IT'S DIFFERENT WHEN WE'RE TOGETHER: THE IMPACT OF EXPERIENCING A PEAK-PROVOKED CIGARETTE CRAVING STATE WITH A SMOKING FRIEND

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Cigarette craving predicts relapse to smoking, which remains the leading cause of preventable death in the United States. Understanding why individuals choose to smoke has important clinical implications and is a research priority. Ecological momentary assessment studies reveal that social factors, such as the presence of other people, affect the craving experience, yet laboratory smoking research has largely ignored these factors by testing participants in isolation. In this study, a shared reality framework aimed to broaden the set of responses related to craving, and in particular to evaluate social processes that may change when smokers experience craving while in the presence of a smoking friend compared to when smokers crave alone. Sixty pairs of smoking friends (n = 120) arrived together at the laboratory following a required a 5-hr of smoking abstinence. Participants then underwent an in vivo smoking cue-exposure craving induction either with their friend present or with the friend in the next room. Participants who were together with their smoking friend while craving experienced a greater sense of shared reality and felt closer to their friend than did those who were alone. Though social context did not influence their urge to smoke or craving-related affect, urge was associated with shared reality when participants were together, but not when they were alone. Further, for participants who were together, shared Duchenne smiles were associated with ratings of shared reality. Results highlight potential social motives for smoking (e.g., satisfying epistemic and relational goals), and highlight the need for increased laboratory research on smoking that includes a social context.

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1.0 BACKGROUND

Smoking is the single largest cause of premature death in the United States, having killed more than 20 million Americans over the past half-century [US Department of Health and Human Services (USDHHS), 2014]. Smokers dramatically increase their risk of dying from no fewer than 15 different cancers, are more likely to contract a range of cardiovascular, metabolic, and pulmonary diseases, increasingly suffer from pregnancy and birth complications, and are at increased risk to experience residential fires (USDHHS, 2014). While smoking rates have declined since the first Surgeon General's report on smoking was published in 1964, this trend has slowed in recent years and nearly 40 million Americans continue to smoke (Centers for Disease Control and Prevention, 2016). Pharmacological (e.g., withdrawal) and economic (e.g., poverty) factors are most often considered when investigating the stubborn persistence of smoking (Watkins, Koob, & Markou, 2000; Peretti-Watel, Seror, Constance, & Beck, 2009); however, social contextual factors (e.g., having friends who smoke) also have been identified as an especially powerful determinant of smoking initiation, maintenance, and cessation failure (Dimoff & Sayette, 2016; Poland et al., 2006).

Social context, also referred to as the social environment, has been defined as the "immediate physical surroundings, social relationships, and cultural milieus within which defined groups of people function and interact" (Barnett & Casper, 2001, p. 465). For many years, researchers have recognized that smoking is influenced by social context (Glad & Adesso,

1976). Surveys often find that social factors can increase motivation to smoke (Piper et al., 2004). Field studies relying on electronic diaries find that smokers are especially likely to smoke when socializing (Hatsukami, Morgan, Pickens, & Champagne, 1990). Furthermore, longitudinal research finds that youth smoking is associated with the number of smokers in their social environment (Simons-Morton & Farhat, 2010). Unfortunately, while these findings make a compelling case for the importance of social context, few experimental smoking studies have been designed to test the effect of social contextual factors (Dimoff & Sayette, 2016).

Many social smoking contexts warrant investigation in the laboratory. It is impractical due to power requirements, however, to vary the type of relationship targeted in this initial study (e.g., married couples, nonromantic friends). Therefore, as a first step in this research program, the present study focused on nonromantic same-sex friendships. These friendships are common in the real-world, with some studies finding that over one-third of all cigarettes are smoked with a friend (e.g., Cerrada, Ra, Shin, Dzubur, & Huh, 2016). Moreover, smoking friendships are correlated with important outcomes. For example, smokers with greater versus fewer smoking friends are more likely to self-identify as a smoker, which in turn is associated with heavier smoking, higher dependence on nicotine, and lower intentions to quit smoking (Pulvers et al., 2014). In addition, for individuals attempting to quit smoking, the likelihood of quitting is negatively associated with the number of smoking friends they have (Hitchman, Fong, Zanna, Thrasher, & Laux, 2014; see also Biener, Hamilton, Siegel, & Sullivan, 2010). These findings raise the possibility that smoking friendships may be instrumental for fulfilling multiple goals (e.g., self-identification, bonding), and thereby be especially valued (Orehek, Forest, & Barbaro, 2018). However, due to the lack of experimental research to focus on the social processes

involved in smoking, it remains unclear to what extent, and by which mechanisms smoking friends influence smoking motivation.

One process that may be critical to consider in a social context is affect, which refers to how a stimulus impacts one's mood or emotional state (Russell, 2003), and is thought to be an intrinsic property of psychological phenomena (Duncan & Barrett, 2007). Germane to the proposed study, affective states play a pivotal role in motivating drug use and relapse (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004), and while affect may be evoked by stimuli that are not explicitly social (e.g., the fear of heights), some of the most powerful and compelling affective states that humans experience emerge when they are in the presence of others (Fairbairn & Sayette, 2015; Knobloch, & Metts, 2013).

For decades, researchers have recognized that there is a fundamental difference between being alone and not being alone (e.g., Pliner & Cappell, 1974; Zajonc, 1965). Moreover, some have suggested that the transition from being alone to being in a dyad, or two-person "group," is a more dramatic change than moving from a dyad to a group of three or more people (e.g., Latané, 1981). As noted by Moreland (2010), people tend to experience different, and often more intense affect in dyads than when they are alone. It is not difficult to think of examples in which one person's affective state is directly influenced by another person. Indeed, one may experience anger when insulted by a stranger, or sadness when rejected by a potential romantic partner. However, as detailed in the following section, other people may modulate one's affective experiences in subtler ways as well.

1.1 SHARED REALITY THEORY

It has long been understood that people's affective states are shaped by exchange and contact with others (e.g., Festinger, 1950). Psychology, and the subdiscipline of social psychology in particular, is well-stocked with theories that bid to explain why affect is experienced differently in a social context (e.g., Hatfield, Cacioppo, & Rapson, 1993; Shteynberg, 2015). Shared reality theory has distinguished itself from related theories by describing not just how social sharing occurs, but also *why* it is of profound importance to the human experience. As posited by Hardin and Higgins (1996), people are fundamentally motivated to achieve a valid and reliable understanding of the world, and thereby satisfy basic epistemic needs relating to the verification of knowledge. Shared reality serves as an ongoing process of social verification that can make one's experience of the world feel phenomenologically "objective," as compared to transitory and random (Hardin & Higgins, 1996). In addition to satisfying epistemic needs, social sharing also tends to satisfy relational needs pertaining to, for example, the need to affiliate and feel close to others (Higgins, 2012).

For shared reality to occur, an individual must subjectively perceive that he or she has an inner state about some feature of the world that is in common with what another person is experiencing. Affect is one of many inner states that individuals can share (others include attitudes and judgments), yet it occupies a privileged position within the shared reality framework. Higgins (2016) described the sharing of affect as the very first phase of shared reality development, occurring in children as young as 6–12 months. While new forms of sharing emerge at subsequent phases of development, the sharing of affect remains an essential tool for shared reality construction across the lifespan (Higgins, 2016). In addition to creating a shared reality, perceiving that another person shares feelings toward something can intensify how those

feelings are experienced. That is, when one person verifies another's affect, the latter perceives that affect to be more of an objective reality, and therefore more intense (Higgins, 2016).

It is thought that nonverbal behaviors such as facial expressions can serve as shared reality cues that help interaction partners to infer a commonality of inner states (Echterhoff et al., 2009). However, shared reality studies have tended to focus only on overt verbal communication (see Echterhoff & Higgins, 2017). Nevertheless, work from outside the shared reality literature suggests that the expression of affect within a dyadic context can satisfy relational needs. Much of this work has focused on how positive expressions can increase feelings of closeness to an interaction partner (e.g., Fredrickson, 2001), yet even negative expressions have been shown to increase such feelings (e.g., Graham, Huang, Clark, & Helgeson, 2008). Irrespective of valence, affective expressions appear to produce the most relational benefits when they are synchronous (i.e., shared by each partner at about the same time; Chartrand & Bargh, 1999; Fairbairn, Sayette, Aalen, & Frigessi, 2015), which fits within a shared reality framework, as synchronous expressions are likely to highlight how partners are experiencing a common inner state about a given referent. This work raises the possibility that shared nonverbal expressions may serve as building blocks for shared reality construction, especially in situations laden with affect.

Because addiction theorists often consider craving to be a type of affective experience (see Baker, Morse, & Sherman, 1987; Sayette, 2016), there is a possibility that cravings, like other affective states, may increase smokers' sense of shared reality when experienced together. Recognizing a social function of craving would have important implications for addiction researchers because, as detailed in the following section, craving is a central feature of addiction.

1.2 CRAVING

Craving has been defined as a drug acquisitive affective state motivating drug use (Sayette et al., 2000). Thousands of studies have been published on cigarette craving (Tiffany & Wray, 2012), and craving is now included as a diagnostic criterion for tobacco use disorder in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 2013). With few exceptions (e.g., Perkins, 2009), it generally is agreed upon that craving is a useful construct for researchers and clinicians alike (Sayette, 2016). Craving is thought to be important in part because it has been shown to predict smoking behavior. For example, craving scores reported in the laboratory have been shown to predict real-world behavioral outcomes such as smoking rates (Carpenter et al., 2009) and time to first lapse (Waters et al., 2004, see Sayette & Tiffany, 2013). However, research indicates that craving is more than just a proxy for drug use behavior. Indeed, as demonstrated by Robinson and Berridge (1993), the neural substrates of drug craving differ from those underlying actual drug use, suggesting that the construct of craving is important to understand in its own right. Accordingly, investigating the effects of craving (e.g., on other affective states, cognitions, behaviors), and examining the ways in which various contexts alter the craving experience, would broaden our understanding of craving and offer new directions for both preventing and treating addictive disorders (Sayette, 2016).

Craving is thought to be fundamentally affective in nature (Baker et al., 1987; Sayette et al., 2003a). Traditionally, craving—and cigarette craving in particular—has been viewed as an unpleasant affective state (see Piasecki et al., 2000). However, Baker and colleagues (Baker et al., 1987) have suggested that the affective "tone" of craving can be positive when elicited by appetitive (vs. aversive) stimuli (e.g., information that smoking is imminent). Thus, there is a

growing sentiment among researchers that craving may hold equivalent, if not greater, reinforcing value than drug use behavior due to classical conditioning processes (Bradford et al., 2015), and thereby serve as a more psychologically relevant aspect of addiction than drug use itself (Baker et al., 1987). Germane to the proposed study, it has been demonstrated that positive affective states (e.g., excitement) can be elicited by photographs of people around whom one typically smokes (Conklin et al., 2013). If the presence of a real-world smoking friend were to influence one's experiences while craving, it would provide support for the idea that craving can include an interpersonal component (Sayette, 2016), and that the cravings of interaction partners are not independent.

Furthermore, should experiencing a discrete craving state with a friend who is perceived to be craving as well (hereafter referred to as *shared craving*) be shown to satisfy epistemic and relational needs (e.g., by helping smoking friends to verify their craving experience), it would highlight potentially "hidden" motives for continued smoking. Indeed, to the extent that shared cravings are found to increase one's sense of shared reality and perceived interpersonal closeness, smoking with a partner could be considered an efficient means of satisfying the concurrent goals of bolstering one's social resources while anticipating smoking, and reducing one's symptoms of nicotine withdrawal while actually smoking. This, in turn, would make smoking a doubly difficult behavior to resist, as individuals tend to favor a single means capable of satisfying multiple goals (Orehek & Vazeou-Nieuwenhuis, 2013).

To summarize, craving is a critical component of addiction, distinct from actual drug use behavior. Many theories hold that craving is a multidimensional affective state, intertwined with other affective states and physiological processes. However, most laboratory smoking studies have focused on a narrow range of craving experiences (often associated with frustration). It is

possible that traditional craving induction procedures, and the asocial contexts in which they have been administered, may not be broad enough to generate the variety of craving-related responses found outside the laboratory.

1.2.1 Craving induction procedures

A common approach to studying cigarette craving in the laboratory is to expose smokers to cues associated with smoking (e.g., by holding a lit cigarette, looking at images of cigarettes; Conklin et al., 2015; Sayette et al., 2000), and then ask them to rate their urge to smoke. Research using these procedures focuses largely on the difference between craving ratings reported during smoking cue-exposure and those reported during an abstinence-based "baseline" assessment, which is assumed to reflect cue-induced craving. However, it has been suggested that this approach may underestimate the effect of smoking cue-exposure on self-reported craving due to issues with its "baseline" assessment (Sayette & Tiffany, 2013). Specifically, completing a "baseline" craving questionnaire in a laboratory that is rich with smoking cues while in a nicotine-deprived state may serve as a cue in itself for smokers, making it difficult to show increases in craving related to the explicitly manipulated smoking cue. (In other words, some of what is picked up at "baseline" is also cued.) Conversely, cue-induced craving effects may appear to be strong even when the absolute level of craving is clinically unremarkable, as in studies for which smokers are not deprived of nicotine (Sayette & Tiffany, 2013).

In light of these concerns, Sayette and Tiffany (2013) proposed an alternative, peak-provoked craving approach that relies on both nicotine deprivation and exposure to explicit smoking cues, which can create powerful craving states when combined. This approach assumes that it is often unfeasible (if not misguided) to disentangle the abstinence-based and cue-induced

components of cigarette craving; therefore, it does not focus on the difference between craving ratings collected at baseline and those collected during smoking cue-exposure. Rather, the peak-provoked craving approach focuses entirely on the craving ratings reported during smoking cue-exposure, at which time abstinent smokers are likely to be experiencing a peak craving state. Importantly, unadjusted craving ratings reported during peak craving states have been shown to predict clinical outcomes such as first-week lapsing and time to first lapse in individuals attempting to quit smoking (Waters et al., 2004), suggesting that the peak-provoked craving approach is ecologically valid and clinically relevant.

While the peak-provoked craving approach seeks to create a "critical mass" of craving influences, peak craving states generated in lab studies are not uniformly overwhelming. Rather, there is evidence suggesting that a smoker's experience of craving, even when he or she is in a peak craving state, may vary when studies account for contextual factors such as motivation to quit smoking and/or the perceived opportunity to smoke soon (Sayette & Dimoff, 2016; Wertz & Sayette, 2001). However, despite calls to better account for social contextual factors in laboratory smoking studies (Dimoff & Sayette, 2016; Poland et al., 2006), the scope of peak-provoked craving studies has thus far been limited to *asocial* contextual factors, or factors assessed when smokers are tested in isolation.

To my knowledge, no published laboratory studies have tested for an effect of social context (e.g., the presence vs. absence of another smoker) using a craving induction or any other procedure related to anticipation (e.g., the marshmallow test; Mischel, Shoda, & Rodriguez, 1989; Mischel, 2014; see also Watts, Duncan, & Quan, 2018). It is important to test for this effect because craving often may include a social component, consistent with early medieval usages of craving as an interpersonal construct (Sayette, 2016). In addition, laboratory research

that explicitly targets social processes would permit investigators to ask novel questions about traditional craving measures (e.g., urge and affect experienced during a peak craving state), and to study non-traditional "social" measures (e.g., shared reality, perceived closeness toward a smoking friend) that may be influenced by sharing a peak craving state. Changes on these dimensions due to social factors would suggest that craving-related responses, long thought to be driven solely by *intra*personal processes (e.g., nicotine withdrawal), are also sensitive to the interpersonal context in which they occur.

1.2.2 Craving-related inner states

Craving generally is defined as a desire to acquire or use a drug, yet there is still some debate about this definition (Sayette et al., 2000). For instance, Marlatt (1985) has suggested that "craving" ought to be defined as the desire for the effects of a drug, rather than the drug itself. There also has been discussion about which variables measure craving and which variables measure the *effects* of craving (e.g., on affect; see Sayette et al., 2000). While these issues remain important for the field to consider, in the present study I distinguished urge to smoke and craving-related affect from social processes (shared reality, perceived interpersonal closeness) and facial expressions, which could be considered consequences of craving.

1.2.2.1 Urge to smoke

Self-reported measures of urge are generally considered to be the gold standard for measurement in laboratory craving studies (Sayette et al., 2000). Indeed, self-reported measures of urge have been related to a range of smoking phenomena (e.g., latency to smoke, number of puffs; Conklin et al., 2015) and seem to be more sensitive to changes in craving as assessed in the laboratory

than a variety of physiological measures (e.g., heart rate, sweat gland activity; Carter & Tiffany, 1999). Furthermore, self-reported measures of urge allow for linkage between laboratory and field studies, which have used ecological momentary assessment techniques to associate self-reported urge with social contextual factors (e.g., smokers report more intense craving when they are with other smokers than when they are alone; Dunbar et al., 2010).

While there is evidence to suggest that social context influences the urge to smoke, it is unclear to what extent this effect is mediated by interpersonal processes, sensory cues, or a combination of both (cf. Shiffman et al., 2002; Shiffman et al., 1996). Modeling may be one interpersonal process by which social context influences the smoking experience (Dimoff & Sayette, 2016; Shiffman et al., 1996), which is consistent with results reported in the alcohol and food literatures (e.g., Spanos, Vartanian, Herman, & Polivy, 2014). In addition, as suggested earlier, social context also may influence urge by providing smokers with explicit cues to smoke (Conklin et al., 2013; Shiffman et al., 2002). Indeed, an interaction partner who also is craving to smoke may serve as a different, and perhaps more potent cue than, for example, a lit cigarette presented in isolation.

1.2.2.2 Craving-related affect

There has been extensive research on craving and affect. As noted previously, certain theories posit that craving is a form of affect (e.g., Baker et al., 2004), whereas other theories draw a distinction between craving and affective processes (e.g., Tiffany, 1990). All these possibilities have received some degree of support, as measures of urge and affect are often correlated (Tiffany, 2009). Like urge, affect has been assessed most often by using self-report measures (e.g., Carter & Tiffany, 2001). These measures are limited in that they must be brief to minimize interference with the craving manipulation, which is sensitive to even minor changes in latency

(see Sayette et al., 2003b). While measures of urge and affect have performed well in traditional studies of cigarette craving, they alone are unlikely to assess the full range of craving-related responses in a social context, as they do not account for uniquely "social" phenomena (e.g., the expression of affect to an interaction partner). For this reason, social smoking studies also call for an expressive–behavioral approach to unobtrusively assess responses to cigarette cues, which, as described in the following section, has already been adopted by some smoking researchers.

1.2.3 Facial expressions

Facial expressions are thought by many to arise from discrete affective states (Ekman, 2016). This position has received support from classic research showing the universality of some facial expressions (e.g., Ekman & Friesen, 1969; Izard, 1971). However, other research has shown that the link between "universal" facial expressions and affect is looser than one might expect, in part because it is sensitive to social-contextual factors (e.g., cultural norms; Russell, 1994). Critics of the traditional affective interpretation of facial expressions have gone so far as to suggest that these expressions are primarily signaling behaviors intended to satisfy social motives (e.g., affiliation), of which affect is an unnecessary component (e.g., Barrett, 2014; Fridlund, 1997). As Fridlund (1997) notes, "[e]xperimental methods that isolate subjects in order to observe 'emotional expressions' merely disguise the sociality that governs them" (p. 124).

Sayette and colleagues have used the *Facial Action Coding System* (FACS; Ekman, Friesen, & Hager, 2002) to identify facial expressions elicited in both isolated and social contexts. They have observed that participants' facial expressions generally correspond to self-reported affect (e.g., Sayette & Hufford, 1995, 1997; Sayette et al., 2003b) while also relating to

social motives (e.g., bonding) in group paradigms (Sayette at al., 2012). Taken together, these findings suggest that facial expressions may reflect both affective experience and communication displays.

Germane to the present study, FACS can detect subtle facial expressions, and its use during brief craving inductions can provide information that otherwise could go unnoticed. Moreover, because FACS can reliably code rapid changes in the expressive behavior of interaction partners, it is ideal for assessing dynamic social processes (Fairbairn et al., 2015). While FACS offers a level of precision that self-report measures lack, the concurrent use of these assessments is needed to comprehensively evaluate how individuals are experiencing a peak craving state. Furthermore, novel measures with explicit social relevance also are needed to assess craving-related responses in a social context. The following measures appear to be well-suited for this purpose.

1.3 SOCIAL PROCESSES

1.3.1 Shared reality

Shared reality can be both manipulated and measured, yet it typically has been used as a manipulation (e.g., by altering the attitudes of a confederate and then assessing the attitudes expressed by a naïve "partner" participant; Sinclair, Huntsinger, Skorinko, & Hardin, 2005). Studies using this type of manipulation have produced valuable insights about the sharing of "cold" cognitive phenomena, but they have generally ignored the sharing of "hot" affective states. Moreover, the use of confederates thus far has prevented researchers from learning how

naturally-occurring processes (e.g., mutual facial expressions) contribute to the construction of shared reality. Despite the challenges associated with using only actual (i.e., non-confederate) participants in experimental settings, there is evidence that such spontaneous, unscripted interactions offer valuable tests of affective experience (Fairbairn & Sayette, 2014).

Cigarette craving appears to be an ideal affective experience to be studied within a shared reality framework. The peak-provoked craving approach floods smokers with a powerful set of target referents—an *in vivo* smoking cue paired with nicotine deprivation—about which smoking partners could create a shared reality should they experience the craving induction together. Furthermore, peak craving states are often accompanied by powerful facial reactivity in smokers expecting to smoke soon (see Sayette & Hufford, 1995; Sayette et al., 2003b), which could facilitate the construction of shared reality because "people draw on various aspects of others' nonverbal behavior, such as their facial expressions and gestures, to intuit their feelings, needs, and intentions" (Echterhoff et al., 2009, p. 498). It follows, then, that smokers who experience a craving induction with another person could infer from each other's nonverbal behaviors (e.g., Duchenne smiles) how they are feeling during the induction, and the degree to which their feelings are shared.

As the preceding information suggests, there are compelling reasons for studying craving within a shared reality framework. The smoking literature would benefit from having a comprehensive theoretical model with which to evaluate the impact of social context on cigarette craving, and conversely the shared reality literature would benefit from expanding the scope of its experimental investigations to include fundamentally affective inner states related to craving (urge, affect). Moreover, each literature would benefit from learning whether interaction partners

benefit from sharing an affective experience, which, as discussed in the following section, would most likely manifest in their subjective perceptions of the partnership.

1.3.2 Perceived closeness

Closeness has been conceptualized as the extent to which each member of a relationship includes in their self-schemata the other person's resources, perspectives, and identities (Aron, Aron, & Smollan, 1992; Aron, Mashek, & Aron, 2004). It has been posited that people are motivated to seek closeness in relationships, which is consistent with the perspective that maintaining and strengthening relationships is a fundamental goal (Baumeister & Leary, 1995; Kopietz & Orehek, 2015). Perceptions of closeness can fluctuate for a variety of reasons. As stated previously, the expression of affect tends to increase feelings of closeness among partners (e.g., Fredrickson, 2001). Further, people tend to feel closer to partners who are thought to be instrumental (vs. non-instrumental) for highly salient goals (Fitzsimons & Fishbach, 2010; Fitzsimon & Shah, 2008). Taken together, these findings suggest that sharing a peak craving state may promote closeness because these states tend to evoke facial expressions associated with affect (e.g., Duchenne smiles), and to make salient the goal of smoking—a goal that real-world smoking friends have presumably helped one another to satisfy on countless occasions (e.g., by going on smoke breaks together).

As noted previously, shared reality can satisfy relational motives such as feeling close to others (Echterhoff et al., 2009). While it is thus tempting to surmise that shared reality and interpersonal closeness are related concepts, no study to my knowledge has yet to include measures of each. In fact, shared reality studies most often include manipulations of closeness, not measures of it (e.g., Echterhoff et al., 2013; Pinel, Long, & Crimin, 2010). These studies

have contributed to the field's understanding of how, for example, individuals "tune" their messages to in- versus out-group members (e.g., Echterhoff et al., 2017); however, they offer little insight into how people's senses of shared reality and interpersonal closeness may fluctuate in response to manipulations of social context, and/or dynamic social-affective processes occurring within an unscripted interaction.

In summary, research employing a variety of study designs suggests that social context may influence smokers' urge to smoke and their craving-related affect. Shared reality theory provides a conceptual framework within which to consider social-affective processes, and it suggests that the sharing of a peak craving state may help interaction partners to construct a common reality and to feel closer to one another. As discussed in the following section, the present study aims to investigate whether, and to what extent these effects are observed in the context of experiencing a peak craving state in the presence or absence of a smoking friend.

1.4 PRESENT STUDY

There is a pressing need for experimental research that better integrates social contextual factors into traditional smoking study paradigms (Dimoff & Sayette, 2016; Sayette, 2016). The present experiment sought to initiate this process by studying pairs of nonromantic same-sex smoking friends, who experienced a peak-provoked craving (combining smoking abstinence and smoking cue-exposure) either together or in isolation, to test a central tenet of shared reality theory that to my knowledge had not been tested—namely, that individuals use affective states such as craving to construct shared reality.

The overarching aim of this study was to test for differences between being alone and not being alone—in this case, being together with a smoking friend—on social processes (shared reality, perceived interpersonal closeness), inner states related to craving (urge, affect), and facial expressions (smiles). By using an explicitly "social" paradigm, I was able to ask a new set of questions pertaining to the experience of a craving state across a range of measures, some of which had not yet been used to investigate craving. Consequently, this study aimed to begin to evaluate as yet unrecognized characteristics and functions of craving, and more generally, to draw attention to the importance of social factors. Consistent with this broad aim, the present study has the following specific aims:

1.4.1 Aim 1

The first aim was to evaluate the effect of social context on the experience of craving. Outcomes included: (a) two social process measures (self-reported shared reality, closeness), which assessed how participants felt in relation to their friend after the craving experience; (b) two inner state measures (self-reported urge to smoke, craving-related affect), which assessed how participants personally felt during the craving experience; and (c) two facial expression measures (FACS-coded Duchenne smiles, non-Duchenne smiles), which assessed participants' smiling behavior during the craving experience.

I predicted that smokers who were with a real-world smoking friend (vs. alone) during smoking cue-exposure would report that there was greater correspondence between how they and their friend were feeling about their current experiences (i.e., increased shared reality), and that they would feel interpersonally closer to their friend. (I analyzed these two measures first to ensure that the manipulation of social context had an impact on explicitly social processes.) I

also examined the correlation between shared reality and closeness to assess the degree to which these social process measures are distinct.

Consistent with the idea that experiences tend to be amplified when shared, I also predicted that smokers who were with a smoking friend (vs. alone) during smoking cue-exposure would report higher urges to smoke and greater positive affect. In addition, I examined the correlation between urge and affect to assess the degree to which these inner state measures are distinct. Finally, I predicted that smokers who were with a smoking friend during smoking cue-exposure would smile more than smokers who were alone, in part because smokers would feel greater positive affect when together, and in part because facial expressions serve an added communicative role in social contexts.

1.4.2 Aim 2

The second aim was to evaluate whether findings observed in tests of Aim 1 can be attributed to social processes occurring in the Together condition, or whether they are better attributed to mere presence effects. (Note that differences could be observed in tests of Aim 1 that have little to do with social processes and more to do with being alone.) To reduce the potential for spurious findings, I focused on the following moderation and mediation analyses because they are conceptually related to shared reality theory.

1.4.2.1 Moderation analysis

To achieve shared reality, it is not enough for people merely to be together (Echterhoff et al., 2009). Rather, shared reality requires that interaction partners capitalize on the sharing of inner states when they are together. Assuming social context affected shared reality, I planned to test

further whether inner states (i.e., urge and/or affect) moderated this effect. This analysis would help to rule out whether simply *not* being alone influenced targets' sense of shared reality. If moderation were to be detected, a parallel analysis, which replaced shared reality with closeness, would be conducted to evaluate whether this finding was specific to shared reality.

1.4.2.2 Mediation analysis

Shared reality is thought to make inner states feel more objective, and thereby more intense (Echterhoff et al., 2009). If at least one inner state measure was affected by my manipulation of social context, I then planned to test for whether shared reality scores mediated this effect. If mediation were to be detected, a follow-up analysis would replace shared reality with closeness in the model.

1.4.3 Aim 3

Co-occurring nonverbal expressions are thought to communicate a commonality of experience, and to serve as building blocks of shared reality (Echterhoff et al., 2009). Thus, if social context was found to affect smiling behavior as predicted in Aim 1, I would test whether dyadic smiling behavior was associated with targets' sense of shared reality. (This analysis necessarily would be limited to the Together condition, as dyadic smiles cannot occur in the Alone condition.) If an association is observed, I then would test for associations of dyadic smiling and other self-report measures (closeness, urge, affect) to evaluate whether this finding was specific to shared reality. Finally, I would test for associations between these social and inner state measures and *only* targets' smiling, to help rule out the possibility that targets' self-report responses were driven simply by emotional "halo effects" (i.e., individuals who are smiling feel differently than if they

are not smiling, irrespective of their partner's experience) and not necessarily by interpersonal processes.

2.0 METHODS

2.1 PARTICIPANTS

The present study included 120 participants, 60 (30 female) who had completed a larger (parent) study conducted by our research group (targets), and 60 (30 female) nonromantic same-sex friends who did not participate in the parent study. The purpose of the parent study was to test the effectiveness of specific olfactory cues on craving reduction, and to examine whether individual difference factors such as working memory, personality, and motivation to quit smoking moderate the craving-reducing effects of olfactory cues. To complete the parent study, participants had to attend one screening session and two experimental sessions, the latter of which evaluated the durability of odor-induced craving-relief. At each experimental session, participants sampled and rated a series of olfactory cues (e.g., peppermint, tobacco) on several dimensions, including pleasantness and familiarity. They then were exposed to an *in vivo* smoking cue (holding a lit cigarette), and randomly assigned to sniff one of three odor types: the odor they had previously rated as being most pleasant, a tobacco odor they had previously sniffed, or a neutral odor they had previously sniffed. Participants reported on their urge to smoke while sniffing the odor that had been assigned to them, and their facial expressions were assessed by trained coders.

Participants for the present study were recruited via telephone calls and e-mails informing them that they and a nonromantic same-sex friend with whom they regularly smoke were invited to participate in a one-session follow-up study. [Recruitment was limited to nonromantic same-sex friendship dyads, as the present study's design offered low statistical power to detect moderating effects of friendship type (e.g., same-sex vs. mixed-sex friendships.] All participants (including those who had completed the parent study) were screened over the phone to ensure that they were appropriate for use in the present study based on their current smoking patterns. To qualify, participants were required to be between the ages of 18–55 and to smoke an average of 10–30 cigarettes/day for at least 12 continuous months. (Heavier smokers were excluded because prior work suggests they may struggle with tobacco abstinence requirements; see Sayette, Martin, Wertz, Shiffman, & Perrott, 2001.) Participants were excluded if they reported a medical condition that ethically contraindicated nicotine administration, if they were illiterate, or if they were dependent on any drug other than nicotine or caffeine. Participants also were excluded if they planned to quit smoking within the next 30 days because motivation to seek treatment can affect self-reported craving ratings (see Wertz & Sayette, 2001; Sayette & Dimoff, 2016).

2.2 MEASURES

2.2.1 Baseline assessment

Prior to experimental manipulation, participants verbally reported the degree to which they were craving a cigarette using a single-item measure of urge described in the next section. Participants

then completed the *Positive and Negative Affective Schedule* (PANAS; Watson, Clark, & Tellegen, 1988), which is comprised of two 10-item scales assessing current experiences of positive and negative affect, and was used to assess participants' affect prior to experimental manipulation. Participants also completed the *Nicotine Dependence Syndrome Scale* (NDSS; Shiffman, Waters, & Hickcox, 2004), which is a 19-item measure that has been shown to predict craving scores reported after smoking cue-exposure (Donny, Griffin, Shiffman, & Sayette, 2008). Additionally, to account for possible baseline differences in the characteristics of friendships, which could influence the way participants experience a peak craving state when together, participants answered questions assessing how long they have known each other, how close they feel toward one another, how often they smoke together, and whether they live or work together at present.

2.2.1.1 Measures during peak-provoked craving

During smoking cue-exposure, participants first rated their urge to smoke using a single-item, 0–100 scale with 0 = "no urge to smoke at all," and 100 = "the most intense urge to smoke that I have ever felt." They then rated their affect using Carter and Tiffany's (2001) two-item affect assessment, which consists of one positive affect item ("I am happy, joyful, or pleased") and one negative affect item ("I am depressed, angry, worried, or frustrated"). This assessment requires that participants respond to each item independently using 0-10 scales, with 0 = "not at all" and 10 = "very much so." The negative affect item was subtracted from the positive affect item to create a single affect score ranging from extremely negative (-10) to extremely positive (+10).

In addition to assessing self-reported urge and affect, I assessed participants' smiling behavior during smoking cue-exposure using FACS. As noted elsewhere, FACS is a continuous and unobtrusive coding tool with good psychometric properties (Sayette, Cohn Wertz, Perrott, &

Parrott, 2001). For the present study, I coded for facial muscle movements associated with Duchenne (true) and non-Duchenne smiles, which have been linked to craving in studies using comparable designs (Sayette et al, 2003b; see also Sayette & Hufford, 1995). Duchenne smiles include the combined movement of the zygomaticus major muscle (AU 12) and the obicularis oculi muscle (AU 6; Ambadar, Cohn, & Reed, 2009), and have been associated in some studies with "felt" affect (Ekman & Rosenberg, 2005). By contrast, non-Duchenne smiles include the movement of AU 12 alone without the movement of AU 6, and they are often associated with "displayed" (but not felt) affect (Fairbairn et al., 2015). However, as noted earlier, it has been argued that most, if not all facial expressions include an element of "display" (i.e., interpersonal communication) when they occur in a social context (Fridlund, 1997).

2.2.1.2 Measures following peak-provoked craving

Participants next completed an interpersonal closeness inventory comprised of two items: the first item was a measure of perceived closeness adapted from Orehek, Forest, and Wingrove (in press), which requires participants to respond to the question "How close do you feel to your friend right now?" using a 7-point Likert scale (1 = "not close at all," 7 = "extremely close"). The second item was the *Inclusion of Other in the Self Scale* (IOS) (Aron, Aron, & Smollan, 1992), which is a pictorial measure of closeness that requires participants to circle one pair of seven increasingly overlapping circles that best describes their relationship with their friend. The IOS has been shown to have good concurrent validity with lengthier measures of closeness, and it is thought to be ideal for studies in which participants' time is limited (Aron et al., 1992). While this inventory was not designed to assess shared reality *per se*, it nevertheless assessed the relational effects of the study's social context manipulation. The two items comprising this

inventory were later averaged together to create a composite score as others have done (e.g., Fitzsimons & Shah, 2008; Orehek et al., 2018).

After completing the IOS, participants then completed an inventory of shared reality comprised of three items. At present, there is no single accepted measure of shared reality, presumably because the construct of shared reality is too specific to assess using coarse-grained measurement (Echterhoff et al., 2009). Nevertheless, there are certain types of items that appear in most studies of shared reality (e.g., Cheng, Conley, & Ziegler, 2014; Conley, Rabinowitz, & Matsick, 2016; Magee & Hardin, 2010), after which I modeled the items used in the present study: "My friend is feeling the same way I'm feeling," "My friend can relate to my experiences in this study," "My friend wants to smoke as badly as I do." These items were measured on a 10-point scale, with 0 = "strongly disagree" and 10 = "strongly agree." To distinguish it from the interpersonal closeness inventory, the shared reality inventory was designed to more readily assess the epistemic effects of the social context manipulation (i.e., the degree to which respondents perceived a commonality of inner states during the craving induction). The three items comprising this inventory were later summed together to create a composite score.

2.3 PROCEDURES

Procedures were approved by the University of Pittsburgh's Institutional Review Board. Note that from this point, participants who completed the parent study will be referred to as *targets*, while their partners will be referred to as *friends*. (I will continue to use the term *participants* in situations that do not require a distinction between targets and friends.) The present study included two experimental conditions: one in which targets completed the smoking cue-exposure

task with their friend (Together, n = 30), and one in which targets completed this task alone (Alone, n = 30). Importantly, the Together and Alone conditions differed *only* on the basis of whether friends were present or absent during the smoking cue-exposure task. All target–friend dyads, regardless of condition, traveled to the laboratory together and completed questionnaires in separate rooms before and after smoking cue-exposure. Accordingly, questionnaire data were collected from both targets and friends. Only the data of targets were analyzed for tests of primary aims. This approach held constant participants' familiarity with the smoking cue-exposure task, as this was the second exposure to the lab for targets (who completed the parent study) and first for friends. The data of friends remains of interest to me and will be analyzed for research separate from this dissertation.

2.3.1 Baseline

Procedures were modeled after our prior work designed to induce strong cravings (e.g., Sayette & Dimoff, 2016). Sessions began between 3:00 p.m. and 7:00 p.m. Participants were required to bring their preferred brand of cigarettes and lighter to the experimental session, and to abstain from nicotine for at least 5-hr prior to their appointment. Many studies, including ones conducted by our research group (e.g., Sayette et al., 2008), have required participants to abstain for 12-hr or more. However, shorter abstinence periods (e.g., Sayette & Dimoff, 2016; Sayette & Parrott, 1999) are sufficient for generating robust cravings without eliciting such intense withdrawal that non-withdrawal (e.g., social) factors become irrelevant. A 5-hr interval seemed well-suited for the present study, as it has been shown to induce strong urge scores in daily smokers (mean urge rating = 68/100), while still leaving room for scores to vary in response to smoking cues and contextual factors (Sayette & Dimoff, 2016).

Participants were instructed to travel together so that they would arrive to the laboratory at the same time, after which they were placed in separate non-experimental rooms. Once separated, participants rated their urge to smoke and reported the last time they smoked. Next, participants' CO readings were collected and recorded, with CO readings ≤ 20 ppm considered abstinent. (This cutoff point was higher than those used in many other studies because participants in the present study were required to abstain from smoking for a shorter interval than is typically required.) Once abstinence was confirmed, targets were randomly assigned to either the Together or Alone condition, and sex was stratified by condition. Because merely separating individuals may not lead them to feel as though they are engaged in unshared activities (Boothby, Smith, Clark, & Bargh, 2016), it was made explicit to participants assigned to the Alone condition that their friend would be completing a series of tasks unrelated to smoking. Following assignment, targets provided the experimenter with their cigarette pack and lighter, which were placed in a secure room until the cue-exposure procedure. Participants then completed the PANAS, NDSS, and baseline measure of friendship characteristics.

2.3.2 Peak-provoked craving induction

In the Alone condition, targets were moved to the experimental room after baseline assessment, while friends completed questionnaires in a separate room. A tray containing a plastic cover was placed on the desk at which targets were seated, which targets were asked not to touch until instructed. Once the experimenter left the room, targets were asked via intercom to pick up the cover, revealing their cigarettes and lighter, as well as an ashtray. Targets removed a cigarette from their pack and lit it without putting it in their mouths, but rather by holding it in the flame for several seconds until the tobacco started to burn. Targets were reminded that they could not

smoke the cigarette until instructed. They next were told to put down their lighter, to hold their cigarette comfortably in their dominant hand, and to stare at it without placing it in their mouths. The facial expressions of targets were recorded using a digital video camera and later coded using FACS. After 20-sec, targets were instructed to set, but not extinguish their cigarette in an ashtray located on the desk in front of them. Targets then rated their urge to smoke using the same 0–100 scale used at baseline, and their affect using the two-item affect measure described previously. After completing the measures of urge and affect, targets completed questionnaires assessing their closeness and perceptions of shared reality. Targets and friends then were debriefed in separate rooms, paid $30, reimbursed for travel expenses, and told where they could smoke outside the laboratory if they wished to do so before leaving.

The same approach was used in the Together condition, with the following exceptions: Targets *and* friends were moved to the experimental room after baseline assessment, and each was given trays containing the materials noted above. In the experimental room, targets and friends sat at a 90-degree angle from one another, with a small divider placed between them so that they could not see each other's written responses. In addition, they were asked not to talk specifically about their cravings during the cue-exposure task. Lastly, to minimize the potential for awkwardness, targets and friends were moved to separate rooms before being given the questionnaires assessing closeness and shared reality.

2.4 DATA CODING AND ANALYSIS

2.4.1 Facial coding

I used The Observer XT software system (Version 10.5, Noldus Information Technology, Wageningen, The Netherlands) to code digital video footage of participants' facial expressions recorded during smoking cue exposure. [I am a FACS-certified coder.] I assessed positive affect by measuring the duration of participants' Duchenne "enjoyment" smiles—defined by the combination of action unit (AU) 6 ("cheek raiser") and AU 12 ("lip corner puller"; Ekman, 1989). If AU 12 appeared in the absence of AU 6, the expression was scored as a non-Duchenne smile, sometimes referred to as a "social" smile. If AU 12 appeared before AU 6, the expression initially was scored as a non-Duchenne smile in the process of transitioning into a Duchenne smile. In the Together group I also coded shared Duchenne smiles (i.e., those occurring simultaneously between targets and friends) as an index of positive affect at the dyad level, as well as shared non-Duchenne smiles. Consistent with prior work (e.g., Sayette et al., 2012), "trace" levels of AUs were not coded (i.e., those at an "A" intensity; see Ekman et al., 2002). The total duration for each type of smile was calculated in seconds and used in analyses. A second FACS-certified coder assessed reliability for a randomly-selected subset of participants. There were substantial levels of agreement (Cohen, 1960) for Duchenne and non-Duchenne smiles (κs = .91 and .87, respectively).

2.4.2 Analytic approach

Analyses were conducted using IBM SPSS Statistics 25. For all outcome measures, skew was assessed using Kolmogorov–Smirnov and Shapiro–Wilk tests, while heteroscedasticity was assessed using Breusch–Pagan and Koenker tests. Data transformations (detailed in a subsequent section) were used to improve the distribution of measures that violated assumptions of normality and/or homoscedasticity. Tests were conducted to evaluate whether baseline measures varied by condition or correlated with outcome measures. Baseline measures meeting either of these criteria were used as covariates in secondary analyses. As noted earlier, self-report data were analyzed for the 60 target participants who completed the parent study. Facial expression data were analyzed for all targets, and for the 30 friends in the Together condition. Aim 1 was tested using the GLM procedure for analysis of variance, while Aims 2 and 3 were tested using linear regression. [Interactions were tested using a dummy-coding approach with the Alone condition as the reference group (Together: 0 = no, 1 = yes).]

3.0 RESULT

3.1 BASELINE MEASURES

Participants consisted of 120 smokers (60 female, 60 male) aged 18–55. Sixty participants had completed our parent study and were classified as targets, while 60 partner participants were classified as friends. Fifty-eight percent of targets identified themselves as African American, 37% as Caucasian, and 5% as more than one race. On average, targets were 43.5 years old and reported having smoked 15.1 cigarettes per day for the past 14.6 years. [Note that friends reported equivelant ages (average = 42.8 years old) and smoking patterns (15.2 cigarettes per day for 14.0 years).] Participants were excluded from the study if they were illiterate, intended to quit smoking within the next 30 days, or reported a medical condition that contraindicated nicotine. Informed consent was obtained from all participants.

3.1.1 Preliminary analyses

3.1.1.1 Random assignment

Table 1 presents the characteristics of target participants by social context condition. (Note that random assignment resulted in slightly more women being assigned to the Together condition.) Participants in the two conditions were equivalent on age, race, nicotine dependence (assessed via NDSS), number of cigarettes per day, and years smoking at current rate. Groups did not

differ on time since last cigarette or on CO readings at study outset. Participants randomly assigned to the Together and Alone conditions did not vary on urge or affect at baseline, or on responses to questions about friendship characteristics.

3.1.1.2 Tests of normality

Negative skew was detected for urge, interpersonal closeness, and shared reality, while positive skew was detected for Duchenne and social smiles. Negatively skewed measures were squared, while positively skewed measures required cube root transformations. Once transformed, all outcome measures fell within acceptable ranges of normality and tested negative for heteroscedasticity.

3.1.1.3 Items used to create composite scores

As shown in Table 2, the three items comprising the shared reality inventory were all correlated with one another. Additionally, the two items comprising the interpersonal closeness inventory were highly correlated, $r = .83$, $p < .001$, while positive and negative affect were inversely correlated, $r = -.43$, $p < .01$.

3.2 TESTS OF HYPOTHESES

3.2.1 Tests of Aim 1

A correlation matrix revealed that each of the four outcome measures (shared reality, closeness, urge, affect) was associated with at least one baseline measure (see Table 3). For this reason, two

analyses were run for each outcome: one that covaried for the outcome's associated baseline measure(s), and one that did not. There were no differences between these analyses with respect to significance testing. Therefore, to avoid the possibility of overfitting, I report here findings from analyses that did not use covariates. (Tables 4 and 5 show associations among baseline and outcomes measures separated by social context condition.)

3.2.1.1 Social process measures

Consistent with hypotheses, there were significant effects of social context on both shared reality[1], $F(1, 58) = 4.81$, $p < .04$, $d = .58$, and perceived interpersonal closeness, $F(1, 58) = 6.69$, $p < .02$, $d = .68$. As shown in Table 6, targets in the Together condition had a stronger sense of shared reality and felt closer to their friend than did targets in the Alone condition. Despite being small- to medium-sized in magnitude (Cohen, 1992), the association of shared reality and closeness did not reach significance, suggesting that these measures were fairly distinct. (Table 7 shows intercorrelations among outcome measures across social context conditions, while Tables 8 and 9 show these intercorrelations separated by condition.)

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[1] It is fair to wonder whether the third item on the shared reality inventory ("My friend wants to smoke as badly as I do") might have augmented the main effect of social context on shared reality. (Note that targets in the Alone condition were told that their friend would be performing tasks unrelated to smoking, and presumably not be exposed to an *in vivo* smoking cue.) Importantly, however, follow-up analyses revealed that the effect of social context on shared reality was slightly more pronounced when this item was removed from the composite, $F(1, 58) = 5.94$, $p < .02$, $d = .63$, from which it can be inferred that this item did not act independently of the other two items in a way that might mischaracterize the observed effect of social context.

3.2.1.2 Inner state measures

There was no effect of social context on either urge or affect (*p*s > .60). Unexpectedly, there was a negative association between urge and (positive) affect across social context conditions, $r(58) = -.35$; $p < .01$. Inspection of the affect scores indicated that participants generally felt neutral to fairly positive during the study, with 76.7% reporting affect scores ranging from neutral (zero) to maximally positive (+10). Thus, it appears that within the context of a peak urge manipulation, those whose urges were especially high (approaching "the most intense urge to smoke that I have ever felt") reported feeling somewhat less positive, though still not negative.

3.2.1.3 Facial expression measures

As hypothesized, there was a significant effect of social context on Duchenne smiling during the craving induction, $F(1, 58) = 13.97$, $p < .001$, $d = .98$. Targets in the Together condition displayed Duchenne smiles for significantly longer amounts of time than did participants in the Alone condition. [Only eight "stable" non-Duchenne smiles were observed in this study, as 90.6% of all smiles first coded as non-Duchenne later transitioned into Duchenne. Because of their low frequency and unlikely distinctiveness, non-Duchenne smiles were not analyzed further.]

3.2.1.4 Summary results of Aim 1

Being Together led to enhanced shared reality and closeness but did not enhance urge or affect ratings.

3.2.2 Tests of Aim 2

Consistent with predictions, there was a significant moderating effect of urge on the effect of social context on shared reality, $\beta = .42$, $t(59) = 2.56$, $p < .02$, 95% CI [.09, .75]. Specifically, there was a large-sized association of urge and shared reality ($r = .74$, $p < .001$) when participants were together during smoking cue-exposure, yet these measures were unrelated when participants were alone ($r = .081$, $p = .67$). To further illustrate this pattern, a median split on urge revealed that in the Together condition, targets with higher urges reported a stronger sense of shared reality ($M = 28.14$, $SD = 1.99$), while targets with lower urges reported a weaker sense of shared reality ($M = 20.01$, $SD = 7.70$). Alternatively, a median split on shared reality showed that in the Together condition, targets with a stronger sense of shared reality reported higher urge scores ($M = 85.58$, $SD = 18.66$), while targets with a weaker sense of shared reality reported much lower urge scores ($M = 54.45$, $SD = 34.94$). Urge did not moderate the effect of social context on closeness ($p > .55$), which suggests that this effect was specific to shared reality in this study.

Interestingly, examination of partners' urges in the Together condition revealed a medium-sized correlation between the urges of targets and friends, $r(58) = .32$, $p < .09$, which suggests that even when targets had a lower urge, their friend tended to have a lower urge as well. Notably, despite the large variability in urge ratings across the 60 participants in the Together condition (SD = 29.5), the mean gap between the target and partner urge ratings was only 4.17, providing evidence of craving synchrony.

Affect did not significantly moderate the effect of social context on either shared reality or closeness (ps > .20). Because there was no effect of social context on urge or affect, mediation analyses were not conducted.

3.2.2.1 Summary results of Aim 2

Targets' urge to smoke moderated the impact of social context on shared reality. This suggests that simply *not* being alone was insufficient for smokers to experience maximal levels of shared reality, and that there was something about the shared craving experience in the Together condition that affected shared reality (i.e., being together had a greater effect on targets' sense of shared reality when they were experiencing higher urges).

3.2.3 Tests of Aim 3

3.2.3.1 Dyad-level Duchenne smiling

Fifty-seven percent of dyads displayed at least one shared Duchenne smile during the craving induction. More than three-quarters (76.7%) of all Duchenne smiles displayed in the Together condition were shared, with sharing occurring on average 1.51-sec (*SD* = 2.08-sec) after smiling was initiated by one member of the dyad. Moreover, shared Duchenne smiles appeared across the entire craving induction (i.e., they were initiated at 13 of 20 possible 1-sec bins). This broad distribution of shared Duchenne smiles suggests that they were not merely arising due to a single momentary "punchline effect," which would have suggested that smiles were co-occurring independently of each other. Thus, there appears to have been something socially interactive about shared Duchenne smiling.

As predicted, there was a significant association between shared Duchenne smiling and targets' sense of shared reality, $\beta = .39$, $t(29) = 2.21$, $p < .04$, 95% CI [.04, .74]. Targets who engaged in more shared Duchenne smiling with their friend—the proposed building blocks of shared reality in this study—had a stronger sense of shared reality. Shared Duchenne smiles were not associated with targets' ratings of closeness ($p = .85$), which once again highlights

differences between this study's social process measures. As shown in Table 4, shared Duchenne smiles were associated with baseline measures of race, years smoking, and urge, while shared reality was associated with baseline measures of age, nicotine dependence, and urge. Follow-up analyses were conducted that covaried for each of these five baseline measures. With one exception (baseline urge) the association of shared Duchenne smiles and shared reality remained significant.

There was an association between shared Duchenne smiles and targets' affect, $\beta = -.37$, $t(29) = -2.08$, $p < .05$, 95% CI [-.73, .01], albeit in the opposite direction to what was predicted. Targets who engaged in more shared Duchenne smiling with their friend tended to feel less good. Additionally, there also was a trend-level association of shared Duchenne smiles and targets' urge to smoke, $\beta = .34$, $t(29) = 1.89$, $p = .07$, 95% CI [-.02, .70], with shared smiling linked to higher urges.

3.2.3.2 Individual-level Duchenne smiling

Sixty-three percent of targets displayed at least one Duchenne smile during the craving induction in the Together condition. Targets' Duchenne smiling was unrelated to the four outcome measures (*p*s > .20).

3.2.3.3 Summary results of Aim 3

Shared Duchenne smiling was observed in the majority of dyadic interactions. These smiles were associated with shared reality and affect. Findings provide support for the idea that Duchenne smiles serve as building blocks for shared reality construction when they are shared with interaction partners.

4.0 DISCUSSION

The idea that social context may affect an individual's urge to smoke is not new (Mettlin, 1976), and many smokers spend time with other smokers as part of their daily routines (Conklin et al., 2013; Dunbar, Scharf, Kirchner, & Shiffman, 2010). Laboratory studies have, however, evaluated craving exclusively while smokers are tested alone, and it is unclear how social context affects the experience of craving. If craving, like other affective states, were to satisfy epistemic and relational goals when experienced with others (e.g., by validating each person's experience of the world and promoting interpersonal closeness), it would broaden the scope of motives thought to underlie smoking and suggest a new direction for experimental research.

4.1 PRACTICAL RELEVANCE

The present study used pairs of real-world smoking friends and a shared reality framework to test whether craving manifests differently depending on whether it is experienced in the presence of another person or in social isolation. This study employed two social process measures (shared reality, interpersonal closeness) that have not been used in prior laboratory smoking research. Results indicated that participants who underwent an *in vivo* smoking cue-exposure craving induction with their friend experienced a greater sense of shared reality and felt closer to their friend than did those who were alone. These findings are notable, as they emerge in a study

designed to offer a stringent test of social context. Specifically, the Together and Alone conditions differed only with respect to the 20-sec smoking cue-exposure task; otherwise, all participants traveled to the laboratory together and spent equivalent time apart completing questionnaires prior to cue exposure.

The observed effects of social context on shared reality and interpersonal closeness suggests that there were interpersonal consequences to being alone versus not being alone while craving. Extending this area of research to smoking, a domain with great public health relevance, may help to promote a more comprehensive biopsychosocial analysis of smoking (Dimoff & Sayette, 2017).

While there are practical implications to this work, conceptually the present study also would be of interest if the differences between the Alone and Together conditions could be attributed in part to the social aspect of the Together condition, rather than the isolation aspect of the Alone condition. That is, it would be useful to know if the shared dynamic experience in the Together condition was any different than what one might find had participants simply sat quietly in a room together.

4.2 CONCEPTUAL RELEVANCE

Several pieces of evidence suggest that there was something about the social nature of the together experience underlying the differences in shared reality and closeness. First, self-reported urge to smoke was associated with perceptions of shared reality when participants were together during smoking cue-exposure, but not when they were alone. In the Together condition, as urge increased, so too did the perception that one's friend was experiencing a common inner state.

While causality cannot be established with correlational data, it does appear that the association between urge and shared reality was dependent upon the presence of participants' friends. The absence of an association between urge and shared reality in the Alone condition helps rule out a less interesting possibility that increased urge to smoke merely enhances perceptions of similarity toward smoking friends regardless of a social context. Target–partner urge correspondence also suggests a social aspect to the peak craving experience.

Second, there was a main effect of social context on Duchenne smiling. This reinforces the social-affective aspect of the Together condition used in the present study, distinguishing it from a dyad that merely sat quietly together in an otherwise neutral state. Moreover, among participants in the Together condition, dyad-level (but not individual-level) Duchenne smiles expressed during the smoking cue-exposure craving induction predicted subsequent shared reality ratings, providing the first evidence of shared reality across both facial expression and self-report data. While the temporal order of these two assessments is consistent with the view that sharing smiles had something to do with the increased shared reality ratings, an alternate interpretation (that shared reality drove the expression of shared Duchenne smiles) cannot be ruled out. Nevertheless, the prospect that a dyad-level facial expression may have driven to some degree the increase in shared reality is consistent with the suggestion that facial expression provides a social signal to enable interaction partners to infer that they are sharing feelings (Echterhoff et al., 2009). Further research is needed to more clearly establish a causal effect of dyad-level Duchenne smiles on feelings of shared reality, although this type of research may be difficult (if not impossible) to conduct using real-world interaction partners, whose facial expression, unlike those of confederates, cannot be systematically manipulated.

Although shared Duchenne smiles predicted shared reality scores, they did not predict perceptions of interpersonal closeness. The available data do not offer clear explanations for this finding; however, certain observations can be made: the near-zero correlation between shared Duchenne smiles and interpersonal closeness does not implicate limited statistical power. Nor does this null finding appear to result from ceiling effects, based on inspection of scatterplots. Though post-hoc, these data raise the possibility that among actual friends, whose relationships were established prior to entering the lab, perceptions of interpersonal closeness as measured by our simple two-item assessment, are influenced more by mere physical proximity (being in the same room) than by brief instances of affect sharing, whereas specific, momentary perceptions of shared reality can be influenced by affect sharing.

Alternatively, the peak-provoked craving context used here may have led the shared Duchenne smile to signal recognition of shared attention toward the smoking cue, rather than the expression of warmth to one's partner (the smile signaling something like "I'm *really* feeling this urge, too"). Though speculative, such an interpretation is in line with the observation that the meaning and function of facial expressions depends in part upon the context in which they occur (Barrett, 2014). Viewing the shared Duchenne smile more as an indication of shared attentional focus on the craving experience rather than shared joy also is in accord with the absence of an association between smiling and reported affect, and, in particular, is consistent with the observed inverse relation between shared smiling and positive affect coupled with a positive association between shared smiling and urge ratings. Thus, the present findings raise the possibility that Duchenne smiles may have primarily signaled recognition of the craving experience rather than joy. Further research is needed to test this possibility.

Contrary to what was hypothesized, social context did not influence self-reported urge or affect during cue-exposure. One might wonder whether the craving induction used in this study was too intense and thereby did not leave enough room to reveal an amplification effect for social context. However, inspection of means and frequencies suggest that neither urge nor affect ratings were biased by ceiling effects. Alternatively, the 20-sec craving induction may not have given participants enough time to show amplification effects on urge or affect. Boothby and colleagues (2016), for example, gave participants 3-min to taste and then rate pieces of chocolate, during which time amplification effects were observed. As noted above, though, extending the craving interval without permitting consumption raises other methodological concerns, as the emotional experience of peak craving states are sensitive to even subtle delay variations (e.g., 15-sec extensions; Sayette et al., 2003b). Thus, it remains a challenge to design a craving induction that is long enough to allow urge and affect to vary across social contexts, but short enough not to frustrate the participants.

4.3 IMPLICATIONS AND CAVEATS

4.3.1 Shared reality theory

From a shared reality perspective, the present study raises the possibility that a smoking habit may be maintained in part because it routinely creates moments of smoking anticipation that can be shared with others in ways that satisfy epistemic and relational goals. That is, when smokers experience a common sense of anticipation about smoking a cigarette, they may be more likely to sense that their understanding of the situation is valid (i.e., it is “correct” to crave under these

circumstances), and to perceive they are interpersonally closer to one another. This offers compelling data to suggest that smoking is indeed a multifaceted habit, affecting and maintained by not only biological (e.g., nicotine withdrawal) and cognitive (e.g., smoking expectancies) processes, but also interpersonal processes that manifest most vividly in a social context.

This study further contributes to the shared reality literature by offering data to evaluate the until now untested proposition that "processes involved in empathizing and mood contagion … might serve as precursor mechanisms in the unfolding of a full-blown shared reality" (Echterhoff et al., 2009, p. 511). It is virtually impossible to establish conclusively that the shared Duchenne smiles observed in this study satisfied the "aboutness" condition of shared reality (i.e., that the shared smiles had the same referent, and were not just a response to another's smiling behavior). Nevertheless, this study's craving induction served to focus participants' attention on their lit cigarette, which weighs against the possibility that participants were attending to completely separate stimuli. Relatedly, participants in the Together condition were generally craving to a similar degree, with targets and friends reporting craving scores within four points of each other on average. Thus, it also seems unlikely that participants were having wholly dissimilar inner experiences during the peak-craving induction.

Lastly, findings raise interesting questions regarding a potential conceptual distinction between perceived shared reality and interpersonal closeness. As expected, there was a medium-sized positive correlation between these constructs, and each was affected by the social context manipulation. However, the proposed mechanism for shared reality in the Together condition (shared Duchenne smiles) was unrelated to interpersonal closeness. It is difficult to explain this pattern of findings because surprisingly little has been written about what distinguishes shared reality from closeness. Though speculative, it is possible that shared reality and closeness

measures differ with respect to granularity. The present data suggest that closeness was predicted only by whether participants were simply together (i.e., a coarse-grained influence), whereas shared reality was predicted by both being together and sharing this "hot" craving experience. Clearly more research assessing both closeness and shared reality is needed to distinguish these two social constructs.

4.3.2 Clinical implications

If the cravings experienced by daily smokers offer regularly scheduled anticipatory experiences that may facilitate the creation of shared reality and promote closeness, then quitting smoking for at least some smokers may lead to the loss of these moments, which may help to explain why smokers with a greater number of smoking friends may be less likely to successfully quit (Hitchman, Fong, Zanna, Thrasher, & Laux, 2014). This is of clinical importance because smoking cessation interventions often focus on times that previously were associated with smoking behavior (e.g., smoke breaks), and pay less attention to periods linked to the pre-consumptive anticipation of smoking phase (Bradford, Curtin, & Piper, 2015; Sayette & Dimoff, 2016). The present findings add to this small but growing literature and raise the possibility that smoking cessation programs may benefit from expanding the scope of intervention to address the potential loss of shared (anticipatory) craving moments (e.g., the minutes prior to taking a smoke break) following a quit attempt.

4.4 STRENGTHS AND LIMITATIONS

The present study is the first to test social context during a peak-provoked craving state. In addition, this study used a conceptual framework (shared reality theory) and measures that have not been used previously to assess craving-related responses. These measures are novel to the craving literature in that they pertain to explicitly social processes (shared reality, perceived closeness), which necessarily cannot be assessed in traditional (i.e., asocial) craving paradigms that test just one smoker at a time. Similarly, the measures used in this study are novel to the shared reality literature in that they pertain to affective (vs. cognitive) inner states, and they allowed for distinctions to be made between shared reality and the putatively related construct of interpersonal closeness. Furthermore, this is the first study to evaluate a behavioral mechanism potentially underlying the construction of shared reality (mutual smiling behavior).

There also were limitations to the study. First, due to limited statistical power, I did not include a condition in which participants were together but not exposed to an *in vivo* smoking cue. Without this third condition, I cannot conclude that differences between the Together and Alone conditions are specific to sharing (vs. not sharing) a cigarette craving with a friend. This raises the question of whether a similar pattern of findings would have emerged even if participants in the Together condition had simply sat next to each other in silence. While the present study was not designed to answer this question *per se*, the finding that urge moderated the effect of social context on shared reality suggests that the mere presence of another person may not be enough to achieve the strongest sense of shared reality. Notwithstanding that, it remains unclear whether shared cravings facilitate shared reality construction differently than do other shared affective states.

There are additional concerns related to power. I intended to run 160 participants (80 targets, 80 friends) in the present study, which would have given me power = .80 to detect a medium–large effect (d = .65) of social context on my primary outcomes measures, with α = .05. While I fell short of this goal (n =120), it does not appear as though power limited my ability to test for the hypothesized main effects of social context as detailed in Aim 1. Indeed, it was observed that social context had significant effects on shared reality, perceived closeness, and individual-level Duchenne smiling, even with this reduced sample. Furthermore, the absence of significant effects of social context on urge intensity and mood while craving also seems unrelated to power based on the very small magnitude of effect. It should be noted, however, that inadequate power also increases the risk of detecting false positives, which suggests that these findings require replication to ensure that they were not the result of type I error.

Power limitations did appear to limit my tests of Aims 2 and 3. Nevertheless, the effect sizes observed for many of the results related to these aims suggest the original proposed sample size might still have fallen short. To illustrate, a power analysis using effect sizes calculated from the reported beta coefficients suggests that a sample of 194 would have been needed to detect that affect moderated the effects of social context on shared reality and closeness. Insufficient power may have prevented a handful of medium-sized associations from reaching statistical significance in the Together condition, including the associations of shared Duchenne smiles and urge ($p < .07$), and the urges of targets and friends ($p < .09$). These trend-level findings highlight the need for further investigation before drawing definitive conclusions.

Lastly, because participants in the Together condition were seated close to each other, FACS coding was not performed blind to experimental condition. Targets and friends were coded separately, however, to minimize this possibility, and the strength of FACS is its reliance

on coding of precisely defined, objective muscle movements rather than subjective judgments of affect. Nevertheless, it cannot be ruled out that the coding of one participant's smiling behavior was influenced by being able to see their partner's expressions at times.

4.5 FUTURE DIRECTIONS

4.5.1 Participant characteristics

This study focused on one type of smoker, someone smoking 10 or more cigarettes per day and not currently interested in quitting smoking. Observing effects of social context using *daily* smokers is noteworthy because there is a long-held assumption that social factors are most potent for novice smokers and those intending to quit smoking soon, whereas the smoking behavior of heavier smokers is driven more by pharmacological factors (Miller, Frederiksen, & Hosford, 1979). Nevertheless, future research ought to explore in greater detail the extent to which social context influences smokers across different stages of dependence, including nondependent smokers and those motivated to seek cessation treatment (Sayette & Dimoff, 2016). By broadening inclusion criteria to include different types of smokers, future studies would be better positioned to identify similarities and differences among types of smokers on sensitivities to social factors.

4.5.2 Relationship characteristics

The present study also focused on one type of interpersonal relationship, nonromantic same-sex friendships. Future research is needed to determine whether observed effects are specific to sharing a peak craving state with a smoking friend, or simply with another person who smokes. If similar effects were to be observed in dyads of strangers, it would suggest that cravings are experienced differently by smokers who are not alone, regardless of whether they have an existing relationship with their smoking partner. Alternatively, if similar effects were to be observed in dyads of romantic partners, but not in dyads of strangers, it would suggest that cravings are experienced differently only when smokers are in the presence of close others. More broadly, use of different types of social contexts provides rich avenues to pursue more nuanced social psychological questions regarding the social processes underlying craving and potentially affecting smoking behavior and relapse.

4.5.3 Type of craving induction

With respect to study design, most participants felt relatively good (or at worst affectively neutral) in the present study, including during the peak-provoked craving induction. This was intentional, as the study used a short smoking abstinence requirement and a fairly brief craving interval, relative to most other cue exposure studies. The aim was to create a situation in which smokers experienced powerful, yet not overwhelming cravings. Future research is needed to determine whether findings from this study may generalize to less pleasant situations (e.g., sharing a peak craving state during longer periods of nicotine deprivation, or when expecting not to smoke for a while longer). Indeed, it would be interesting to test, consistent with “misery

loves miserable company" findings (e.g., Gray, Ishii, & Ambady, 2011), whether shared frustration can help smokers create shared reality and enhance perceived closeness to the extent that anticipation did in this study.

4.5.4 Mechanisms of shared reality

Beyond its focus on cigarette craving, this study also serves as an important first step in evaluating factors and mechanisms relevant to shared reality theory, such as being together with a friend during an evocative situation and synchronizing facial expressions when together. Further research is needed to test other mechanisms of potential relevance to shared reality, such as being with a friend during a less evocative situation or being led to believe that one's friend is experiencing a concurrent situation despite their not being present. It also would be informative to test whether the present study's smoking cue-exposure task can weaken participants' sense of shared reality when they believe that their friend is experiencing an inner state different from theirs (e.g., if one person is deprived of nicotine while the other is satiated, or one's partner is a nonsmoker).

Future studies also are needed to draw clearer distinctions between shared reality and concepts such as interpersonal closeness. Because shared reality theory integrates various interpersonal processes into a single framework, it is likely to be associated with many of these processes. Learning which associations are strongest (or weakest) would be of conceptual import to shared reality researchers, and to social psychologists more generally.

4.6 GENERAL SUMMARY

There is a disconnect between how cravings are regularly experienced by smokers in the real-world and how they are studied in the laboratory. The present study offers an initial test of whether cigarette cravings are experienced differently when real-world smoking friends are together during a peak craving induction than when they are alone. Results indicated that participants experienced a greater sense of shared reality and felt closer to their friend after being together (vs. alone) during the craving induction. Moreover, it was observed that target and partner urges tended to be correlated, and that both urge and shared Duchenne smiling were positively associated with shared reality for participants when they were together.

The present data do not speak to the specificity of craving's effect on social processes relative to other affective states. Findings nevertheless suggest that cigarette cravings, like other affective states, can satisfy epistemic and relational needs when experienced concurrently with another person. These results are in accord with recent work suggesting that many harmful behaviors can be considered rational when viewed as the means to goals other than physical health (Kopetz & Orehek, 2015). Indeed, the present data suggest that smoking—despite its harmful health consequences—may be rewarding in part because it allows smokers to share craving states in ways that validate their understanding of the world and cause them to feel closer to one another. If replicated, these findings would challenge certain stigmatizing assumptions about smokers (e.g., that they are simply dependent on nicotine) and call for a broader conceptualization of smoking that may prove difficult for those who have typically portrayed it merely as an irrational behavior and/or nuisance to public health.

The present research aimed to offer new ideas about why millions of Americans continue to smoke despite advances in pharmacological treatments and mounting anti-smoking initiatives.

The present data reinforce the position that it is impossible to understand fully why people smoke without knowing how various aspects of the smoking experience (e.g., anticipatory cravings) interact with social contexts (de Wit & Sayette, in press). Advances in our understanding of these largely hidden social motives for smoking, when combined with ongoing efforts to better understand the neurobiological and pharmacological processes underlying smoking, will help to prevent smoking initiation, and to develop more effective aids for smoking cessation.

REFERENCES

Ambadar, Z., Cohn, J. F., & Reed, L. I. (2009). All smiles are not created equal: Morphology and timing of smiles perceived as amused, polite, and embarrassed/nervous. *Journal of Nonverbal Behavior, 33*(1), 17-34.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: American Psychiatric Association.

Aron, A., Aron, E. N., & Smollan, D. (1992). Inclusion of Other in the Self scale and the structure of interpersonal closeness. *Journal of Personality and Social Psychology, 63*, 596-612.

Aron, E. N., Mashek, D. J., & Aron, A. P. (2004). Closeness as including other in the self. In *Handbook of closeness and intimacy* (pp. 37-52). Psychology Press.

Baker, T. B., Morse, E., & Sherman, J. E. (1987). The motivation to use drugs: A psychobiological analysis of urges. In *Nebraska symposium on motivation*. University of Nebraska Press.

Baker, T. B., Piper, M. E., McCarthy, D. E., Majeskie, M. R., & Fiore, M. C. (2004). Addiction motivation reformulated: an affective processing model of negative reinforcement. *Psychological Review, 111*(1), 33.

Barnett, E., & Casper, M. (2001). A definition of "social environment". *American Journal of Public Health, 91*, 465.

Barrett, L. F. (2014, February 28). What faces can't tell us. *The New York Times*, Retrieved from http://www.nytimes.com.

Bastian, B., Jetten, J., Hornsey, M. J., & Leknes, S. (2014). The positive consequences of pain: A biopsychosocial approach. *Personality and Social Psychology Review, 18*(3), 256-279.

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin,117*(3), 497-529.

Biener, L., Hamilton, W. L., Siegel, M., & Sullivan, E. M. (2010). Individual, social-normative, and policy predictors of smoking cessation: A multilevel longitudinal analysis. *American Journal of Public Health, 100*(3), 547-554.

Boothby, E. J., Clark, M. S., & Bargh, J. A. (2014). Shared experiences are amplified. *Psychological Science, 25*(12), 2209-2216.

Boothby, E. J., Smith, L. K., Clark, M. S., & Bargh, J. A. (2016). Psychological distance moderates the amplification of shared experience. *Personality and Social Psychology Bulletin, 42*(10), 1431-1444.

Bradford, D. E., Curtin, J. J., & Piper, M. E. (2015). Anticipation of smoking sufficiently dampens stress reactivity in nicotine-deprived smokers. *Journal of Abnormal Psychology, 124*(1), 128-136.

Carpenter, M. J., Saladin, M. E., DeSantis, S., Gray, K. M., LaRowe, S. D., & Upadhyaya, H. P. (2009). Laboratory-based, cue-elicited craving and cue reactivity as predictors of naturally occurring smoking behavior. *Addictive Behaviors, 34*(6-7), 536-541.

Carter, B. L., & Tiffany, S. T. (1999). Meta-analysis of cue-reactivity in addiction research. *Addiction, 94*(3), 327-340.

Carter, B. L., & Tiffany, S. T. (2001). The cue-availability paradigm: the effects of cigarette availability on cue reactivity in smokers. *Experimental and Clinical Psychopharmacology, 9*(2), 183-190.

Centers for Disease Control and Prevention. (2016). Cigarette smoking among adults—United States, 2005-2015. *Morbidity and Mortality Weekly Report, 65*(44), 1205-11.

Cerrada, C. J., Ra, C. K., Shin, H., Dzubur, E., & Huh, J. (2016). Using ecological momentary assessment to identify common smoking situations among Korean American emerging adults. *Prevention Science, 17*(7), 892-902.

Chartrand, T. L., & Bargh, J. A. (1999). The chameleon effect: The perception-behavior link and social interaction. *Journal of Personality and Social Psychology, 76*(6), 893-910.

Cheng, K., Conley, T., & Ziegler, A. (2014). Interpersonal relationships influence ethnic identification among Asian-American women. *Group Processes & Intergroup Relations, 17*(1), 100-109.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement, 20*(1), 37-46.

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*(1), 155-159.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, N.J.: Lawrence Erlbaum.

Conklin, C. A., Salkeld, R. P., Perkins, K. A., & Robin, N. (2013). Do people serve as cues to smoke? *Nicotine & Tobacco Research, 15*(12), 2081-2087.

Conklin, C. A., Vella, E. J., Joyce, C. J., Salkeld, R. P., Perkins, K. A., & Parzynski, C. S. (2015). Examining the relationship between cue-induced craving and actual smoking. *Experimental and Clinical Psychopharmacology, 23*(2), 90-96.

Conley, T. D., Rabinowitz, J. L., & Matsick, J. L. (2016). U.S. ethnic minorities' attitudes towards whites: The role of shared reality theory in intergroup relations. *European Journal of Social Psychology, 46*(1), 13-25.

de Wit, H. & Sayette, M.A. (in press). Considering the context: Social factors in responses to drugs in humans. *Psychopharmacology*.

Dimoff, J. D., & Sayette, M. A. (2016). The case for investigating social context in laboratory studies of smoking. *Addiction.* Advance online publication.

Dimoff, J. D., & Sayette, M. A. (2017). The case for investigating social context in laboratory studies of smoking. *Addiction*, *112*(3), 388-395.

Donny, E. C., Griffin, K. M., Shiffman, S., & Sayette, M. A. (2008). The relationship between cigarette use, nicotine dependence, and craving in laboratory volunteers. *Nicotine & Tobacco Research*, *10*(3), 447-455.

Dunbar, M. S., Scharf, D., Kirchner, T., & Shiffman, S. (2010). Do smokers crave cigarettes in some smoking situations more than others? Situational correlates of craving when smoking. *Nicotine & Tobacco Research, 12*(3), 226-234.

Duncan, S., & Barrett, L. F. (2007). Affect is a form of cognition: A neurobiological analysis. *Cognition and Emotion*, *21*(6), 1184-1211.

Echterhoff, G., & Higgins, E. T. (2017). Creating shared reality in interpersonal and intergroup communication: The role of epistemic processes and their interplay. *European Review of Social Psychology, 28*(1), 175-226

Echterhoff, G., Higgins, E. T., & Levine, J. M. (2009). Shared reality experiencing commonality with others' inner states about the world. *Perspectives on Psychological Science, 4*(5), 496-521.

Echterhoff, G., Kopietz, R., & Higgins, E. T. (2013). Adjusting shared reality: Communicators' memory changes as their connection with their audience changes. *Social Cognition, 31*(2), 162-186.

Echterhoff, G., Kopietz, R., & Higgins, E. T. (2017). Shared reality in intergroup communication: Increasing the epistemic authority of an out-group audience. *Journal of Experimental Psychology: General, 146*(6), 806-825.

Ekman, P., & Friesen, W. V. (1969). The repertoire of nonverbal behavior: Categories, origins, usage and coding. *Semiotica, 1*, 49-98

Ekman, P., & Rosenberg, E. L. (2005). *What the face reveals: Basic and applied studies of spontaneous expression using the Facial Action Coding System (FACS)* (2nd ed.). New York, NY: Oxford University Press.

Ekman, P. (1989). The argument and evidence about universals in facial expressions. *Handbook of social psychophysiology*, 143-164.

Ekman, P., Friesen, W. V., & Hager, J. C. (2002). FACS investigator's guide. *A Human Face*, 96.

Ekman, P. (2016). What scientists who study emotion agree about. *Perspectives on Psychological Science*, *11*(1), 31-34.

Fairbairn, C. E., & Sayette, M. A. (2014). A social-attributional analysis of alcohol response. *Psychological Bulletin*, *140*(5), 1361.

Fairbairn, C. E., Sayette, M. A., Aalen, O. O., & Frigessi, A. (2015). Alcohol and emotional contagion: An examination of the spreading of smiles in male and female drinking groups. *Clinical Psychological Science, 3*(5), 686-701.

Festinger, L. (1950). Informal social communication. *Psychological Review*, *57*(5), 271-282.

Fitzsimons, G. M., & Fishbach, A. (2010). Shifting closeness: interpersonal effects of personal goal progress. Journal of personality and social psychology, 98(4), 535-549.

Fitzsimons, G. M., & Shah, J. Y. (2008). How goal instrumentality shapes relationship evaluations. *Journal of Personality and Social Psychology, 95*(2), 319-338.

Franken, I. H. (2003). Drug craving and addiction: Integrating psychological and neuropsychopharmacological approaches. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, *27*(4), 563-579.

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist, 56*(3), 218-226.

Fridlund, A. J. (1997). The new ethology of human facial expressions. In J. A. Russell & J. M. Fernández-Dols (Eds.), *Studies in emotion and social interaction, 2nd series. The psychology of facial expression* (pp. 103-129).

Glad, W., & Adesso, V. J. (1976). The relative importance of socially induced tension and behavioral contagion for smoking behavior. *Journal of Abnormal Psychology, 85*(1), 119-121.

Graham, S. M., Huang, J. Y., Clark, M. S., & Helgeson, V. S. (2008). The positives of negative emotions: Willingness to express negative emotions promotes relationships. *Personality and Social Psychology Bulletin, 34*(3), 394-406.

Gray, H. M., Ishii, K., & Ambady, N. (2011). Misery loves company: When sadness increases the desire for social connectedness. *Personality and Social Psychology Bulletin, 37*(11), 1438-1448.

Guerin, B. (1986). Mere presence effects in humans: A review. *Journal of Experimental Social Psychology, 22*(1), 38-77.

Hardin, C. D., & Higgins, E. T. (1996). Shared reality: How social verification makes the subjective objective. In R. M. Sorrentino & E. T. Higgins (Eds.), *Handbook of motivation and cognition. Handbook of motivation and cognition, Vol. 3. The interpersonal context* (pp. 28-84). New York, NY, US: Guilford Press.

Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1993). Emotional contagion. *Current Directions in Psychological Science, 2*(3), 96-99.

Hatsukami, D. K., Morgan, S. F., Pickens, R. W., & Champagne, S. E. (1990). Situational factors in cigarette smoking. *Addictive Behaviors, 15*(1), 1-12.

Heckman, B. W., Carpenter, M. J., Correa, J. B., Wray, J. M., Saladin, M. E., Froeliger, B., et al. (2015). Effects of experimental negative affect manipulations on ad libitum smoking: A meta-analysis. *Addiction, 110*(5), 751-760.

Herman, C. P. (2015). The social facilitation of eating. A review. *Appetite, 86*, 61-73.

Higgins, E. T. (2012). *Beyond pleasure and pain: How motivation works*. New York: Oxford University Press.

Higgins, E. T. (2016). Shared-Reality Development in Childhood. *Perspectives on Psychological Science*, *11*(4), 466-495.

Hitchman, S. C., Fong, G. T., Zanna, M. P., Thrasher, J. F., & Laux, F. L. (2014). The relation between number of smoking friends, and quit intentions, attempts, and success: Findings from the International Tobacco Control (ITC) Four Country Survey. *Psychology of Addictive Behaviors*, *28*(4), 1144-1152.

Izard, C. E. (1971). The face of emotion. New York, NY: Appleton-Century-Crofts.

Kavanagh, D. J., Andrade, J., & May, J. (2005). Imaginary relish and exquisite torture: the elaborated intrusion theory of desire. *Psychological Review*, *112*(2), 446-467.

Knobloch, L. K., & Metts, S. (2013). Emotion in relationships. In Simpson, J. A., & Campbell, L. (Eds.). *The Oxford handbook of close relationships* (pp. 514-534). New York: Oxford University Press.

Kopetz, C., & Orehek, E. (2015). When the end justifies the means: Self-defeating behaviors as "rational" and "successful" self-regulation. *Current Directions in Psychological Science, 24*(5), 386-391.

Latane, B. (1981). The psychology of social impact. *American Psychologist*, *36*(4), 343-356.

Le Foll, B., & Goldberg, S. R. (2009). Effects of nicotine in experimental animals and humans: an update on addictive properties. In *Nicotine Psychopharmacology* (pp. 335-367). Springer Berlin Heidelberg.

Magee, M. W., & Hardin, C. D. (2010). In defense of religion: Shared reality moderates the unconscious threat of evolution. *Social Cognition*, *28*(3), 379-400.

Markus, H. (1978). The effect of mere presence on social facilitation: An unobtrusive test. *Journal of Experimental Social Psychology*, *14*(4), 389-397.

Marlatt, G. A. (1985). Cognitive factors in the relapse process. In G. A. Marlatt & J. R. Gordon (Eds.), *Relapse prevention* (pp. 128-200). New York: Guilford Press.

Mettlin, C. (1976). Peer and other influences on smoking behavior. *Journal of School Health*, *46*(9), 529-536.

Miller, P. M., Frederiksen, L. W., & Hosford, R. L. (1979). Social interaction and smoking topography in heavy and light smokers. *Addictive Behaviors*, *4*(2), 147-153.

Mischel, W. (2014). The marshmallow test: understanding self-control and how to master it. Random House.

Mischel, W., Shoda, Y., & Rodriguez, M. I. (1989). Delay of gratification in children. *Science*, *244*(4907), 933-938.

Moreland, R. L. (2010). Are dyads really groups? *Small Group Research, 41*(2), 251-267.

Orehek, E., & Vazeou-Nieuwenhuis, A. (2013). Sequential and concurrent strategies of multiple goal pursuit. *Review of General Psychology, 17*(3), 339-349.

Orehek, E., Forest, A. L., & Barbaro, N. (2018). A people-as-means approach to interpersonal relationships. *Perspectives on Psychological Science*, *13*(3), 373-389.

Orehek, E., Forest, A. L., & Wingrove, S. (in press). People as means to multiple goals: Implications for interpersonal relationships. *Personality and Social Psychology Bulletin*.

Peretti-Watel, P., Seror, V., Constance, J., & Beck, F. (2009). Poverty as a smoking trap. *International Journal of Drug Policy, 20*(3), 230-236.

Perkins, K. A. (2009). Does smoking cue-induced craving tell us anything important about nicotine dependence?. *Addiction*, *104*(10), 1610-1616.

Peterson, R. A., & Brown, S. P. (2005). On the use of beta coefficients in meta-analysis. *Journal of Applied Psychology*, *90*(1), 175-181.

Piasecki, T. M., Niaura, R., Shadel, W. G., Abrams, D., Goldstein, M., Fiore, M. C., & Baker, T. B. (2000). Smoking withdrawal dynamics in unaided quitters. *Journal of Abnormal Psychology*, *109*(1), 74-86.

Pinel, E. C., Long, A. E., & Crimin, L. A. (2010). I-sharing and a classic conformity paradigm. *Social Cognition, 28*(3), 277-289.

Piper, M. E., Piasecki, T. M., Federman, E. B., Bolt, D. M., Smith, S. S., Fiore, M. C., & Baker, T. B. (2004). A multiple motives approach to tobacco dependence: the Wisconsin Inventory of Smoking Dependence Motives (WISDM-68). *Journal of Consulting and Clinical Psychology*, *72*(2), 139-154.

Pliner, P., & Cappell, H. (1974). Modification of affective consequences of alcohol: A comparison of social and solitary drinking. *Journal of Abnormal Psychology*, *83*(4), 418-425.

Poland, B., Frohlich, K., Haines, R. J., Mykhalovskiy, E., Rock, M., & Sparks, R. (2006). The social context of smoking: the next frontier in tobacco control?. *Tobacco Control, 15*(1), 59-63.

Pulvers, K., Scheuermann, T. S., Romero, D. R., Basora, B., Luo, X., & Ahluwalia, J. S. (2014). Classifying a smoker scale in adult daily and nondaily smokers. *Nicotine & Tobacco Research, 16*(5), 591-599.

Robinson, T. E., & Berridge, K. C. (1993). The neural basis of drug craving: an incentive-sensitization theory of addiction. *Brain Research Reviews, 18*(3), 247-291.

Russell, J. A. (1994). Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychological Bulletin, 115*(1), 102-141.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*(1), 145-172.

Sayette, M. A., Shiffman, S., Tiffany, S. T., Niaura, R. S., Martin, C. S., & Shadel, W. G. (2000). The measurement of drug craving. *Addiction, 95*, S189-S210.

Sayette, M. A., Martin, C. S., Wertz, J. M., Shiffman, S., & Perrott, M. A. (2001). A multi-dimensional analysis of cue-elicited craving in heavy smokers and tobacco chippers. *Addiction, 96*(10), 1419-1432.

Sayette, M. A., Cohn, J. F., Wertz, J. M., Perrott, M. A., & Parrott, D. J. (2001). A psychometric evaluation of the facial action coding system for assessing spontaneous expression. *Journal of Nonverbal Behavior, 25*(3), 167-185.

Sayette, M.A., Martin, C.S., Hull, J.G., Wertz, J.M, & Perrott, M.A. (2003a). The effects of nicotine deprivation on craving response covariation in smokers. *Journal of Abnormal Psychology, 112*, 110-118.

Sayette, M. A., Wertz, J. M., Martin, C. S., Cohn, J. F., Perrott, M. A., & Hobel, J. (2003b). Effects of smoking opportunity on cue-elicited urge: A facial coding analysis. *Experimental and Clinical Psychopharmacology, 11*(3), 218-227.

Sayette, M. A., Creswell, K. G., Dimoff, J. D., Fairbairn, C. E., Cohn, J. F., Heckman, B. W., ... & Moreland, R. L. (2012). Alcohol and group formation: A multimodal investigation of the effects of alcohol on emotion and social bonding. *Psychological Science, 23*(8), 869-878.

Sayette, M. A. (2016). The role of craving in substance use disorders: Theoretical and methodological issues. *Annual Review of Clinical Psychology, 12*, 407-433.

Sayette, M. A., & Dimoff, J. D. (2016). In search of anticipatory cigarette cravings: The impact of perceived smoking opportunity and motivation to seek treatment. *Psychology of Addictive Behaviors*, *30*(3), 277.

Sayette, M. A., & Hufford, M. R. (1995). Urge and affect: A facial coding analysis of smokers. *Experimental and Clinical Psychopharmacology, 3*(4), 417-423.

Sayette, M. A., & Hufford, M. R. (1997). Effects of smoking urge on generation of smoking-related information. *Journal of Applied Social Psychology*, *27*(16), 1395-1405.

Sayette, M. A., & Parrott, D. J. (1999). Effects of olfactory stimuli on urge reduction in smokers. *Experimental and Clinical Psychopharmacology, 7*(2), 151-159.

Sayette, M. A., & Tiffany, S. T. (2013). Peak provoked craving: an alternative to smoking cue-reactivity. *Addiction*, *108*(6), 1019-1025.

Shiffman, S., Paty, J. A., Gnys, M., Kassel, J. A., & Hickcox, M. (1996). First lapses to smoking: Within-subjects analysis of real-time reports. *Journal of Consulting and Clinical Psychology, 64*(2), 366-379.

Shiffman, S., Gwaltney, C. J., Balabanis, M. H., Liu, K. S., Paty, J. A., Kassel, J. D., ... & Gnys, M. (2002). Immediate antecedents of cigarette smoking: an analysis from ecological momentary assessment. *Journal of Abnormal Psychology*, *111*(4), 531-545.

Shiffman, S., Waters, A. J., & Hickcox, M. (2004). The nicotine dependence syndrome scale: a multidimensional measure of nicotine dependence. *Nicotine & Tobacco Research*, *6*(2), 327-348.

Shteynberg, G. (2015). Shared attention. *Perspectives on Psychological Science*, *10*(5), 579-590.

Simons-Morton, B., & Farhat, T. (2010). Recent findings on peer group influences on adolescent smoking. *Journal of Primary Prevention, 31*(4), 191-208.

Sinclair, S., Huntsinger, J., Skorinko, J., & Hardin, C. D. (2005). Social tuning of the self: Consequences for the self-evaluations of stereotype targets. *Journal of Personality and Social Psychology, 89*(2), 160-175.

Slatcher, R. B., Vazire, S., & Pennebaker, J. W. (2008). Am "I" more important than "we"? Couples' word use in instant messages. *Personal Relationships*, *15*(4), 407-424.

Spanos, S., Vartanian, L. R., Herman, C. P., & Polivy, J. (2014). Failure to report social influences on food intake: Lack of awareness or motivated denial?. *Health Psychology*, *33*(12), 1487.

Tiffany, S. T. (1990). A cognitive model of drug urges and drug-use behavior: role of automatic and nonautomatic processes. *Psychological Review*, *97*(2), 147-168.

Tiffany, S. T. (2009). Drug craving and affect. In J. Kassel (Ed.), *Substance abuse and emotion* (pp. 83-108). Washington, D.C.: American Psychological Association.

Tiffany, S. T., & Wray, J. M. (2012). The clinical significance of drug craving. *Annals of the New York Academy of Sciences*, *1248*(1), 1-17.

US Department of Health and Human Services (USDHHS). (2014). *The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General*. Atlanta, GA: USDHHS.

Waters, A. J., Shiffman, S., Sayette, M. A., Paty, J. A., Gwaltney, C. J., & Balabanis, M. H. (2004). Cue-provoked craving and nicotine replacement therapy in smoking cessation. *Journal of Consulting and Clinical Psychology, 72*(6), 1136-1143.

Watkins, S. S., Koob, G. F., & Markou, A. (2000). Neural mechanisms underlying nicotine addiction: acute positive reinforcement and withdrawal. *Nicotine & Tobacco Research*, *2*(1), 19-37.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063-1070.

Watts, T. W., Duncan, G. J., & Quan, H. (2018). Revisiting the marshmallow test: A conceptual replication investigating links between early delay of gratification and later outcomes. *Psychological Science.*

Wertz, J. M., & Sayette, M. A. (2001). A review of the effects of perceived drug use opportunity on self-reported urge. *Experimental and Clinical Psychopharmacology, 9*(1), 3-13.

Zajonc, R. B. (1965). Social facilitation. *Science*, *149*(3681), 269-274.

Zinser, M. C., Baker, T. B., Sherman, J. E., & Cannon, D. S. (1992). Relation between self-reported affect and drug urges and cravings in continuing and withdrawing smokers. *Journal of Abnormal Psychology*, *101*(4), 617-629.

Zinser, M. C., Fiore, M. C., Davidson, R. J., & Baker, T. B. (1999). Manipulating smoking motivation: Impact on an electrophysiological index of approach motivation. *Journal of Abnormal Psychology, 108*(2), 240-254.

Table 1. Target participant characteristics by social context condition.

	Together (*n* = 30)	**Alone (*n* = 30)**
Demographics		
Age	44.05 (9.98)	42.65 (10.06)
% Female	53.3%	46.7%
% African American	53.3%	63.3%
% Caucasian	40.0%	33.3%
% More than one race	6.7%	3.3%
Smoking patterns		
Cigarettes per day	15.83 (5.53)	14.45 (4.98)
Years Smoking	15.43 (9.60)	13.77 (10.65)
Dependence (NDSS)	-.14 (1.11)	.13 (0.89)
Baseline measures		
Affect (PANAS)	17.77 (9.20)	18.03 (11.40)
Urge to smoke	65.37 (30.19)	69.03 (28.58)
Hours abstinent	5.96 (2.27)	7.71 (5.14)
Friendship characteristics		
Years known	11.48 (9.11)	8.97 (8.07)
Baseline closeness	8.75 (1.39)	8.07 (1.95)
Smoke together per week	5.35 (7.23)	5.30 (5.26)
% Live together	6.7%	16.7%
% Work together	13.3%	13.3%

Note: Participants randomly assigned to the Together and Alone conditions did not differ on any of the above characteristics (all *p*s > .10).

Table 2. Correlations among items on the shared reality inventory.

	SR 1	**SR 2**
SR 2	.77**	
SR 3	.71**	.53**

SR 1 = My friend is feeling the same way I'm feeling.
SR 2 = My friend can relate to my experiences in this study.
SR 3 = My friend wants to smoke as badly as I do.

Table 3. Correlations among baseline and outcome measures across conditions.

	SR	IC	Urge	Affect	D-smiles
Demographics					
Age	-.32*	.09	-.28*	.26*	-.21
Sex	.07	.37**	.01	-.06	-.13
Race	-.14	-.20	.04	.11	-.21
Smoking patterns					
Cigarettes per day	.03	-.12	-.04	-.05	.21
Years Smoking	-.03	-.13	-.12	-.02	-.26*
Dependence (NDSS)	.32*	-.09	.39**	-.30*	.12
Baseline measures					
Affect (PANAS)	-.23	.31*	-.15	.46**	.08
Baseline urge to smoke	.31*	.11	.81**	-.33*	.25
Hours abstinent	.11	.14	.09	-.17	-.22
Friendship characteristics					
Years known	-.03	.43**	-.01	.15	-.02
Baseline closeness	.10	.56**	-.01	.00	.17
Smoke together per week	.17	.07	.05	-.12	.04
% Live together	-.08	.08	.03	-.06	-.05
% Work together	-.05	-.08	-.09	-.14	-.06

** = Correlation is significant at the .01 level.
* = Correlation is significant at the .05 level.

SR = Shared reality
IC = Interpersonal closeness
Urge = Urge to smoke
Affect = Craving-related affect
D-smiles = Duchenne smiles

Table 4. Correlations among baseline and outcome measures in Together condition.

	SR	IC	Urge	Affect	D-smiles (Target)	D-smiles (Shared)
Demographics						
Age	-.40*	-.05	-.39*	.20	-.31	-.24
Sex	-.25	.34	-.21	.26	-.21	-.21
Race	-.14	-.10	.16	.24	-.35	-.52**
Smoking patterns						
Cigarettes per day	.05	-.31	.20	-.34	.00	-.13
Years Smoking	-.20	-.09	-.19	.14	-.37*	-.42*
Dependence (NDSS)	.45*	-.10	.31	-.20	.14	.08
Baseline measures						
Affect (PANAS)	-.08	.32	-.09	.16	.00	.03
Baseline urge to smoke	.66**	-.02	.85**	-.19	.49**	.46**
Hours abstinent	-.24	.02	.02	-.12	-.21	-.16
Friendship characteristics						
Years known	-.07	.44*	-.30	.22	-.03	-.01
Baseline closeness	-.15	.61**	-.13	.25	.16	.02
Smoke together per week	.16	.18	.08	-.07	.12	.21
% Live together	-.15	-.14	-.29	.17	-.14	-.25
% Work together	-.19	-.22	-.12	-.29	.07	.12

** = Correlation is significant at the .01 level.
* = Correlation is significant at the .05 level.

SR = Shared reality
IC = Interpersonal closeness
Urge = Urge to smoke
Affect = Craving-related affect
D-smiles = Duchenne smiles

Table 5. Correlations among baseline and outcome measures in Alone condition.

	SR	IC	Urge	Affect	D-smiles
Demographics					
Age	-.31	.16	-.15	.30	-.23
Sex	.32	.40*	.26	-.30	-.14
Race	-.22	-.37*	-.03	.00	-.21
Smoking patterns					
Cigarettes per day	-.07	-.09	-.31	.16	.41*
Years Smoking	.07	-.21	-.05	-.13	-.29
Dependence (NDSS)	.29	.00	.50**	-.40*	.31
Baseline measures					
Affect (PANAS)	-.35	.34	-.20	.64**	.20
Baseline urge to smoke	.03	.26	.78**	-.45*	.07
Hours abstinent	.36*	.29	.12	-.18	-.14
Friendship characteristics					
Years known	-.05	.41*	.38*	.10	-.18
Baseline closeness	.17	.50**	.10	-.14	.05
Smoke together per week	.21	-.02	.02	-.17	-.08
% Live together	.04	.29	.24	-.16	.21
% Work together	.09	.03	-.07	-.02	-.21

** = Correlation is significant at the .01 level.
* = Correlation is significant at the .05 level.

SR = Shared reality
IC = Interpersonal closeness
Urge = Urge to smoke
Affect = Craving-related affect
D-smiles = Duchenne smiles

Table 6. Mean (*SD*) responses on outcome measures.

	Together	**Alone**
Social processes		
Shared reality*	23.81 (7.03)	18.81 (9.93)
Interpersonal closeness*	5.38 (1.21)	3.84 (2.35)
Inner states		
Urge to smoke	74.16 (29.50)	78.93 (23.52)
Craving-related affect	2.89 (4.29)	2.41 (5.91)
Facial expressions		
Duchenne smiles (target)**	3.98 (4.52)	0.99 (2.31)
Duchenne smiles (dyad)[a]	2.20 (3.10)	—

** = Difference is significant at the .01 level.
* = Difference is significant at the .05 level.

[a] Dyadic smiles could only appear in Together condition.

Note: Values were calculated using non-transformed data.

Table 7. Correlations among outcome measures across social context conditions.

	SR	**IC**	**Urge**	**Affect**
IC	.19			
Urge	.37**	.05		
Affect	-.40**	.22	-.35**	
D-smiles	.26*	.27*	.13	-0.08

** = Correlation is significant at the .01 level.
* = Correlation is significant at the .05 level.

SR = Shared reality
IC = Interpersonal closeness
Urge = Urge to smoke
Affect = Craving-related affect
D-smiles = Duchenne smiles

Table 8. Correlations among outcome measures in Together condition.

	SR	**IC**	**Urge**	**Affect**	**D-smiles (Target)**
IC	-.10				
Urge	.74**	.00			
Affect	-.22	.46*	-.15		
D-smiles (Target)	.19	.12	.24	-.20	
D-smiles (Shared)	.39*	.04	.34	-.37*	.81**

** = Correlation is significant at the .01 level.
* = Correlation is significant at the .05 level.

SR = Shared reality
IC = Interpersonal closeness
Urge = Urge to smoke
Affect = Craving-related affect
D-smiles = Duchenne smiles

Table 9. Correlations among outcome measures in Alone condition.

	SR	**IC**	**Urge**	**Affect**
IC	.24			
Urge	.08	.13		
Affect	-.57**	.10	-.51**	
D-smiles	.14	.19	.10	-.04

** = Correlation is significant at the .01 level.
* = Correlation is significant at the .05 level.

SR = Shared reality
IC = Interpersonal closeness
Urge = Urge to smoke
Affect = Craving-related affect
D-smiles = Duchenne smiles