'Teeth Damage' (US arm=-$1.03; Blank arm=-$1.24; GWL arm=-$0.88) packs.

Change in Willingness to Pay for Cigarettes Branded with Industry Imagery. Willingness to pay for industry imagery remained unchanged following the three-month intervention among smokers in the US arm of the trial (appeal valuation change=-$0.02 [95%CI=-$0.28, $0.24]). Those randomized to the GWL arm had reduced willingness to pay for industry packs by V2 (appeal valuation change=-$0.27 [95%CI=-$0.52, -$0.03]). The greatest change in willingness to pay for US packs by V2 was among those in the Blank arm of the trial (appeal valuation change=-$0.46 [95%CI=-$0.77, -$0.13]), although some of this might be expected by regression to the mean. After adjustment for potential confounding, mixed effects model results showed that appeal valuations for US packs decreased during the intervention among those in the Blank (β=-0.49 [95%CI=-0.87, -0.10]) versus US arm of the trial (**Table 3.3**). Though not significantly different, estimated marginal means showed willingness to pay for current US packs at V2 was lowest among those in the GWL arm (appeal valuation=$1.46 [95%CI=$1.19, $1.74]) followed by those in the Blank (appeal valuation=$1.70 [95%CI=$1.43, $1.97]) and US (appeal valuation =$1.87 [95%CI=$1.59, $2.15]) study arms (**Figure 3.2**).

Change in Willingness to Pay for Blank Packaging Devoid of Industry Imagery. For each arm, in the unadjusted analysis, willingness to pay for blank packs did not change by V2. After adjustment, willingness to pay for Blank packs decreased among those in the Blank (β=-0.49 [95%CI=-0.87, -0.10]) versus US arm of the trial. By intervention end, willingness to pay for blank packaging was lowest among those in the GWL arm (Mean=$1.31 [95%CI=$1.04, $1.57]) followed by the Blank (Mean=$1.56 [95%CI=$1.30, $1.83]) and US (Mean=$1.60 [95%CI=$1.33, $1.86]) arms.

Change in Willingness to Pay for GWL Plain Packaging. Among those randomized to the GWL arm of the trial, aversion valuations for the 'Gangrene' GWL pack weakened following three-month

exposure to the same imagery (valuation change=$0.49 [95%CI=0.26, 0.72]). Conversely, GWLs not used in the intervention by those in the GWL arm experienced an increased aversion valuation ('Teeth damage' pack change=-$0.20 [95%CI=-0.40, -0.01]) or no change in valuation ('Blindness' pack change=$0.05 [95%CI=-0.11, 0.20]). Those in the Blank arm also had weakened aversion valuations to the 'Gangrene' GWL pack by V2 (change= $0.69 [95%CI=0.42, 0.97]) which occurred without three-month exposure to the image. Those in the US arm, increased their aversion valuation for of the 'Teeth Damage' GWL pack by V2 (mean change= -$0.26 [95%CI=-$0.46, -$0.07]) but did not change their valuations of the 'Gangrene' and 'Blindness' GWL packs. Relative to the US arm, aversion valuations for the 'Gangrene' pack weakened over time among those in the GWL (β=0.41 [95%CI=0.06, 0.76]) and Blank (β=0.70 [95%CI=0.35, 1.04]) arm of the trial. By intervention end, the US arm would need the greatest discount to willingly purchase the 'Gangrene' pack (aversion valuation=-$1.52 [95%CI=-$1.76, -$1.27]) followed by the Blank (aversion valuation =-$1.33 [95%CI=-$1.57, -$1.09]) and GWL (aversion valuation =-$1.07 [95%CI=-$1.31, -$0.82]) arms.

Covariate Associations with Appeal-Aversion Valuations. Mixed effect models predicting willingness to pay indicated that, regardless of study arm or visit, as FTND scores increased, appeal-aversion valuations were less prominent across all packaging options relative to the direction of the valuations (US β=-0.10; Blank β=-0.08; 'Blindness' GWL β=0.03, 'Teeth Damage' GWL β=0.07; and 'Gangrene' GWL β=0.08 ; *p*'s<.05). Conversely, when compared to males, females had more prominent appeal-aversion valuations for all packaging options (US β=0.47; Blank β=0.50; 'Blindness' GWL β=-0.21, 'Teeth Damage' GWL β=-0.29; and 'Gangrene' GWL β=-0.47 ; *p*'s<.01). Similarly, as a smokers' baseline level of brand appeal increased, appeal-aversion valuations became more prominent for all but the 'Blindness' GWL pack (US β=0.18; Blank β=0.14; 'Teeth Damage' GWL β=-0.12; and 'Gangrene' GWL β=-0.16 ; *p*'s<.05). Lastly, Marlboro branded US packaging carried greater appeal valuations than Camel (β=-0.42) or Newport (β=-0.63) packaging but was valued no differently than American Spirt packaging.

Discussion

When determining initial purchase choices among adult US daily smokers, we found price to be most important factor (~70% of the decision) followed by packaging design (~24% of decision). After first

exposure to GWL plain packaging, smokers were price aversive to the products and would require moderate discounts (e.g., ~$-3.11) to willingly purchase GWL packs over their current US pack. As expected, US packs containing industry imagery generated considerable appeal valuations which varied by brand, with Marlboro and American Spirt carrying the most perceived value. When industry imagery was removed (i.e., blank packs), valuations lessened with smokers needing small discounts (e.g., ~$0.39) to willingly purchase a blank pack over their own US pack, a finding consistent with research linking diminished willingness to pay for blank packaging designs.[26] These patterns remained consistent across study groups randomly assigned to purchase cigarettes using the three design options. Randomization did not result in comparable groups on the baseline valuations, initial valuations were unbalanced going into the 3-month intervention.

After the intervention, the importance of price remained unchanged, but pack design became slightly less important when determining purchases. No reduction in appeal-aversion valuations were observed across pack designs among those assigned to use industry branded packs. Smokers randomized to the Blank pack arm of the trial had lessened appeal valuations for US packs but also lessened aversion valuations for the 'Teeth Damage' and 'Gangrene' GWL packs. A possible explanation for this might be that the blank packaging led to smokers focusing on the rewarding elements inside the product and associating that reward with the packaging. Thus, it is plausible that inhibiting incentive salience attribution led to a reduction in the value placed on appealing or aversive pack designs. Aversion valuations became less pronounced over time for the 'Gangrene' pack which was included in the GWL arm's rotating set of images. This could indicate potential wear out effects resulting from extended exposure. Further, aversion valuations were not reduced for the packs excluded from the GWL rotating set of images (i.e., 'Blindness' and 'Teeth Damage') which may indicate that desensitization effects do not generalize to smoking harm images not regularly seen.

Nevertheless, the impact GWLs had on product price perceptions was relatively minimal considering the sample reported paying roughly $8.00 per pack of cigarettes. Should graphic packaging be so aversive that it forces smokers to feel they have to quit, we would expect to see them only willing to use packs with GWLs if they were given away for free (i.e., price aversion valuations match the price they currently pay); this was not the case. Price aversion generated by GWLs was equivalent to approximately

a $3.00 excise tax, which is nothing close to the $A40 excise tax goal in Australia which has not resulted in major changes to smoking prevalence rates.[27] Further, unlike a fixed tax increase, willingness-to-pay cognitions are malleable and aversion valuations for GWL packs used in the intervention began to wane after a relatively short period of exposure (< 3-months). This is not surprising given the CASA trial found evidence that GWLs only changed smoking related cognitions and perceptions but did not significantly alter behavior,[28] which was consistently with the analysis of trends in smoking prevalence across 60 countries before and after mandating GWLs.[29] Thus, the industry argument that a GWL rule is "unduly burdensome" and will lead to them suffering financial harm would likely not be as onerous as argued.[6] Further, cigarette sales do not necessarily fall following implementation of GWLs[30] and additional manufacturing costs appear to be passed along to the consumer.[31]

Overall appeal-aversion valuations for both current US and all GWL packaging were weakened across study groups as a smoker's level of nicotine dependence increased. This suggests smokers with high levels of nicotine dependence are less willing to pay premiums for industry branded cigarettes but would also need less of a discount to willingly purchase packs with GWLs. This finding is consistent with point-of-sale purchase behavior for GWLs[32] and theoretical underpinnings that link nicotine dependence severity with the price elasticity of demand for cigarettes.[33] By contrast, those with greater brand appeal appraisals were willing to pay more for industry branded packs and would need greater discounts to willingly purchase GWL packs with highly aversive imagery. This finding accords with research indicating that appealing branding elements may directly motivate persistent smoking[34] whereas GWL imagery impedes the products ability to generate appeal.[35,36] Lastly, females had higher appeal valuations for industry packaging and stronger aversion valuations for GWLs than men. This relationship may partly be explained by research showing that women find GWLs more credible and emotionally arousing,[37] responses which have been previously linked to product price appraisals.[38,39]

These results is subject to certain limitations. Despite the ecological validity of conjoint tasks,[14] price valuations tend to overstate the amount that consumers would actually pay in the marketplace. We attempted to correct for exaggerated willingness to pay by removing outlier responses and centering the price per utility at the sample median before multiplying across attribute level utilities. Also, the sample was recruited in the San Diego, CA and thus not representative of smokers living in the US, or other

countries. California's tobacco control policies have led to stronger social norms against smoking compared to the rest of the US,[40] limiting generalizability. The study's randomization did not stratify by the smoker's willingness to pay for packaging options and the intervention arms were unbalanced as a result. However, we attempted to control for these baseline differences in the analysis. The GWL plain packaging used in this study is not the same hybrid packaging proposed by the US, which contains half industry marketing and half GWLs.[2] However, we would expect this hybrid style packaging to generate lesser aversion valuations.[41] Notwithstanding these limitations, the study has numerous strengths. We followed prior recommendations[42] by capturing data on brand smoked, modifying the packaging of those same brands, and anchoring choice options around the price they currently pay. This approach allowed us to isolate the effects that pack design attributes have on product valuations. We also used an adaptive fractional factorial design in the price task to efficiently estimate willingness to pay across the full factorial set of pack attributes. In an effort to anchor choices to actual products, we exposed participants to the packaging by allowing them to handle the designs prior to completion of the first price task. We then assigned them to purchase their cigarettes packaged in one of these design variants for 3-months before once again completing the task.

CONCLUSION

Compared to current US packaging which generates appeal and adds to the value of the product, GWL plain packaging engenders price aversion which represents a loss in product value. Yet this cost effect appears to wear out after 3-month exposure and is influenced by gender, dependence, and brand appeal. Should the US GWL mandate be finalized, the perceived value of cigarette packs would be impacted which may deter purchasing.

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inclusion in this dissertation. The dissertation author, Matthew Stone, led all aspects of the analysis and is the primary author on this manuscript

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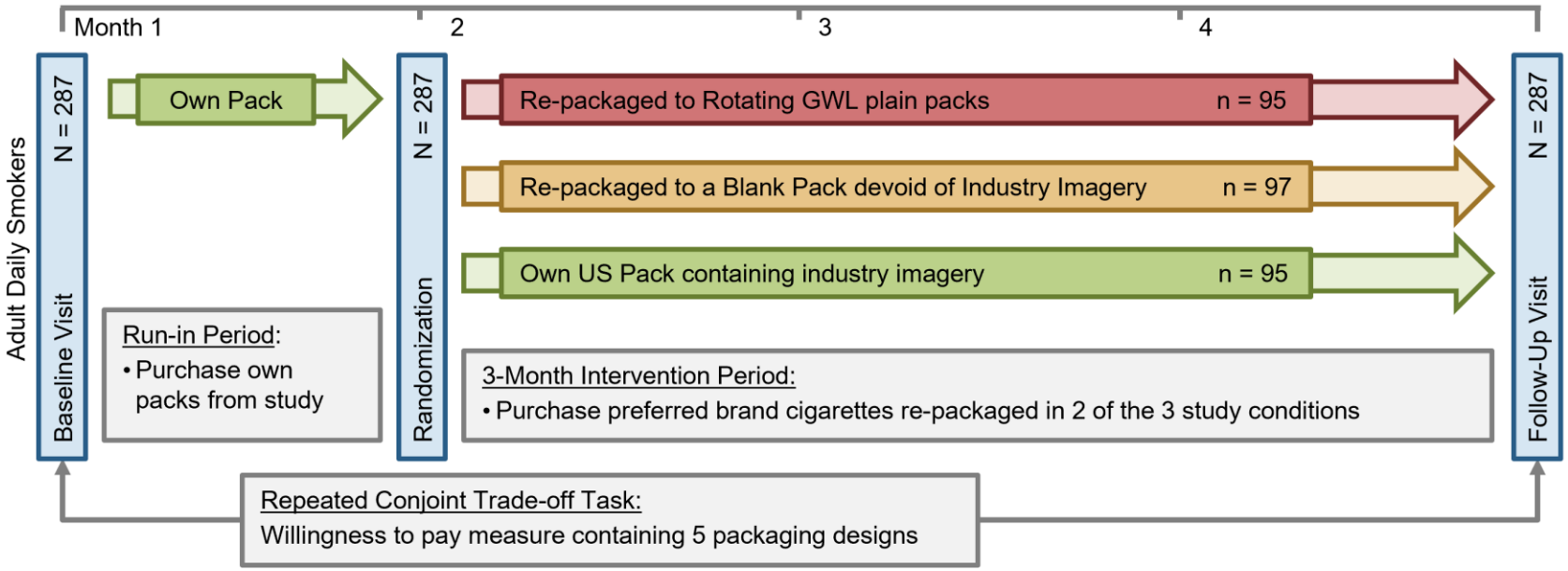

Figure 3.1 Change in Willingness to Pay Assessment after 3-month Exposure to Differing Packaging Design Options

Table 3.1 Change in Cigarette Pack Attribute Importance after 3-month Packaging Invention

	Relative Importance		
Attribute[1]	Visit 1	Visit 2	Difference in importance[2]
Price	69.40 (68.49, 70.31)	70.96 (69.98, 71.95)	1.38 (-0.49, 3.24)
Packaging	24.07 (23.21, 24.92)	22.03 (21.10, 22.97)	-1.87 (-3.61, -0.12)*
Tobacco origin	3.78 (3.62, 3.95)	4.33 (4.16, 4.50)	0.54 (0.17, 0.91)**
Quitline	2.75 (2.63, 2.87)	2.68 (2.59, 2.76)	-0.05 (-0.32, 0.22)

Note. N=287. Data expressed as mean (95% confidence intervals).
[1] Attributes represent the different product characteristics of the cigarette pack (i.e., price, packaging, quitline number and tobacco origin) and importance scores reflect the relative weight of an individual attribute in comparison with other attributes, with scores summing to 100.
[2] From bootstrapped dependent samples t-tests (n=10,000).
* $p < .05$ ** $p < .01$, *** $p < .001$.

Table 3.2 Change in Price Utilities of Cigarette Pack Designs by Intervention Arm among Daily Smokers

Packaging attribute level	Own Pack Arm		Blank Pack Arm		GWL Pack Arm	
	Mean price utility[1] at V1	Change[2] in price utility at V2	Mean price utility[1] at V1	Change[2] in price utility at V2	Mean price utility[1] at V1	Change[2] in price utility at V2
	(N = 95)	Δ (95%CI)	(N = 97)	Δ (95%CI)	(N = 95)	Δ (95%CI)
Industry imagery	$1.92	-$0.02 (-0.28, 0.24)	$2.22	-$0.46 (-0.77, -0.13)**	$1.69	-$0.27 (-0.52, -0.03)*
Blank imagery	$1.51	$0.13 (-0.11, 0.37)	$1.81	-$0.22 (-0.51, 0.07)	$1.35	-$0.06 (-0.30, 0.20)
Blindness	-$0.80	$0.11 (-0.04, 0.25)	-$0.74	-$0.02 (-0.18, 0.14)	-$0.65	$0.05 (-0.11, 0.20)
Teeth damage	-$1.03	-$0.26 (-0.46, -0.07)*	-$1.24	$0.01 (-0.24, 0.24)	-$0.88	-$0.20 (-0.40, -0.01)*
Gangrene	-$1.60	$0.05 (-0.18, 0.28)	-$2.06	$0.69 (0.42, 0.97)***	-$1.52	$0.49 (0.26, 0.72)***

Note. N=287. Abbreviations: V1, Visit 1; V2, Visit 2. Data expressed as Mean or Mean Δ (95% confidence intervals).

[1] Utility scores represent the preference for each packaging design and dollar valuation associated with that preference, with positive values indicating a relative willingness to pay more for the packaging and negative values representing the discount needed to purchase the packaging.

[2] From bootstrapped dependent samples t-tests (n=10,000).

* $p < .05$ ** $p < .01$, *** $p < .001$

Table 3.3 Change in Cigarette Pack Design Price Utilities by Intervention Arm Following 3-months of Exposure to Study Packaging

	Pack Outcome: Price Utility (i.e., Willingness to Pay)				
Regressor	Current US	Blank	Blindness	Teeth Damage	Gangrene
Interactions					
Post-intervention ×					
Own pack arm	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Blank pack arm	-0.49 (-0.87, -0.10)*	-0.39 (-0.76, -0.03)*	-0.14 (-0.35, 0.07)	0.33 (0.02, 0.64)*	0.70 (0.35, 1.04)***
GWL pack arm	-0.23 (-0.62, 0.16)	-0.14 (-0.52, 0.21)	-0.08 (-0.29, 0.13)	0.05 (-0.25, 0.35)	0.41 (0.06, 0.76)*
Main effects					
Intervention arm					
Own pack	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Blank pack	0.32 (-0.07, 0.71)	0.36 (-0.01, 0.73).	0.06 (-0.12, 0.25)	-0.24 (-0.54, 0.06)	-0.51 (-0.86, -0.17)**
GWL pack	-0.18 (-0.58, 0.22)	-0.14 (-0.52, 0.23)	0.12 (-0.07, 0.30)	0.17 (-0.13, 0.47)	0.04 (-0.31, 0.39)
Study visit					
Baseline	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Post-intervention	-0.03 (-0.31, 0.25)	0.11 (-0.14, 0.37)	0.12 (-0.03, 0.28)	-0.26 (-0.48, -0.04)*	0.06 (-0.19, 0.30)
Age (years)	0.01 (-0.00, 0.02)	0.01 (-0.00, 0.02)	-0.01 (-0.01, 0.00)*	-0.01 (-0.02, 0.00)	-0.00 (-0.02, 0.01)
Sex					
Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Female	0.47 (0.18, 0.76)**	0.50 (0.22, 0.78)***	-0.21 (-0.34, -0.08)**	-0.29 (-0.51, -0.07)**	-0.47 (-0.72, -0.22)***
Race/Ethnicity					
White, non-Hispanic	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Hispanic	-0.03 (-0.50, 0.45)	-0.06 (-0.51, 0.40)	-0.07 (-0.28, 0.14)	0.06 (-0.29, 0.41)	0.10 (-0.30, 0.52)
Other, non-Hispanic	0.14 (-0.21, 0.49)	0.12 (-0.22, 0.46)	-0.10 (-0.26, 0.05)	-0.07 (-0.34, 0.20)	-0.09 (-0.39, 0.22)
Education					
College degree or more	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Some college	0.16 (-0.14, 0.46)	0.19 (-0.10, 0.48)	-0.04 (-0.17, 0.10)	-0.14 (-0.37, 0.08)	-0.17 (-0.43, 0.10)
High School or less	-0.19 (-0.64, 0.28)	-0.24 (-0.67, 0.20)	0.11 (-0.10, 0.31)	0.14 (-0.21, 0.49)	0.17 (-0.23, 0.58)
Cigarette Brand					
Marlboro	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
American Spirit	-0.31 (-0.69, 0.07)	-0.46 (-0.83, -0.10)*	-0.10 (-0.27, 0.06)	0.36 (0.07, 0.64)*	0.51 (0.17, 0.84)**
Camel	-0.42 (-0.74, -0.10)*	-0.04 (-0.35, 0.27)	0.20 (0.06, 0.35)**	0.05 (-0.18, 0.30)	0.20 (-0.08, 0.48)
Newport	-0.63 (-1.25, -0.01)*	-0.11 (-0.69, 0.48)	0.14 (-0.14, 0.42)	-0.20 (-0.68, 0.26)	0.82 (0.27, 1.36)**
Nicotine Dependence	-0.10 (-0.17, -0.04)**	-0.08 (-0.14, -0.02)*	0.03 (0.00, 0.06)*	0.07 (0.02, 0.12)**	0.08 (0.03, 0.14)**
Brand Appeal	0.18 (0.06, 0.31)**	0.14 (0.02, 0.26)*	-0.04 (-0.10, 0.01)	-0.12 (-0.21, -0.03)*	-0.16 (-0.27, -0.05)**

Note. N=287. Data are expressed as β (95% confidence intervals). From five separate intercept only conditional linear mixed effects models with bootstrapped (n=10,000) CI's predicting respective packaging design price utility outcome. * $p < .05$ ** $p < .01$, *** $p < .001$.

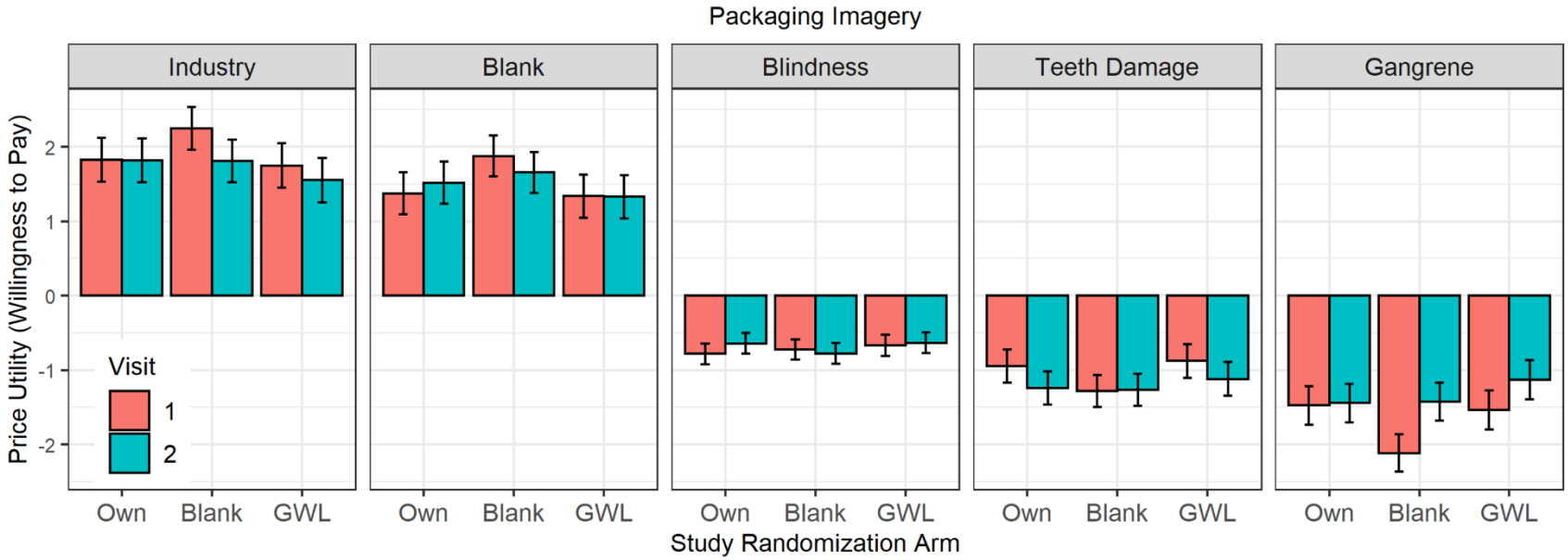

Figure 3.2 Pre- and Post-Invention Estimated Marginal Means of Willingness to Pay for Various Cigarette Pack Images by Randomization

Note. Effects extracted from five separate intercept only conditional linear mixed effects models predicting respective packaging price utility outcome.

SUPPLEMENTAL MATERIALS

Supplementary Table 3.1 Sample Characteristics

Variable	Total (N = 287)
Age	39.6 (11.8)
Gender	
Male	127 (44%)
Female	160 (56%)
Race/Ethnicity	
Non-Hispanic White	199 (69%)
Hispanic	30 (10%)
Other Non-Hispanic	58 (20%)
Education	
High School or less	35 (12%)
Some college	126 (44%)
College or Advanced Degree	126 (44%)
Nicotine dependence (range: 1-10)	3.8 (2.3)
FTND levels	
Low (0-2)	89 (31.0%)
Mid (3-5)	121 (42.2%)
High (6-10)	77 (26.8%)
Cigarettes per day (range: 3-35)	11.8 (6.0)
Brand appeal (range: 1-6)	3.7 (1.2)
Primary brand	
American Spirit	48 (16.7%)
Camel	82 (28.6%)
Marlboro	122 (42.5%)
Other	35 (12.2%)

Note. Data expresses as M(SD) or N(%). Abbreviations: FTND, Fagerström Test of Nicotine Dependence

Supplementary Figure 3.1 Examples of Packaging Design Options used in Cigarette Purchase Task

CHAPTER 5: CONCLUSION

Cigarette packaging is a key component of tobacco industry marketing aimed at generating brand appeal to increase willingness to pay for such products and encourage continued smoking. In the 21st century, this marketing strategy may prove fatally effective for the estimated one billion smokers who will have lost their lives to the use of tobacco.[1-3] In a landmark and remarkable treaty, the WHO's Framework Convention on Tobacco Control recommended the explicit removal of all tobacco marketing and advertising.[4] However, industry marketing persists and continues to build and maintain brand loyal customers.[5,6] Graphic Warning Labels (GWLs) have been designed, in part, to counter these tobacco marketing strategies and curb smoking by reminding users of the deleterious health hazards in the moments before lighting up.[4] Many legal battles have been fought around the globe as regulators attempt to mandate use of GWLs.[7] However, as long as tobacco marketing persist so will regulatory challenges. In this dissertation, a series of studies explores the appeal-aversion response to various cigarette packaging designs among US daily smokers.

In Chapter 2, we asked smokers to describe their thoughts and feelings as they handled differing cigarette packaging options: 1) their current US pack, 2) blank packs devoid of any industry imagery, and 3) plain packs containing large graphic warning labels. Using a team of six human coders and natural language processing we quantified the smokers' reactions to such packaging options. After exposure to at least one GWL, positive reactions were expressed in response the smoker's own pack, while blank packs prompted mostly neutral responses. Graphic packaging provoked differential aversive responses that aligned with utterances of disgust, anger, fear, and sadness. Thus, this study provided evidence that these designs provoke the array of responses needed to evaluate the effect that cigarette packaging has on smoking related cognitions and behavior.

In Chapter 2, we psychometrically validated an existing 6-item measure of brand appeal for smokers' preferred cigarettes. Non-parametric factor analytics and graded response models supported a single primary construct with strong internal validity, reliability, scalability, and item-level equivalence for males and females. Significant independent associations were seen between the summated 6-item composite and positive reactivity to current US packaging and perceptions of the comparative healthiness

of the brand. While use of the 6-item measure is recommend for evaluating brand appeal, we found support for a single-item appeal measure that was also reliable over a one-month period. These brand appeal measure should prove useful in evaluating the impact that regulatory actions, such as the use of GWLs, have on the appeal of cigarette products and related cognitions and behavior.

In Chapter 4, we employed the use of a novel discrete-choice purchase task to evaluate willingness to pay for differing cigarette pack design options. Smokers were given this task both before and after being enrolled into a randomized controlled trial where they purchased all their cigarettes in one of the three packaging design options. Results of these tasks indicated that smokers would require significant discounts if there were to purchase cigarette packs containing large graphic warning labels. These discounts remained largely unchanged after 3-months of intervention. Yet, wear-out costs were present in the most aversive of the GWL images (i.e., Foot Gangrene). Smokers experiencing heightened levels of nicotine dependence appeared to be less affected by packaging designs while females and those with heightened ratings of appeal for their brand appeared more affected.

This dissertation adds to the abundant amount of evidence supporting the beneficial effect of requiring graphic warning labels on cigarette packaging.[8-10] These findings indicate that current US packaging generates appeal and positive affect among smokers, which translates to increased valuations when purchases are considered. Removal of such industry packaging appears to neutralize these positive reactions and reduces a smoker's willingness to pay for the product. However, adding GWLs that remind smokers of the health effects leads to a weakening in the valuation of the product, at least temporarily. Thus, plain packaging that includes large graphic warning labels would seem to be an important component of an effective tobacco control strategy. This is particularly the case given that the US stands out amongst a dwindling number of countries yet to mandate such warnings.

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