DOI: HTTPS://DOI.ORG/10.15446/RCP.V34N1.115255

Visual Nudges and Smoking Prevention: Exploring Implicit and Explicit Emotional Responses to Graphic Health Warnings

JOHANNA SÁNCHEZ-MORA

Departamento de Psicología, Universidad Nacional de Colombia, Bogotá, Colombia

RICARDO M. TAMAYO

Departamento de Psicología, Universidad Nacional de Colombia, Bogotá, Colombia

How to cite this article: Sánchez-Mora, J. and Tamayo, R. M. (2025). Visual Nudges and Smoking Prevention: Exploring Implicit and Explicit Emotional Responses to Graphic Health Warnings. *Revista Colombiana de Psicología*, *34*(1). pp 145–160. https://revistas.unal.edu.co/index.php/psicologia/article/view/115255

Correspondence: Johanna Sánchez-Mora (https://orcid.org/0000-0001-7333-4974), Departamento de Psicología, Universidad Nacional de Colombia, Bogotá, Colombia. Email: cijsanchezmo@unal.edu.co

SCIENTIFIC RESEARCH ARTICLE

RECEIVED: JULY 24TH, 2024–ACCEPTED: JULY 26TH, 2024

Visual Nudges and Smoking Prevention: Exploring Implicit and Explicit Emotional Responses to Graphic Health Warnings

Abstract

This article presents two studies (N = 301) investigating the implicit and explicit effects of graphic health warnings (GHWs) on smoking prevention. Framed within the intersection of implicit cognition and bounded rationality models, we aim to characterize GHWs as Type 1 nudges driven by automatic processing and evaluate the consistency of observed effects with this characterization. In the first study, participants performed the Affect Misattribution Procedure (AMP) with a prime exposure time of 75 milliseconds (ms). Participants were randomly assigned to an experimental condition with graphic warnings as primes or a control condition with neutral images from the International Affective Picture System (IAPS). Results indicated that graphic warnings produced significantly more negative valence and faster implicit evaluations of the target stimuli compared to neutral images. The second study utilized a modified AMP where participants evaluated the valence of the prime images directly, with an extended exposure time of 500ms. This study also demonstrated significant differences in both image valence and reaction times, consistent with the findings from the first study, indicating explicit effects of the graphic warnings. Our findings suggest a translation process from implicit to explicit effects, shedding light on the relationship between automatic and controlled processing in the context of nudges. These results have key implications for understanding the cognitive mechanisms underlying health warnings and optimizing their design for public health interventions.

Keywords: nudges, graphic health warnings, automatic processing, controlled processing, implicit cognition, smoking.

Empujones visuales y prevención del tabaquismo: Exploración de las respuestas emocionales implícitas y explícitas a las advertencias sanitarias gráficas

Resumen

Este artículo presenta dos estudios (N = 301) en los que se investigaron los efectos implícitos y explícitos de las advertencias sanitarias gráficas (GHW) en la prevención del tabaquismo. Enmarcados en la intersección de los modelos de cognición implícita y racionalidad limitada, pretendemos caracterizar las advertencias sanitarias gráficas como empujones de tipo 1 impulsados por el procesamiento automático y evaluar la coherencia de los efectos observados con esta caracterización. En el primer estudio, los participantes realizaron el Procedimiento de Mala Atribución del Afecto (AMP) con un tiempo de exposición primario de 75 milisegundos (ms). Los participantes fueron asignados aleatoriamente a una condición experimental con advertencias gráficas como imprimación o a una condición de control con imágenes neutras del Sistema Internacional de Imágenes Afectivas (IAPS). Los resultados indicaron que las advertencias gráficas producían significativamente más valencia negativa y evaluaciones implícitas más rápidas de los estímulos objetivo en comparación con las imágenes neutras. El segundo estudio utilizó un PGA modificado en el que los participantes evaluaron directamente la valencia de las imágenes primarias, con un tiempo de exposición ampliado de 500 ms. Este estudio también demostró diferencias significativas tanto en la valencia de las imágenes como en los tiempos de reacción, en consonancia con los resultados del primer estudio, lo que indica efectos explícitos de las advertencias gráficas. Nuestros resultados sugieren un proceso de traslación de los efectos implícitos a los explícitos, arrojando luz sobre la relación entre el procesamiento automático y el controlado en el contexto de los codazos. Estos resultados tienen implicaciones clave para comprender los mecanismos cognitivos subyacentes a las advertencias sanitarias y optimizar su diseño para intervenciones de salud pública.

Palabras clave: nudges, advertencias sanitarias gráficas, procesamiento automático, procesamiento controlado, cognición implícita, tabaquismo.

Nudge theory advocates subtly altering the context in which decisions are made to guide behavior toward better choices without restricting people's freedom (e.g., Thaler & Ganser, 2015). This approach has had a significant impact on public health policy (Thaler & Sunstein, 2009). For example, nudges can improve dietary choices, vaccination rates, and physical activity (Kovács, 2021). As smoking remains one of the leading causes of preventable disease and death worldwide, it might become a critical target for nudge-based public health interventions (Hoffman & Tan, 2015).

Graphic health warnings (GHWs) on cigarette packs act as powerful nudges to discourage smoking (Francis, et al., 2017). They typically include images depicting the dire health consequences of smoking (e.g., diseased lungs, oral cancer, etc.) that immediately evoke negative emotional responses (Hammond et al., 2007; Hammond, 2011; Madera-Carrillo et al., 2015) and, unlike traditional informational messages that rely on cognitive elaboration and comprehension, these negative feelings of vulnerability can quickly promote quit intentions and prevent smoking initiation (Pang, 2021).

Despite the widespread implementation of GHWs through MPOWER[1] policies, there is a significant gap in understanding how implicit emotional reactions to these warnings interact with explicit cognitive processing (Bogliacino et al., 2015; Drovandi et al., 2019; Erceg-Hurn & Steed, 2011; Hall et al., 2018). This gap hinders the optimal design and implementation of GHWs. Understanding the psychological mechanisms behind these responses is crucial because nudge theory, which supports the use of GHWs, relies on behavioral economics and bounded rationality principles that recognize the impact of emotional and cognitive biases on decision making.

1 These are six evidence-based strategies recommended by the World Health Organization (WHO) to reduce tobacco use and exposure: Monitor tobacco use, Protect people from tobacco smoke, Offer help to quit, Warn about tobacco dangers, Enforce bans on advertising, and Raise taxes on tobacco. https://www.who.int/initiatives/mpower

Bounded Rationality

Bounded rationality (Simon, 2000; Kahneman, 2003a, 2003b) suggests that temporary emotional or cognitive states may override rational decisions. For example, advertisements that portray smoking as sophisticated and social may make it seem appealing despite known long-term health risks (Slovic, 2001). However, GHWs may redirect risk perceptions towards more healthy options (Bansal-Travers et al., 2011; Slovic, 2003; Thaler & Sunstein, 2009). Thus, GHWs act as nudges, effectively alerting the public to the dangers of smoking and serving as cost-effective health promotion tools (Benartzi et al., 2017).

The reported efficacy of nudges in multiple contexts, ranging from tax compliance (Cialdini et al., 1990; Coleman, 1996), to reducing littering (Kolodko et al., 2016; see also alcohol reduction, Perkins, 2003; household energy management, Schultz et al., 2007), motivated us to explore the potential of GHWs as nudges. Specifically, within the framework of bounded rationality, which focuses on the interaction between automatic (system 1) and controlled (system 2) processing. System 1, which is faster and more emotional, may often lead to suboptimal decisions for well-being that are detached from normative rationality (Kahneman, 2003b). In contrast, System 2, characterized as deliberative and logical, often guides individuals to behave rationally and maximize their well-being (Kahneman, 2003b). Thaler and Sunstein (2009) proposed that nudges, including GHWs, are effective because they channel System 1 tendencies in everyday situations where System 2 processing is often limited by time and cognitive load.

Implicit Cognition

Bounded rationality is closely related to implicit cognition, which posits that many cognitive processes occur automatically and without people's explicit awareness (Corneille & Hütter, 2020). Both approaches address critical questions about involuntary and automatic processing in human cognition. Implicit cognition has its origins in memory and learning research and highlights the fact that some efficient cognitive processes do not necessarily require conscious and deliberate effort. For example, pioneering studies have shown that amnesic patients, while highly impaired on tasks involving conscious learning (e.g., free recall and recognition), perform effectively on tasks that do not require conscious memory (e.g., skill acquisition, object completion, lexical decision tasks, Graf & Schacter, 1985; Schacter & Graf, 1986; Warrington & Weiskrantz, 1968; Weiskrantz & Warrington, 1979). Both bounded rationality and implicit cognition suggest a distinction between systems or processes based on the degree of conscious control exerted by individuals. Specifically, the division between System 1 and System 2 in bounded rationality largely overlaps with the distinction between implicit and explicit processes in implicit cognition (Corneille & Hütter, 2020). System 1 is characterized as fast, automatic, and unconscious, whereas System 2 is slow, deliberate, and conscious. Similarly, in cognitive research, implicit processes are considered automatic, nondeliberative, and incidental, while explicit processes are considered controlled, deliberative, and intentional (Frensch & Rünger, 2003).

On the one hand, nudge theory, which aims to achieve quick social outcomes, often focuses on taking advantage of System 1 processes to influence behavior efficiently. On the other hand, implicit cognition investigates the psychological mechanisms that support behavior, enhancing our understanding of how nudges operate at a deeper cognitive level. Both theories acknowledge cognitive and heuristic biases that influence human judgment and decision-making (Corneille & Hütter, 2020; Kahneman, 2003b).

Importantly, research on implicit cognition has examined whether implicit and explicit systems operate independently or interact (Willingham & Goedert-Eschmann, 1999). Sleep studies, for instance, suggest that implicitly acquired knowledge can become explicit during sleep, as procedural skills are processed offline, facilitating knowledge consolidation (Fischer et al., 2006; Sánchez-Mora & Tamayo, 2021). This interaction model can inform research that seeks to explain how nudges work by characterizing the mechanisms that translate implicit effects, as immediate fear, into explicit outcomes, as attitudes toward smoking (e.g., Hollands et al., 2016). Consequently, type 1 nudges may initially act implicitly but eventually facilitate explicit effects through an analogous transition process.

Some evidence indicates that GHWs can significantly alter implicit attitudes towards smoking. For example, a study by Bogliacino et al. (2015) demonstrated that exposure to GHWs leads to more negative implicit evaluations of smoking-related stimuli and that these emotional changes significantly influence later smoking decisions. Similarly, Macy et al. (2016) found that young adults exposed to GHWs exhibited more negative implicit attitudes toward smoking than those exposed to text-only warnings (Wiers & Stacy, 2006).

Implicit Processing of Graphic Health Warnings

The effectiveness of GHWs can be partly attributed to their ability to engage System 1 processing. This view is supported for instance by findings from Peters et al. (2007), who observed that images demand less cognitive effort and elicit stronger emotional reactions than text-only messages. Consequently, GHWs are more likely to capture attention and trigger immediate emotional responses, leading to greater, or at least more evident, behavioral impact. However, since explicit processing involves conscious and reflective thought, which is typically slower and more deliberate (Kahneman, 2003b), it is not clear how GHWs influence both implicit and explicit processing (Drovandi et al., 2019; Gantiva et al., 2022). Some evidence suggests that GHWs may also support explicit attitudes and intentions over time. For example, a study by Noar et al. (2016) found that GHWs increased the intentions to quit smoking more effectively than text-only warnings, indicating a possible shift from implicit to explicit processing. Furthermore, Evans et al. (2017) reported that graphic warnings led to higher levels of fear and disgust, which were associated with increased quit intentions, suggesting that the emotional reactions triggered by GHWs can translate into explicit behavioral intentions (Jansen et al., 2006; Smith & De Houwer, 2015; Wang et al., 2015). This reinforces our view of a gap in the literature regarding the need to explore the transition from implicit to explicit processing to understand more precisely the formation of explicit attitudes toward smoking.

Clearly, it is essential to investigate how initial automatic responses to GHWs evolve into conscious and reflective evaluations over time. This understanding can help refine the use of graphic warnings to maximize their impact on smoking cessation and prevention (Parada et al., 2017). In this paper, we aim to address this gap by examining both implicit and explicit emotional responses to GHWs. By exploring how warnings affect automated and controlled processing, we can gain deeper insights into their effectiveness as a public health intervention. This research can additionally inform practical evidence-based strategies for enhancing public health campaigns aimed at reducing smoking prevalence.

Overview of the Experiments

Our research examines whether early emotional reactions to GHWs are automatic and implicit, and how these reactions develop into conscious, explicit judgments. Specifically, we investigate whether GHWs induce implicit effects with brief exposure times and if longer exposure times facilitate explicit evaluations. We conducted two complementary studies using the AMP to measure these effects. In the first experiment, participants were exposed to GHWs presented as primes for short times (75 ms) in the experimental condition and neutral images from IAPS in the control condition. We hypothesize that would exhibit more negative implicit evaluations of the target stimuli. In the second experiment, we extended the prime exposure time (to 500 ms) to measure explicit responses, hypothesizing that evaluations would be more negative in the experimental condition, reflecting the transition from implicit to explicit processing.

Additionally, in both experiments, we collected measures of the reaction times (RTs) participants required to judge the primes (Experiment 1) or the targets (Experiment 2). We collected and analyzed these latencies because current models suggest that RTs can helpfully describe the time course of the evidence accumulation of the cognitive process required to reach a simple decision (e.g., Berkovich & Meiran, 2024; Brown & Heathcote, 2008), in our case valence rating decisions. RTs have the potential to supports the view that our experimental manipulation taps into the time course of the transition from implicit to explicit processing.

Experiment 1: Implicit Effects

The first study evaluated the implicit reactions produced by GHWs. Using the standard AMP, we assessed the perceived pleasantness of a neutral target stimulus (a kanji character) following a prime (either a graphic warning or a neutral image). Participants were assigned to one of two conditions based on the type of prime stimulus presented in each trial. The experimental group viewed GHW primes, while the control group viewed neutral primes from the IAPS. We hypothesized that implicit pleasantness judgments would be more negative for the experimental group than for the control group. Both studies were approved by the ethics committee of the Faculty of Human Sciences of the National University of Colombia (B.FCH.1.002-190-22).

Method

Participants

We recruited 150 undergraduates (85 women and 65 men) who participated for partial course credit. A power analysis (Power = 0.80, α = .05) indicated that samples for experiments with a simple factorial design and two conditions should include approximately 129 participants to detect moderate (η^2 = 0.06) or high (η^2 = 1.38) effect sizes (Fong et al., 2010). To account for potential participant withdrawal and data loss, we aimed for 150 participants. The sample size and all study aspects were preregistered on aspredicted.org (https://aspredicted.org/8mf27.pdf). Participants were randomly assigned to either the experimental or control condition. The experimental group included 75 participants (43 female), aged 20-34 years (M = 23.8, SD = 2.9). The control group included 75 participants (42 female), aged 20-43 years (M = 23.7, SD = 3.3).).

Instruments

We collected demographic information and smoking history and used this as control variables in the analyses.

Affect Misattribution Procedure (AMP). This experimental task involves the presentation of a prime stimulus (GHW or IAPS) for 75 ms, followed by a black screen for 125 ms and a target stimulus (a kanji) for 100ms. After the target, a visual noise mask appears and a 4-point rating scale (-2 very unpleasant, -1 slightly unpleasant, +1 slightly pleasant, +2 very pleasant) is displayed at the bottom of the screen (Payne et al., 2005; Payne et al., 2008).

Need to Smoke. We used the short version of the Questionnaire of Smoking Urges (QSU-brief; Cox et al., 2001), a 10-item self-report measure on a 7-point Likert scale (e.g., "I want to smoke right now"), with higher scores indicating a greater need to smoke (Tiffany & Drobes, 1991). Non-smokers received the minimum score for all items (range 0-70).

Nicotine Dependence. Participants completed the first item of the Fagerström Test for Nicotine Dependence (FTND) to assess nicotine dependence (Heatherton et al., 1991). This scale measures dependence through a Likert scale (range 0-10).

Frequency and History of Smoking. Smoking frequency was assessed by asking participants how many cigarettes they smoke per week or day. Smoking history was determined by asking participants their age when they started smoking, whether they have ever quit, the number of quit attempts, and how soon after waking they smoke their first cigarette.

Procedure

Participants were tested in individual cubicles equipped with PCs and QWERTY keyboards. First, they completed a sociodemographic questionnaire. Next, they performed the AMP task, implemented by Inquisit 4 testing software, providing valence ratings as described above. Participants were instructed to judge the targets and avoid any influence of the prime on their judgments, making this clearly an implicit task as instructions directed attention toward the targets (not the valence primes). The software measured the RTs from the onset of the rating scale on the screen to the key press corresponding to each of the 4-point rating scale values. Finally, participants completed questionnaires on smoking attitudes and smoking status. The entire procedure, including debriefing, took approximately 10 minutes.

Results

The participants in this experiment had a mean age of 23.7 (SD = 3.1). 85 (56.7%) were female, 65 were male. The participants were middle class (M=2.81 (SD = 0.8) on the 1-6 scale used by the national government). A total of 37 participants were smokers. On nicotine dependence (range 0-10), smoking participants had a mean of 3.0 (SD = 0.62). On the need to smoke scale (range 0-70), the mean was 6.5 (SD = 0.96). 10% percent of smoking participants reported needing to smoke between 31 to 60 minutes after waking up, 5% between 6 to 30 minutes after the same moment, and the rest more than 60 minutes after. Average cigarette consumption was 0.44 (SD = 0.14) per day. Occasional smokers reported smoking 0.57 (SD = 0.15) days per week. The also reported smoking on average 0.51 cigarettes (SD = 0.12) the days they smoke and smoking 1.56 cigarettes a week on average (SD = 0.49). Participants reported starting smoking at 17.22 (SD = 2.91). The 77.5% of smoking participants reported having tried to quit smoking.

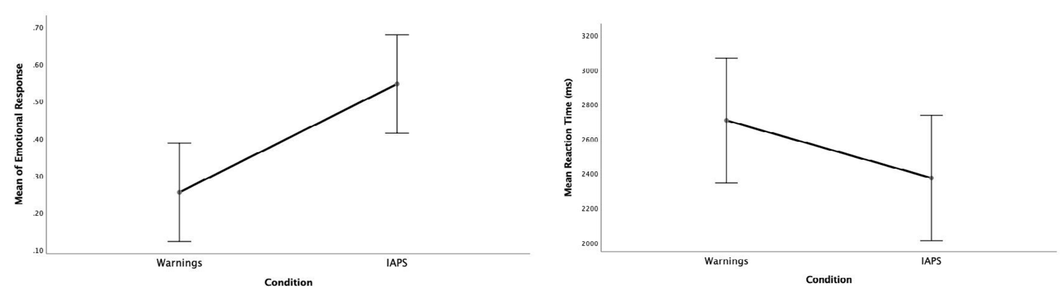
Main Results

We used a one-way ANOVA with condition (GHWs vs. IAPS) as a fixed factor. Each analysis included the average emotional ratings and the average RTs from the 36 trials in the AMP split by type of prime.

There was a main effect of experimental condition $F(1, 148) = 5.43$, $p = .021$, $\eta p^2 = 0.035$. That is, participants rated the target as less pleasant when preceded by a GHW than in the control condition when preceded by a neutral IAPS image (Figure 1). The mean rating in the experimental condition was M = 0.25 (SD = 0.83), while in the control condition (neutral prime) it was M = 0.54 (SD = 0.69). This suggests that the GHWs had implicit effects on the judgments of the primes. Even when covariates (e.g., need to smoke) were included in general linear models, these results were consistent.

We did not find a significant effect for RTs, $F(1, 148) = 0.957$, $p = .33$, the mean RT was 2707 ms (SD = 2779) for GHWs and 2374 ms (SD = 988) for IAPS. These results indicate that the experimental manipulation did not affect the latencies required to rate target stimuli.

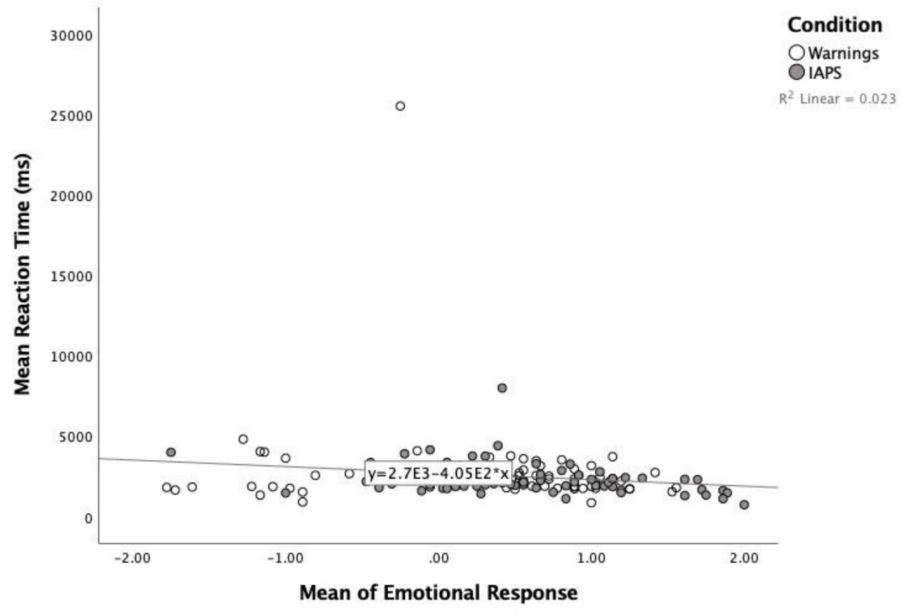
Figure 1. *Results by Condition in study 1*



Note. Mean of pleasantness judgments (left) and reaction times in milliseconds for target stimuli (kanjis) as a function of condition (graphic warning prime vs neutral prime). Error bars represent +/-1.5 S.E.

Additionally, correlations were performed between reaction times and the emotional response reported for the kanji. Figure 2. Scatterplot of kanjis' pleasantness evaluation and reaction times in study 1. This correlation was not significant (r (148) = -0.151, $p = .065$). Additionally, as can be seen in Figure 2, responses to graphic warnings were more negative than responses to neutral images. Although the correlation was not significant, reaction times for the experimental group tended to be lower than reaction times in the control group.

Figure 2. *Correlation between Reaction Time and Implicit Emotional Response.*



Discussion

Study 1 shows that GHWs have clear implicit effects. Participants exposed to GHWs as primes reported more negative perceptions of the targets. However, there were no significant differences in reaction times and no significant correlation between reaction times and implicit ratings of the targets. These results indicate that GHWs effectively influence the implicit ratings of the targets preceded by GHWs. In this procedure, participants are instructed to focus only on judging the target, but presumably, the negative affect triggered by the prime transfers to the evaluation of the target. However, this study does not indicate whether GHWs also induce explicit effects. This limitation emerges because the design specifically involves judging neutral target stimuli with short exposure times (75 ms for the prime and 100 ms for the target).

Experiment 2: Explicit Effects

To focus on explicit processing, Study 2 evaluates the explicit effects of GHWs using an exposure time of 500 ms for the prime and 100 ms for the target. In this case, participants are asked explicitly about the prime's pleasantness. This follows a variant of the AMP developed by Payne, Burkley, and Stokes (2008) to measure explicit influences within the AMP experimental paradigm. We expected that explicit judgments of pleasantness would be more negative in the experimental group compared to the control group, with values closer to -2.

Method

The method used in this study was identical to the one used in study 1 except for the stimulus presentation times, and instructions directed participants to judge the primes.

Participants

Participants were 151 undergraduates (63 women and 88 men) who participated for partial course credit. Similar to Experiment 1, the sample size and all other aspects of the study were pre-registered in the aspredicted.org platform (https://aspredicted.org/8mf27.pdf). Participants were randomly assigned to either the experimental or control condition. The experimental group had 76 participants (48 female) with ages between 18 and 32 years (M = 22.5, SD = 2.8). The control group had 75 participants (40 female), with ages between 18 and 29 years (M = 21.6, SD = 2.2).

Results

Participants in this experiment had an average age of 22 years (SD = 2.5). The sample included 88 women (58.3%) and 63 men (41.7%), primarily middle-class individuals (average of 3 on the 1-6 scale used by the national government). Similar to Experiment 1, we performed ANOVAs for continuous variables (e.g., age) and Chi-Square tests for categorical variables (e.g., gender) to check the effectiveness of the random assignment. The results indicated no significant differences between conditions for any variables. Among the participants, 29 were smokers. For nicotine dependence (range 0-10), the mean score was 0.65 (SD = 0.23). The mean score on the need to smoke scale (range 0-70) was 6.7 (SD = 1.02). Only 4.1% of smokers reported needing to smoke within 6 to 30 minutes after waking, while the rest reported waiting more than 60 minutes. The average cigarette consumption was 0.39 (SD = 0.12) per day. Occasional smokers reported smoking 0.64 (SD = 0.13) days per week, with an average of 0.57 cigarettes (SD = 0.13) on smoking days. On average, this group smoked 1.87 cigarettes per week (SD = 0.64). Participants reported starting smoking at an average age of 15.86 years (SD = 2.08), and 86.1% of smokers had attempted to quit smoking.

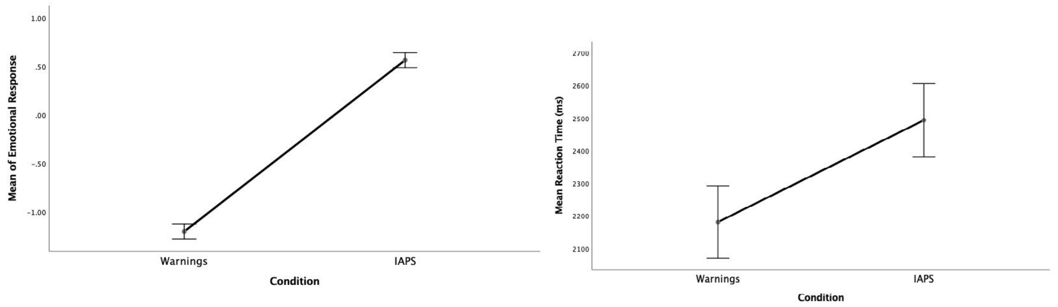
Main Results

A one-way ANOVA was conducted with condition (prime type) entered as a fixed effect. The experimental condition involved negative primes (GHWs), while the control condition involved neutral IAPS images. Analyses involved the mean explicit valence ratings and mean RTs.

For explicit ratings, the results showed a significant effect of condition, $F(1, 149) = 579$, $p < .001$, $\eta p^2 = .795$. Participants rated the pleasantness of the prime as more negative (less pleasant) in the experimental condition (GHWs) than in the control condition (neutral IAPS). Recall that explicit emotional responses were measured on a scale from -2 to +2, with negative values indicating unpleasantness and positive values indicating pleasantness. The mean emotional response was M = -1.2 (SD = 0.44) for the experimental condition and M = 0.56 (SD = 0.45) for the control condition. This result indicates that graphic warnings as primes have explicit effects. When we conducted general linear models including covariates (e.g., need to smoke), the results of the manipulation remained significant.

For RTs, the results were also significant, $F(1, 149) = 8.81$, $p < .003$, $\eta p^2 = .795$. Responses were faster in the experimental condition (GHWs: M = 2181 ms, SD = 567) than in the control condition (neutral IAPS: M = 2493 ms, SD = 717). These effects remained significant when we included covariates.

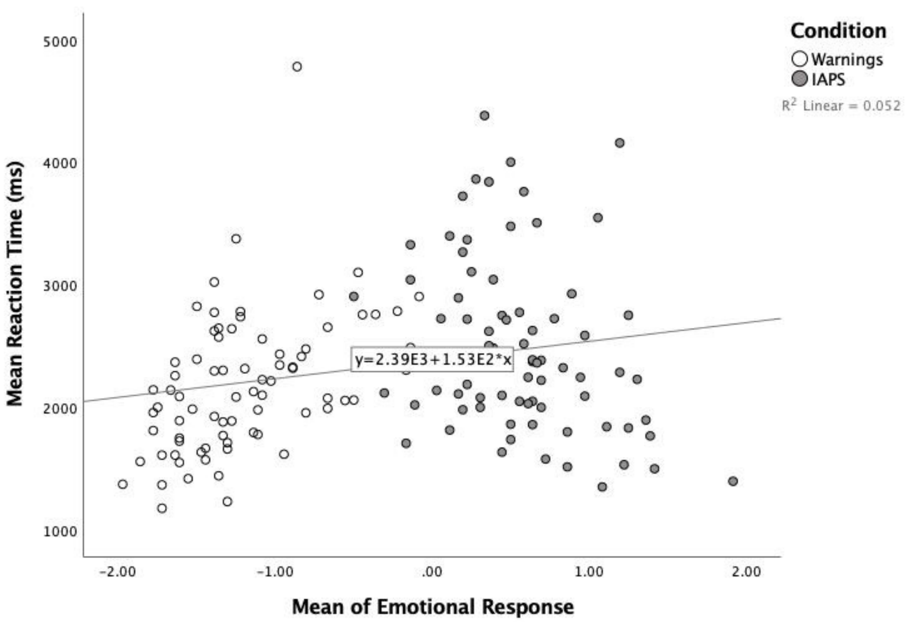
Figure 3. *Results by Condition in study 2*



Note. Mean of pleasantness judgments (left) and reaction times in milliseconds for target stimuli (prime) as a function of condition (graphic warning prime vs neutral prime). Error bars represent +/-1.5 S.E.

Additionally, we found a significant correlation between RTs and the valence ratings ($r(149) = .228$, $p < .01$), indicating that emotional implicit processing can lead to faster reactions. Figure 4 shows that reaction times in the graphic warning group are, on average, shorter when the emotional responses are more negative.

Figure 4. *Correlation between RTs and Explicit Valence Ratings in study 2*



Discussion

Study 2 demonstrates that GHWs have explicit effects when the prime images are presented for longer durations. Using the same paradigm as in Study 1, but with extended exposure times, GHWs resulted in faster and more negative pleasantness evaluations compared to neutral stimuli. This finding suggests that longer exposure times lead to a transition from implicit to explicit processing. This shift from automatic to deliberate processing has been explored in previous literature (e.g., Chartrand et al., 2006; Sánchez-Mora & Tamayo, 2021) and is instrumental in understanding the relationship between the automatic and educational functions of GHWs from a nudge perspective.

General Discussion

Taken together, our two studies show that GHWs can have implicit or explicit effects, depending on the time allowed to process the stimuli and the attention paid to them. The standard AMP in Experiment 1, with short presentation times for GHWs and instructions to direct participants' attention to the targets, showed implicit effects. This provides evidence that GHWs may behave as "type 1" nudges, harnessing implicit, automatic cognitive processes to discourage smoking.

The modified AMP procedure in Experiment 2, with longer presentation times for GHWs and instructions to direct participants' attention to the primes, showed explicit negative evaluations. These findings jointly suggest that the experimental conditions favored a transition from implicit to explicit affect, where automatic responses elicited by GHWs may influence more deliberate valence ratings. These results are consistent with previous literature showing that graphic warnings help prevent smoking initiation and relapse by appealing to negative emotions (Hammond, 2011; Macy et al., 2016).

Implicit vs. Explicit Effects

Most previous research on GHWs has focused on their explicit effects based on self-report measures (Pang et al., 2021). However, our use of the standard version of the AMP demonstrates the potential for a transition from initial automatic implicit processing of GHWs to more elaborated and deliberative evaluation of the messages conveyed by GHWs.

Interestingly, early implicit responses tend to be congruent with the valence of the primes, indicating that implicit processing consistently reflects the emotional direction of the targets. This suggests that implicit processing might be always present and aligned with the valence of the stimuli. In contrast, explicit processing occurs at a later stage and involves more deliberate and controlled cognitive processes. This later stage can lead to positive outcomes, as intentions to quit smoking or prevention of smoking initiation. However, it can also backfire resulting in defensiveness or reactance to GHWs (e.g., Bekalu et al., 2018).

The initial automatic implicit processing captures the immediate emotional responses to GHWs, while explicit processing allows for a more thoughtful and reflective evaluation of the warnings. In our view, this transition underscores the importance of considering both stages in the design of public health interventions.

Methodological Contributions

The AMP represents an original methodological contribution to the study of GHWs and their application in public policies. Our research demonstrates how easily the AMP can be adapted to capture both implicit and explicit affective responses to GHWs. For example, the entire procedure, including collection of demographic data and instructions, took no more than 10 minutes for each of our 300 participants.

In addition to collecting valence ratings, we measured the latencies required for participants to reach each decision. This approach yielded surprisingly interesting results. RTs correlated with explicit judgments in Experiment 2, but not with implicit effects in Experiment 1. This discrepancy provides information regarding the cognitive and emotional processing of GHW, suggesting that different cognitive processes are recruited at distinct stages of the evaluation process.

We suggest that current decision frameworks as the Linear Ballistic Accumulator (LBA) model (e.g., Berkovich & Meiran, 2024; Brown & Heathcote, 2008) can be applied to our data. From this perspective, the significant correlation between RTs and explicit judgments in Experiment 2 implies that longer presentation times and instructions that focus attention on GHWs facilitate explicit accumulation of information, leading to rapid explicit valence judgments. In contrast, the lack of correlation in Experiment 1 suggests that the predominantly implicit effects observed did not produce sufficient information accumulation for controlled deliberative judgments within the short time manipulated. This interpretation fills a gap in understanding the transition from implicit to explicit processing, or, in terms of nudge theory, the transition from type 1 to type 2 nudges.

Implications for Nudge Theory

Our research also intersects with Nudge theory, as highlighted in our introduction. Nudges can be classified into two types. Type 1 nudges appeal to automatic and implicit processing, while type 2 nudges focus on controlled processing (Lin et al., 2017). Previous research classifies GHWs as type 1 nudges (e.g., Barton, 2013; Bogliacino et al., 2015). However, our data show that varying exposure times can modulate the effects of GHWs. This implies that the type of nudge alone does not determine whether the effect is implicit or explicit; rather, exposure times and instructions that control participants' attention play a critical role.

These results suggest the existence of a temporal activation pathway and transition processes between implicit and explicit effects, (e.g., Hollands et al., 2016; Parada et al., 2017; Sanchez-Mora & Tamayo 2021). This pathway implies that individuals progress from automatic, unconscious processing to controlled processing in an effort to consciously extract information from fuzzy signals arising from the initial phase. This idea is consistent with serial models of cognitive processing, as Evans and Stanovich's (2013) model. Their model suggests that System 1 is engaged first, followed by System 2, which monitors and, if necessary, corrects the output of System 1.

Recent approaches, like De Neys' hybrid model (2017), also support this view. In this model, System 1 operates in parallel with both heuristic and algorithmic intuitions, coupled with a conflict detection process that may or may not activate System 2. Although these models provide a framework, the exact pathways between implicit and explicit processing remain unclear.

Limitations

Correlational data guided our interpretation of the utility of RTs as supplementary indicators of explicit negative affective processing. Future studies should employ directly RT modeling frameworks to predict the formation of explicit judgments and long-term smoking attitudes. This approach could lead to stronger evidence and deeper understanding of this purported transition.

The sample in our study comprised only university students, which may limit the generalizability of the findings to a more diverse demographic. Future research should include a more diverse sample.

Recommendations

Future research should examine the relationship between implicit and explicit effects at different exposure times. Our results suggest that explicit effects are more pronounced than implicit effects, indicating that a well-designed strategy may encourage longer viewing times. Understanding the time course of these effects will help optimize the design of GHWs to evoke key attitudinal outcomes. In addition, examining how repeated presentation times influence familiarity and responses to GHWs may inform strategies for maintaining their long-term effectiveness. Additionally, further research could manipulate repeated vs. single presentation times of GHWs in order to assess how familiarity influences implicit ant explicit responses.

In addition, our research encourages the measure of RTs to model and predict the formation of explicit judgments and long-term attitudes related to smoking should be encouraged. RTs as a measure of evidence accumulation highlights the need to include the decision time in future models to develop accurate accounts of the transition from implicit to explicit processing.

Effective GHWs should consider both automatic responses and explicit judgments. Strategies that generate explicit effects through longer exposure times and engaging content can enhance their impact, ensuring GHWs continue to play a critical role in deterring smoking. Additionally, future research should assess the implicit emotional valence of GHWs prior to their public release. This strategy could supplement usual GHWs validation methods, as questionnaires and explicit ratings, providing a more comprehensive evaluation of their potential success.

References

Bansal-Travers, M., Hammond, D., Smith, P., & Cummings, K. M. (2011). The impact of cigarette pack design, descriptors, and warning labels on risk perception in the U.S. *American journal of preventive medicine*, 40(6), 674–682. https://doi.org/10.1016/j.amepre.2011.01.021

Barton, A. (2013). How tobacco health warnings can foster autonomy. *Public Health Ethics*, *6*(2), 207-219. https://doi.org/10.1093/phe/pht011

Bekalu, M. A., Ramanadhan, S., Bigman, C. A., Nagler, R. H., & Viswanath, K. (2018). Graphic and arousing? Emotional and cognitive reactions to tobacco graphic health warnings and associated quit-related outcomes among low SEP population groups. *Health Communication*, *34*(7), 726-734. https://doi.org/10.1080/10410236.2018.1434733

Benartzi, S., Beshears, J., Milkman, K. L., Sunstein, C. R., Thaler, R. H., Shankar, M., ... & Galing, S. (2017). Should governments invest more in nudging? *Psychological science*, *28*(8), 1041-1055.

Berkovich, R., & Meiran, N. (2024). Both pleasant and unpleasant emotional feelings follow Weber's law but it depends how you ask. *Emotion*, *24*(5) 1180-1189. https://doi.org/10.1037/emo0001343

Bogliacino, F., Codagnone, C., Veltri, G. A., Chakravarti, A., Ortoleva, P., Gaskell, G., Ivchenko, A., Lupianez-Villanueva, F., Mureddu, F., & Rudisill, C. (2015). Pathos & ethos: Emotions and willingness to pay for tobacco products. *PLoS ONE*, *10*(10). https://doi.org/10.1371/journal.pone.0139542

Brown, S., & Heathcote, A. (2008). The simplest complete model of choice response time: Linear ballistic accumulation. *Cognitive Psychology*, 57, 153-178. https://doi.org/10.1016/j.cogpsych.2007.12.002

Chartrand, T. L., Van Baaren, R. B., & Bargh, J. A. (2006). Linking automatic evaluation to mood and information processing style: Consequences for experienced affect, impression formation, and stereotyping. *Journal of Experimental Psychology. General*, *135*(1), 70-77. https://doi.org/10.1037/0096-3445.135.1.70

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, *58*(6), 1015–1026. https://doi.org/10.1037/0022-3514.58.6.1015

Coleman, S. (1996). The Minnesota income tax compliance experiment: State tax results.

Corneille, O., & Hütter, M. (2020). Implicit? What do you mean? A comprehensive review of the delusive implicitness construct in attitude research. *Personality and Social Psychology Review*, *24*(3), 212-232. https://doi.org/10.1177/1088868320911325

Cox, L. S., Tiffany, S. T., & Christen, A. G. (2001). Evaluation of the brief questionnaire of smoking urges (QSU-brief) in laboratory and clinical settings. *Nicotine & tobacco research: official journal of the Society for Research on Nicotine and Tobacco*, *3*(1), 7–16. https://doi.org/10.1080/14622200020032051

De Neys, W. (2017). Dual process theory 2.0. In Dual Process Theory 2.0. https://doi.org/10.4324/9781315204550 OK

Drovandi, A., Teague, P. A., Glass, B., & Malau-Aduli, B. (2019). Smoker perceptions of health warnings on cigarette packaging and cigarette sticks: A four-country study. *Tobacco induced diseases*, *17*, 23. https://doi.org/10.18332/tid/104753

Evans, A. T., Peters, E., Shoben, A. B., Meilleur, L. R., Klein, E. G., Tompkins, M. K., Romer, D., & Tusler, M. (2017). Cigarette graphic warning labels are not created equal: They can increase or decrease smokers' quit intentions relative to text-only warnings. *Nicotine & Tobacco Research*, *19*(10), 1155–1162. https://doi.org/10.1093/ntr/ntw389

Evans, J. S. B. T., & Stanovich, K. E. (2013). Dual-process theories of higher cognition: Advancing the debate. *Perspectives on Psychological Science, 8*(3), 223–241. https://doi.org/10.1177/1745691612460685

Erceg-Hurn, D. M., & Steed, L. G. (2011). Does exposure to cigarette health warnings elicit psychological reactance in smokers? *Journal of applied social psychology*, *41*(1). https://doi.org/10.1111/j.1559-1816.2010.00710.x

Fischer, S., Drosopoulos, S., Tsen, J., & Born, J. (2006). Implicit learning–explicit knowing: A role for sleep in memory system interaction. *Journal of Cognitive Neuroscience*, *18*(3), 311-319. https://doi.org/10.1162/jocn.2006.18.3.311

Fong, G. T., Hammond, D., Jiang, Y., Li, Q., Quah, A. C. K., Driezen, P., & Yan, M. (2010). Perceptions of tobacco health warnings in China compared with picture and text-only health warnings from other countries: An experimental study. *Tobacco Control*, *19*(Supplement 2), i69–i77. https://doi.org/10.1136/tc.2010.036483

Francis, D. B., Hall, M. G., Noar, S. M., Ribisl, K. M., & Brewer, N. T. (2017). Systematic review of measures used in pictorial cigarette pack warning experiments. *Nicotine & Tobacco Research*, *19*(10), 1127-1137. https://doi.org/10.1093/ntr/ntx082

Frensch, P. A., & Runger, D. (2003). Implicit learning. *Current Directions in Psychological Science*, *12*(1), 13–18. https://doi.org/10.1111/1467-8721.01213

Gantiva, C., Sotaquirá, M., Chaparro, V., Colorado, L., & Gómez, A. (2022). Emotional impact of graphic health warnings on tobacco packaging: Analysis of their content. *Europe's Journal of Psychology*, *18*(1), 40–52. https://doi.org/10.5964/ejop.2885

Graf, P., & Schacter, D. L. (1985). Implicit and explicit memory for new associations in normal and amnesic subjects. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *11*(3), 501. http://dx.doi.org/10.1037/0278-7393.11.3.501

Hall, M. G., Sheeran, P., Noar, S. M., Boynton, M. H., Ribisl, K. M., Parada, H., Jr, Johnson, T. O., & Brewer, N. T. (2018). Negative affect, message reactance and perceived risk: How do pictorial cigarette pack warnings change quit intentions? *Tobacco control*, *27*(e2), e136–e142. https://doi.org/10.1136/tobaccocontrol-2017-053972

Hammond, D. (2011). Health warning messages on tobacco products: A review. *In Tobacco Control*, *20*(5), 327–337. https://doi.org/10.1136/tc.2010.037630

Hammond, D., Fong, G. T., Borland, R., Cummings, K. M., McNeill, A., & Driezen, P. (2007). Text and Graphic Warnings on Cigarette Packages: Findings from the International Tobacco Control Four Country Study. American Journal of Preventive Medicine, 32(3), 202-209. https://doi.org/10.1016/j.amepre.2006.11.011

Heatherton, T. F., Kozlowski, L. T., Frecker, R. C., & Fagerstrom (1991). The Fagerström test for nicotine dependence: A revision of the Fagerstrom Tolerance Questionnaire. British *Journal of Addiction*, *86*(9), 1119-1127. https://doi.org/10.1111/j.1360-0443.1991.tb01879.x

Hoffman, S. J., & Tan, C. (2015). Overview of systematic reviews on the health-related effects of government tobacco control policies. *BMC Public Health*, *15*(1). https://doi.org/10.1186/s12889-015-2041-6

Hollands, G. J., Marteau, T. M., & Fletcher, P. C. (2016). Non-conscious processes in changing health-related behaviour: A conceptual analysis and framework. *Health Psychology Review*, *10*(4), 381-394. https://doi.org/10.1080/17437199.2015.1138093

Jansen, C., van den Berg, M., & Buurman, C. (2006). Effects of adding images to verbal warnings on cigarette packages. Information and document design: Varieties on recent research, 7, 129. In Carliner, S.; Waele, C. de; Verckens, J.P. (ed.), Information and Document Design: Varieties on Recent Research, pp. 129-147

Kahneman, D. (2003a). A psychological perspective on economics. *American economic review*, *93*(2), 162-168. http://www.jstor.org/stable/3132218

Kahneman, D. (2003b). Maps of bounded rationality: Psychology for behavioral economics. *American Economic Review*, *93*(5), 1449-1475. http://www.jstor.org/stable/3132137

Kolodko, J., Read, D., & Taj, U. (2016). Using Behavioural Insights to Reduce Littering in the UK. Nudgeathon, sl.

Kovács, R. (2021). Public health policy: Nudge theory in a discourse of behavioural economics. *Socio-Economic and Humanities Studies*, *14*(2), 57–86. https://doi.org/10.61357/sehs.v14i2.32

Lin, Y., Osman, M., & Ashcroft, R. (2017). Nudge: Concept, effectiveness, and ethics. *Basic and Applied Social Psychology*, *39*(6), 293–306. https://doi.org/10.1080/01973533.2017.1356304

Madera-Carrillo, H., Zarabozo, D., Ruiz-Díaz, M., & Berriel-Saez, P. (2015). El Sistema Internacional de Imágenes Afectivas (IAPS) en población mexicana. Guadalajara, México: Universidad de Guadalajara.

Macy, J. T., Chassin, L., Presson, C. C., & Yeung, E. (2016). Exposure to graphic warning labels on cigarette packages: Effects on implicit and explicit attitudes towards smoking among young adults. *Psychology & Health*, *31*(3), 349-363. https://doi.org/10.1080/08870446.2015.1104309

Noar, S. M., Hall, M. G., Francis, D. B., Ribisl, K. M., Pepper, J. K., & Brewer, N. T. (2016). Pictorial cigarette pack warnings: A meta-analysis of experimental studies. *Tobacco control*, *25*(3), 341-354. http://dx.doi.org/10.1136/tobaccocontrol-2014-051978

Pang, B., Saleme, P., Seydel, T., Kim, J., Knox, K., & Rundle-Thiele, S. (2021). The effectiveness of graphic health warnings on tobacco products: A systematic review on perceived harm and quit intentions. *BMC Public Health*, *21*(1). https://doi.org/10.1186/s12889-021-10810-z

Parada, H., Hall, M. G., Boynton, M. H., & Brewer, N. T. (2017). Trajectories of responses to pictorial cigarette pack warnings. *Nicotine & Tobacco Research*, *20*(7), 876-881. https://doi.org/10.1093/ntr/ntx182

Payne, B. K., Burkley, M. A., & Stokes, M. B. (2008). Why do implicit and explicit attitude tests diverge? The role of structural fit. *Journal of Personality and Social Psychology*, *94*(1), 16–31. https://doi.org/10.1037/0022-3514.94.1.16

Payne, B. K., Cheng, C. M., Govorun, O., & Stewart, B. D. (2005). An inkblot for attitudes: Affect misattribution as implicit measurement. Journal of Personality and Social Psychology, 89(3), 277–293. https://doi.org/10.1037/0022-3514.89.3.277

Perkins, H. W. (Ed.). (2003). The social norms approach to preventing school and college age substance abuse: A handbook for educators, counselors, and clinicians. Jossey-Bass/Wiley.

Peters, E., Romer, D., Slovic, P., Jamieson, K. H., Wharfield, L., Mertz, C. K., & Carpenter, S. M. (2007). The impact and acceptability of Canadian-style cigarette warning labels among US smokers and nonsmokers. *Nicotine & Tobacco Research*, *9*(4), 473-481. https://doi.org/10.1080/14622200701239639

Sánchez-Mora, J., & Tamayo, R. M. (2021). From incidental learning to explicit memory: The role of sleep after exposure to a serial reaction time task. *Acta Psychologica*, 217, 103325. https://doi.org/https://doi.org/10.1016/j.actpsy.2021.103325

Schacter, D. L., & Graf, P. (1986). Effects of elaborative processing on implicit and explicit memory for new associations. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 12(3), 432. http://dx.doi.org/10.1037/0278-7393.12.3.432

Schultz, P. W., Nolan, J. M., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2007). The constructive, destructive, and reconstructive power of social norms. *Psychological Science*, *18*(5), 429-434. https://doi.org/10.1111/j.1467-9280.2007.01917.x

Simon, H. A. (2000). Bounded rationality in social science: Today and tomorrow. In *Mind & Society* (Vol. 1). www.irpublicpolicy.ir

Smith, C. T., & De Houwer, J. (2015). Hooked on a feeling: Affective anti-smoking messages are more effective than cognitive messages at changing implicit evaluations of smoking. *Frontiers in psychology*, 6, 1488. https://doi.org/10.3389/fpsyg.2015.01488

Slovic, P. (2001). Cigarette smokers: Rational actors or rational fools? In P. Slovic (Ed.), *Smoking: Risk, perception, & policy* (p. 97–124). Sage Publications, Inc. https://doi.org/10.4135/9781452232652.n6

Slovic, P. (2003). Affect, analysis, adolescence, and risk. In D. Romer (Ed.), *Reducing adolescent risk: Toward an integrated approach* (pp. 44-48). Thousand Oaks, CA: Sage.

Tiffany, S. T., & Drobes, D. J. (1991). The development and initial validation of a questionnaire on smoking urges. *British journal of addiction*, *86*(11), 1467–1476. https://doi.org/10.1111/j.1360-0443.1991.tb01732.x

Thaler, R. H., & Ganser, L. J. (2015). Misbehaving: The making of behavioral economics. New York: WW Norton.

Thaler, R. H., & Sunstein, C. R. (2009). *Nudge: Improving decisions about health, wealth, and happiness*. Penguin.

Wang, A. L., Lowen, S. B., Romer, D., Giorno, M., & Langleben, D. D. (2015). Emotional reaction facilitates the brain and behavioural impact of graphic cigarette warning labels in smokers. Tobacco control, 24(3), 225-232. http://dx.doi.org/10.1136/tobaccocontrol-2014-051993

Warrington, E. K., Weiskrantz, L. (1968). New method of testing long-term retention with special reference to amnesic patients. *Nature Publishing Group*, *217*, 972–974. ↓

Wiers, R. W., & Stacy, A. W. (Eds.). (2006). *Handbook of implicit cognition and addiction*. Sage

Weiskrantz, L., & Warrington, E. K. (1979). Conditioning in amnesic patients. *Neuropsychologia*, *17*(2), 187–194. https://doi.org/10.1016/0028-3932(79)90009-5

Willingham, D. B., & Goedert-Eschmann, K. (1999). The relation between implicit and explicit learning: Evidence for parallel development. *Psychological Science*, *10*(6), 531–534. https://doi.org/10.1111/1467-9280.00201