Examining the Role of Close Relationships in Smoking Behavior: Insights from Dual and Single-Smoker Couples

by

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ABSTRACT

Dual-smoker couples are a high-risk, and underserved population, facing unique challenges to quitting smoking. A distinguishing factor among this population of smokers is the influence of their romantic partner on smoking habits and their subsequent ability to facilitate or hinder cessation efforts. Yet, empirical evidence on the extent and significance of a smokers' interpersonal environment remains relatively underdeveloped. The present research examines associations between close relationships and smoking behavior by conducting 5 studies that explore the social environments of current smokers (Chapter 2), examine the role of romantic partners as smoking cues (Chapter 3), and assess the mutual influence of relationship quality and support behaviors on individual abstinence (Chapter 4). Findings from this research will enhance outcomes for both dual and single-smoker couples by identifying couple-related triggers that can inform targeted interventions promoting cessation and minimizing negative effects on relationships. This work also broadens our understanding of the impact of romantic partners on goal pursuit.

INDEX WORDS: Smoking, smoking cessation, dual-smoker couples, smoking cues, relationships

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

A smoker's social environment, particularly the influence of their romantic partner, constitutes a pivotal determinant in their smoking behavior and ability to quit smoking (Etcheverry et al., 2010; Mermelstein et al., 2009). Research in the field of addictions, close relationships, and health behavior change offer theoretical insight into *why* and *how* social influences are relevant to smoking cessation. The purpose of the present work is to examine the influence of social factors, particularly a smoker's romantic partner, on smoking behavior and cessation efforts. Specifically, I consider the potentially unique context of dual-smoker couples and how close others in these relationships serve as cues for smoking. Additionally, the research aims to identify individual and relationship factors related to these associations, ultimately seeking to reduce smoking rates by informing treatment strategies that consider the role of social influences on smoking habits.

Interpersonal Dynamics in Smoking Behavior

Smoking behavior is embedded in social contexts, where social influences not only affect the decision *to* smoke but also affect smoking *patterns.* Numerous studies have explored how interpersonal dynamics shape health-related behaviors (Holt-Lunstad et al., 2010; Pietromonaco & Collins, 2017; Slatcher & Selcuk, 2017; Young et al., 2019). The findings indicate that the influence of close others (e.g., family, romantic partners, close friends) plays a significant role in reinforcing and sustaining health behaviors (i.e., quitting smoking) through mechanisms such as

social norms, modeling, and social support or pressure within social networks (Cohen, 1988; Lewis & Rook, 1999; Miller et al., 2009; Pietromonaco et al., 2013; Uchino et al., 1996).

Social norms and attitudes toward smoking, as reinforced by one's social environment, play a key role in normalizing smoking as an acceptable behavior (Eisenberg & Forster, 2003; Nyborg & Rege, 2003). Social networks that normalize or encourage smoking contribute to higher rates of initiation and sustained cigarette smoking (Denney et al., 2022; Schaefer et al., 2013). Close relationships also influence smoking behavior through modeling, as individuals tend to mimic the smoking habits of their close social contacts (Christakis & Fowler, 2008). Individuals with close friends, family members, or a romantic partner who smokes may experience greater social reinforcement for their own smoking, while those in environments that discourage smoking may be more motivated to quit or avoid initiation (Dohnke et al., 2011; Urberg et al., 1990).

Research on the mechanisms underlying these social dynamics has highlighted the role of social systems and the impact of support, or lack thereof, on smoking behavior. Studies consistently show that individuals in supportive social environments are more likely to adopt and maintain healthy behaviors, including smoking cessation (Mermelstein et al., 1986; Park et al., 2004; Westmaas et al., 2010). A key distinction in the social support literature is between incidental support and intentional support. Incidental support refers to support that is provided unintentionally or as a biproduct of another activity, often without the specific intent to change someone's behavior (e.g., one partner decides to quit smoking and, as a byproduct, the other partner reduces their smoking as well). This type of support is not specifically aimed at helping but happens naturally during other interactions. Intentional support, on the other hand, is provided with the direct goal of influencing others' behavior (e.g., actively participating in a

quit-smoking program together). While both types of support promote behavior change, they do so in different ways (Hulesnitz et al., 2022; Rothman et al., 2020).

Romantic Partners as Key Influencers in Smoking Behavior and Cessation

Romantic partners are a crucial component of the smoking environment due to their significant influence on each other's behavior (Homish & Leonard, 2005). Romantic partners often share living spaces and daily routines, leading to frequent exposure to each other's smoking habits. This proximity can normalize smoking behavior within the relationship and create a social environment that either encourages or discourages smoking. Additionally, partners can directly influence each other's smoking behavior through social reinforcement and control, such as providing encouragement or disapproval regarding smoking (Cohen & Lichtenstein, 1990; Craddock et al., 2015).

Assortative mating refers to the tendency of individuals to select romantic partners who are similar to themselves in various characteristics (Vandenberg, 1971). Assortative mating extends to health behaviors (Guner et al., 2018; Barlow, & Pedersen, 2006), including smoking (Treur et al., 2015). Individuals are more likely to partner with someone who has a similar smoking status (i.e., both smokers or both non-smokers), and similar quantity and frequency of smoking (i.e., smoke similar number of cigarettes per day) (Ramsey et al., 2019; Rognmo et al., 2012; Treur et al., 2015). The mechanisms driving assortative mating include shared environments, such as growing up in a house where smoking is common, and active assortment wherein individuals choose partners who have similar attitudes as them, such as their standpoint on smoking (Luo, 2017; Luo & Klohnen, 2005). Assortative mating not only shapes the initial selection of partners but also contributes to the shared behaviors and environments within romantic relationships.

Shared environments and routines often lead to concordant health behavior in which individuals in romantic relationships exhibit similar health behaviors and outcomes. In the context of smoking, research on concordant health behavior suggests that partners who smoke may influence each other's smoking habits, leading to either both partners smoking or both partners quitting smoking together. While support in general has been associated with changes in smoking behavior, support from a romantic partner is particularly impactful in determining smoking patterns and influencing quitting. For example, in retrospective reports gathered from former smokers, partner support has been cited as a critical factor in successful quit attempts (Buitenhuis et al., 2021; Scholz et al., 2013). Smokers who receive more support from their romantic partners are more likely to become and stay abstinent (Coppotelli & Orleans, 1985; Lewis et al., 2006; Lüscher et al., 2017; Mermelstein et al., 1983).

Dual-Smoker Couples as a Unique Context for Smoking Cessation

An estimated 54% of partnered smokers are in relationships with another smoker, while 46% are in relationships with non-smokers (Wright et al., in progress). Dual-smoker couples face significant challenges in smoking cessation, resulting in less frequent quit attempts and lower rates of sustained abstinence compared to single-smoker couples (Homish & Leonard, 2005; Margolis & Wright, 2016; Tooley & Borrelli, 2017).

While concordance in health beliefs and behavior can lead to positive outcomes in smoking cessation, such as both partners quitting together, this is not always the case for dual-smoker couples. The unique social context of Dual-smoker couples presents multiple barriers to successful cessation. Firstly, they experience weaker motivation to quit (Etcheverry & Agnew, 2008; Jackson, Steptoe, & Wardle, 2015), potentially due to concerns about how quitting will interfere with their relationship. During quit attempts, these couples often find themselves in

different stages of readiness to quit (Ranby et al., 2013), complicating joint cessation efforts. Furthermore, the ongoing presence of smoking cues (Conklin et al., 2012; Hyman et al., 2006) can undermine quit attempts, making it harder for each partner to stay motivated and resist cravings. Smokers often reference a lack of relevant and effective cessation strategies (e.g., avoiding exposure to smoking cues) as a barrier to successfully quitting (Derrick et al., 2013).

Maintenance of smoking cessation is another significant hurdle for dual-smoker couples. Compared to single-smoker couples, dual-smoker couples tend to smoke more cigarettes and have a greater nicotine dependence, making relapse prevention and long-term abstinence challenging (Homish & Leonard, 2005; Margolis & Wright, 2016). Living with another smoker while trying to quit is one of the biggest challenges to abstinence, as it perpetuates exposure to smoking-related triggers and weakens the individual's resolve to quit (Cobb et al., 2014; Derrick et al., 2013). Moreover, dual-smoker couples often receive low support from their partner, who may fail to recognize and offer sufficient assistance or resources during the quitting process (Ranby et al., 2013; vanDellen et al., 2016). Despite these recognized risk-factors, limited research has been conducted on the unique experience of dual-smoker couples. Understanding the social dynamics—specifically a smoker's romantic partner—is crucial for developing targeted interventions that address their specific needs and challenges, ultimately improving smoking cessation outcomes for this at-risk population.

Underestimating the Impact of a Smoker's Social Environment Undermines Public Health

There are several gaps in the current state of the literature that, if addressed, would lead to greater understanding of smoking behavior and more targeted intervention development. First, the extent to which a smoker's romantic partner influences smoking patterns remains uncertain, hindering our understanding of the dynamics at play in the formation and reinforcement of

smoking habits within relationships. Information such as household smoking, living with other smokers, and partner smoking status are rarely collected or reported in tandem in empirical research. Yet, supporting evidence suggests that these factors may contribute to heavier nicotine dependence and a harder time quitting (Stevenson et al., 2017; Wright et al., in progress). Additionally, the lack of available and accurate metrics about a smoker's partner's (i.e., their smoking status) is problematic. Researchers often fail to measure or report information about a smoker's social environment which can lead to misinterpretations or inaccurate conclusions of findings or implications, particularly when all smoker's experiences are assumed to be similar.

Second, as a result of this missing information, cessation treatments may be ineffective (or even potentially harmful) to certain groups of smokers. This lack of data can lead to treatments that are not tailored to their specific needs and circumstances (Ranney et al., 2006); such as treatments that do not consider the smoking status of a smoker's partner. Similarly, treatment plans that do not account for the support (or lack thereof) from a smoker's social network may not provide the necessary resources to help them quit. Treatment plans that advise smokers to avoid smoking cues neglect the potential social nature of these cognitive associations and ignore the possibility that avoiding triggers might be impossible for some smokers. This oversight can lead to several unintended consequences including increased exposure to cues, relationship conflict, decreased motivation to quit, failure to address the underlying issues that contribute to smoking behavior and missed opportunities to leverage relationship dynamics to support quitting. Incomplete information about quitting motives can contribute to cessation efforts that do not align with the smoker's goals or readiness to quit. For example, a smoker who is motivated to quit to improve their relationship with their non-smoking partner may need different interventions compared to a smoker who is primarily motivated by personal health

concerns. If treatment plans do not account for these influences, they may not effectively address the underlying reasons for smoking.

Third, the impact of quitting smoking and the potential consequences for a smoker's romantic relationship are largely unknown. The limited research on this topic reveals mixed evidence. A study by Margolis and Wright (2016) highlights positive effects on a smoker's relationship including improved relationship dynamics, reduced conflict and increased social integration. However, quitting smoking can also lead to relationship challenges. Couples can experience conflict due to withdrawal symptoms, or a perceived lack of support, as well as tension if one partner quits and the other does not. Moreover, there are areas which have not garnered much attention at all and need to be addressed. For instance, the majority of studies have examined short-term consequences, leaving the long-term effects of quitting on relationships not well understood. Furthermore, there is limited research on the factors that moderate the effects of quitting on romantic relationships (e.g., relationship satisfaction or support).

Implications for Public Health and Meeting the Needs of Dual-Smoker Couples

These complications need to be addressed because they pose considerable concerns for public health, the accuracy of empirical literature on these topics, and the equitable and effective treatment opportunities available to potentially vulnerable populations.

Smoking Remains a Significant Public Health Concern

Cigarette smoking is a significant public health concern with widespread implications for individuals and communities. As of 2019, an estimated 34.1 million Americans were cigarette smokers, resulting in nearly 20% of all deaths in America (CDC, 2022). Smoking remains a leading cause of preventable diseases and premature death globally. Among the more than 30

million smokers living in the United States, a significant majority want to quit (68%) and have made a quit attempt (55%), yet very few are successful (7.5%) (CDC, 2022).

Challenges of Smoking Cessation

A significant reason smoking remains a public health concern is not due to a lack of desire to quit—many smokers want to quit and have attempted to do so. The challenge is overcoming the physical, psychological, and behavioral aspects of smoking addiction. A common challenge is nicotine addiction, characterized by intense withdrawal symptoms (i.e., irritability, anxiety, and cravings) which contributes to maintaining smoking habits (Betts et al., 2021; Heatherton et al., 1991, Rose, 2006). Beyond physical dependence, smokers often develop psychological dependence on smoking as a coping mechanism for stress and anxiety (Bindu et al., 2011; Siqueira et al., 2000). This dual dependency makes cessation challenging. Additionally, smoking becomes entrenched in routines and activities, forming strong behavioral habits. These habits can be triggered by specific situations, emotions, or rituals, making it difficult for individuals to quit without addressing these associations (i.e., smoking cues) (Shiffman et al., 2002).

Current Treatment Options are Ineffective for Dual-Smoker Couples

Current best practice recommendations for quitting smoking are not well-suited to dual-smoker couples. Comprehensive guidelines often include combinations of behavioral approaches and pharmacotherapy (e.g., Nicotine Replacement Therapy). Despite significant advances in research and the development of evidence-based smoking cessation interventions, dual-smoker couples still face worse quit rates compared to other groups (Cobb et al., 2014; Margolis & Wright, 2016; Tooley & Borrelli, 2017). With the exception of studies on pregnant women (e.g., Cornelius et al., 2016) and adolescents (e.g., Garrison et al., 2003; Karpinski et al., 2010), most

smoking interventions have traditionally targeted general smoking populations without acknowledging the distinct needs of different groups of smokers. Dual-smoker couples face a lack of relevant and effective cessation strategies because they do not consider the unique couple-related obstacles they face (e.g., inability to avoid smoking cues) leading to poorer outcomes. Current treatment interventions must be tailored to take a more targeted approach. There is a considerable need for data that can inform the development of more effective cessation strategies. The current research aims to provide information to further refine and improve interventions ultimately informing public health efforts focused on creating supportive environments and policies to facilitate quitting.

The Present Research

Broadly, this project investigates the interdependent nature of smoking and smoking cessation. In Chapter 2, we examined the social demographics of current tobacco smokers (N = 2,402) to highlight the important relationships between social environment and smoking risk factors, highlighting the need to take a dyadic approach to smoking cessation research and interventions. After developing arguments about why social context is an important determinant of smoking behavior, in Chapter 3 (N = 383) we tested the idea that partners serve as cues that might help to explain differences in smoking patterns. In Chapter 4, we take a relationships perspective to explore how relationship factors impact point-prevalence abstinence among dual-smoker couples using data from the feasibility phase of a randomized control trial testing a dyadic behavioral economic intervention (N = 190).

Contributions to Theory and Practice on Smoking Cessation from Dual-Smoker Couples

Results from this research will contribute to theoretical advancements and practical applications, paving the way for a more complete understanding of how couples pursue and

achieve health behavior goals. This work has the potential to make several contributions to literature and theory. First, data from these studies will provide updated metrics on the current characteristics of smokers. The smoking demographic information included across these studies will provide a standard for better and more complete reporting expectations in future publications. Second, findings from this work could prompt a re-prioritization of the study of dual-smoker couples as an important treatment refractory population that contributes to persistent smoking rates in the U.S. Third, it could drive future research opportunities by promoting further investigations of the impact of close relationships on health goals. Future work could examine how and why romantic partners differ from other relationships in a smoker's life (i.e., friend, parent), particularly in the context of quitting. This extends beyond smoking cessation, impacting how the field conceptualizes, theorizes about, and approaches health behavior change more broadly.

On a practical level, this research has implications for the development of targeted treatments, specifically, interventions aimed at effectively addressing challenges faced by dual-smoker couples. Knowledge about the social and relational aspects of health behavior change is crucial for crafting effective interventions that consider the interplay between interpersonal dynamics and smoking behavior. This approach opens research opportunities to capture dual-smoker couples' experiences more accurately and can inform cessation treatment development for this hard-to-treat population. Lessons learned from this research may also inform which dyads are most likely to respond to specific interventions, additional ways to tailor cessation interventions to maximize outcomes, as well as how current guidelines may be updated to address the hurdles faced by dual-smoker couples. Furthermore, this research can facilitate future innovation by being adapted to other contexts. Although this work is intended to focus primarily

on smoking cessation efforts within romantic relationships, it could be adapted to other health concordant behaviors (e.g., obesity, substance use), or populations (e.g., parent and child, roommate).

References

Betts, J. M., Dowd, A. N., Forney, M., Hetelekides, E., & Tiffany, S. T. (2021). A Meta-Analysis of Cue Reactivity in Tobacco Cigarette Smokers. *Nicotine & Tobacco Research*, *23*(2), 249–258. https://doi.org/10.1093/ntr/ntaa147

Buitenhuis, A. H., Tuinman, M. A., Stadler, G., & Hagedoorn, M. (2021). Daily support and negative control during a quit attempt in single-smoking couples. *Health Psychology*, *40*(3), 207–216. https://doi.org/10.1037/hea0000969

Centers for Disease Control and Prevention (CDC) (2022, August 22). *Current cigarette smoking among adults in the United States*. Centers for Disease Control and Prevention. https://www.cdc.gov/tobacco/data_statistics/fact_sheets/adult_data/cig_smoking/index.htm

Chassin, L., Presson, C. C., & Sherman, S. J. (1984). Cigarette smoking and adolescent psychosocial development. *Basic and Applied Social Psychology, 5*(4), 295–315. https://doi.org/10.1207/s15324834basp0504_4

Christakis, N. A., & Fowler, J. H. (2008). The collective dynamics of smoking in a large social network. *New England Journal of Medicine*, *358*(21), 2249–2258. https://doi.org/10.1056/NEJMsa0706154

Cobb, L. K., McAdams-DeMarco, M. A., Huxley, R. R., Woodward, M., Koton, S., Coresh, J., & Anderson, C. A. M. (2014). The association of spousal smoking status with the ability to quit smoking: The atherosclerosis risk in communities study. *American Journal of Epidemiology*, *179*(10), 1182–1187. https://doi.org/10.1093/aje/kwu041

Cohen, S. (1988). Psychosocial models of the role of social support in the etiology of physical disease. *Health Psychology, 7*(3), 269–297. https://doi.org/10.1037/0278-6133.7.3.269

Conklin, C. A., Parzynski, C. S., Salkeld, R. P., Perkins, K. A., & Fonte, C. A. (2012). Cue reactivity as a predictor of successful abstinence initiation among adult smokers. *Experimental and Clinical Psychopharmacology*, *20*(6), 473–478. https://doi.org/10.1037/a0029599

Coppotelli, H. C., & Orleans, C. T. (1985). Partner support and other determinants of smoking cessation maintenance among women. *Journal of Consulting and Clinical Psychology*, *53*, 455–460. https://doi.org/10.1037/0022-006X.53.4.455

Cornelius, T., Desrosiers, A., & Kershaw, T. (2016). Spread of health behaviors in young couples: How relationship power shapes relational influence. *Social Science & Medicine (1982)*, *165*, 46–55. https://doi.org/10.1016/j.socscimed.2016.07.030

Craddock, E., vanDellen, M. R., Novak, S. A., & Ranby, K. W. (2015). Influence in relationships: A meta-analysis on health-related social control. *Basic and Applied Social Psychology*, *37*(2), 118–130. https://doi.org/10.1080/01973533.2015.1011271

Cornelius, T., Desrosiers, A., & Kershaw, T. (2016). Spread of health behaviors in young couples: How relationship power shapes relational influence. *Social Science & Medicine (1982)*, *165*, 46–55. https://doi.org/10.1016/j.socscimed.2016.07.030

Denney, J. T., Sharp, G., & Kimbro, R. T. (2022). Community social environments and cigarette smoking. *SSM - Population Health*, *19*, 101167. https://doi.org/10.1016/j.ssmph.2022.101167

Dohnke, B., Weiss-Gerlach, E., & Spies, C. D. (2011). Social influences on the motivation to quit smoking: Main and moderating effects of social norms. *Addictive Behaviors, 36*(4), 286–293. https://doi.org/10.1016/j.addbeh.2010.11.001

Eisenberg, M. E., & Forster, J. L. (2003). Adolescent smoking behavior: Measures of social norms. *American Journal of Preventive Medicine*, *25*(2), 122–128. https://doi.org/10.1016/S0749-3797(03)00116-8

Etcheverry, P. E., & Agnew, C. R. (2008). Romantic partner and friend influences on young adult cigarette smoking: Comparing close others' smoking and injunctive norms over time. *Psychology of Addictive Behaviors*, *22*(3), 313–325. https://doi.org/10.1037/0893-164X.22.3.313

Etcheverry, P. E., Hoffman, N. G., & Agnew, C. R. (2010). Romantic partner influence on young adult cigarette smoking: Testing a behavioral mechanism. *Social Influence, 5*(4), 289–305. https://doi.org/10.1080/15534510.2010.502044

Ferguson, J., Bauld, L., Chesterman, J., & Judge, K. (2005). The English smoking treatment services: One-year outcomes. *Addiction*, *100*(s2), 59–69. https://doi.org/10.1111/j.1360-0443.2005.01028.x

Garrison, M. M., Christakis, D. A., Ebel, B. E., Wiehe, S. E., & Rivara, F. P. (2003). Smoking cessation interventions for adolescents: A systematic review. *American Journal of Preventive Medicine*, *25*(4), 363–367. https://doi.org/10.1016/S0749-3797(03)00213-7

Guner, N., Kulikova, Y., & Llull, J. (2018). Marriage and Health: Selection, Protection, and Assortative Mating. European economic review, 104, 138–166. https://doi.org/10.1016/j.euroecorev.2018.02.005

Haskins, L. B., Payne, C. A., Schiavone, W. M., Beach, S. R. H., MacKillop, J., & vanDellen, M. R. (2022). Feasibility, tolerability, and potential advantages of a dyadic financial incentive treatment for smoking cessation among dual-smoker couples: A pilot study. *Experimental and Clinical Psychopharmacology*, *30*(6), 1001–1007. https://doi.org/10.1037/pha0000521

Heatherton T, Kozlowski L, Frecker R, et al. (1991) The Fagerström Test for Nicotine Dependence: A revision of the Fagerström Tolerance Questionnaire. British Journal of Addiction 86: 1119–1127.

Huelsnitz, C. O., Jones, R. E., Simpson, J. A., Joyal-Desmarais, K., Standen, E. C., Auster-Gussman, L. A., & Rothman, A. J. (2022). The Dyadic Health Influence Model. Personality and Social Psychology Review, 26(1), 3-34. https://doi.org/10.1177/10888683211054897

Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: A meta-analytic review. *PLoS medicine*, *7*(7), e1000316. https://doi.org/10.1371/journal.pmed.1000316

Homish, G. G., & Leonard, K. E. (2005). Spousal influence on smoking behaviors in a US community sample of newly married couples. *Social Science & Medicine*, *61*(12), 2557–2567. https://doi.org/10.1016/j.socscimed.2005.05.005

Hyman, S. E., Malenka, R. C., & Nestler, E. J. (2006). Neural mechanisms of addiction: The role of reward-related learning and memory. *Annual Review of Neuroscience*, *29*, 565–598. https://doi.org/10.1146/annurev.neuro.29.051605.113009

Jackson, S.E., Steptoe, A., & Wardle, J. (2015). The influence of partner's behavior on health behavior change: The English longitudinal study of ageing. *JAMA Intern Med.* 175(3)385–392. https://doi:10.1001/jamainternmed.2014.7554

Karpinski, J. P., Timpe, E. M., & Lubsch, L. (2010). Smoking Cessation Treatment for Adolescents. *The Journal of Pediatric Pharmacology and Therapeutics : JPPT*, *15*(4), 249–263.

Kennedy, D. P., Tucker, J. S., Pollard, M. S., Go, M.-H., & Green, H. D. (2011). Adolescent romantic relationships and change in smoking status. *Addictive Behaviors*, *36*(4), 320–326. https://doi.org/10.1016/j.addbeh.2010.11.014

Leonard, K. E., Smith, P. H., & Homish, G. G. (2014). Concordant and discordant alcohol, tobacco, and marijuana use as predictors of marital dissolution. *Psychology of Addictive Behaviors, 28*(3), 780–789. https://doi.org/10.1037/a0034053

Lüscher, J., Stadler, G., & Scholz, U. (2017). A Daily Diary Study of Joint Quit Attempts by Dual-Smoker Couples: The Role of Received and Provided Social Support. Nicotine & tobacco research : official journal of the Society for Research on Nicotine and Tobacco, 20(1), 100–107. https://doi.org/10.1093/ntr/ntx079

Lewis, M. A., & Rook, K. S. (1999). Social control in personal relationships: Impact on health behaviors and psychological distress. *Health Psychology*, *18*(1), 63–71. https://doi.org/10.1037/0278-6133.18.1.63

Lewis, M. A., McBride, C. M., Pollak, K. I., Puleo, E., Butterfield, R. M., & Emmons, K. M. (2006). Understanding health behavior change among couples: an interdependence and communal coping approach. *Social science & medicine (1982)*, *62*(6), 1369–1380. https://doi.org/10.1016/j.socscimed.2005.08.006

Luo, S. (2017). Assortative mating and couple similarity: Patterns, mechanisms, and consequences. *Social and Personality Psychology Compass, 11*(8), 1–14. https://doi.org/10.1111/spc3.12337

Luo, S., & Klohnen, E. C. (2005). Assortative mating and marital quality in newlyweds: A couple-centered approach. *Journal of Personality and Social Psychology*, *88*(2), 304–326. https://doi.org/10.1037/0022-3514.88.2.304

Margolis, R., & Wright, L. (2016). Better off alone than with a smoker: The influence of partner's smoking behavior in later life. *The Journals of Gerontology: Series B*, *71*(4), 687–697. https://doi.org/10.1093/geronb/gbu220

Mermelstein, R., Cohen, S., Lichtenstein, E., Baer, J. S., & Kamarck, T. (1986). Social support and smoking cessation and maintenance. *Journal of Consulting and Clinical Psychology*, *54*(4), 447–453. https://doi.org/10.1037//0022-006x.54.4.447

Mermelstein, R. J., Colvin, P. J., & Klingemann, S. D. (2009). Dating and changes in adolescent cigarette smoking: Does partner smoking behavior matter? *Nicotine & Tobacco Research : Official Journal of the Society for Research on Nicotine and Tobacco*, *11*(10), 1226–1230. https://doi.org/10.1093/ntr/ntp127

Mermelstein, R., Lichtenstein, E., & McIntyre, K. (1983). Partner support and relapse in smoking-cessation programs. *Journal of Consulting and Clinical Psychology*, *51*(3), 465–466. https://doi.org/10.1037/0022-006X.51.3.465

Miller, G., Chen, E. & Cole, S.W. (2009) Health psychology: Developing biologically plausible models linking the social world and physical health. *Annual Review of Psychology*, 60, 501-524. http://dx.doi.org/10.1146/annurev.psych.60.110707.163551

Nyborg, K., & Rege, M. (2003). On social norms: The evolution of considerate smoking behavior. *Journal of Economic Behavior & Organization*, *52*(3), 323–340. https://doi.org/10.1016/S0167-2681(03)00031-3

Park, E. W., Tudiver, F., Schultz, J. K., & Campbell, T. (2004). Does enhancing partner support and interaction improve smoking cessation? A meta-analysis. *Annals of family medicine*, *2*(2), 170–174. https://doi.org/10.1370/afm.64

Pietromonaco, P. R., & Collins, N. L. (2017). Interpersonal mechanisms linking close relationships to health. The American psychologist, 72(6), 531–542. https://doi.org/10.1037/amp0000129

Pietromonaco, P. R., Uchino, B., & Dunkel Schetter, C. (2013). Close relationship processes and health: Implications of attachment theory for health and disease. *Health Psychology, 32*(5), 499–513. https://doi.org/10.1037/a0029349

Ramsey, M. W., Jr, Chen-Sankey, J. C., Reese-Smith, J., & Choi, K. (2019). Association between marital status and cigarette smoking: Variation by race and ethnicity. Preventive medicine, 119, 48–51. https://doi.org/10.1016/j.ypmed.2018.12.010

Ranby, K. W., Lewis, M. A., Toll, B. A., Rohrbaugh, M. J., & Lipkus, I. M. (2013). Perceptions of smoking-related risk and worry among dual-smoker couples. *Nicotine & Tobacco Research*, *15*(3), 734–738. https://doi.org/10.1093/ntr/nts210

Ranney, L., Melvin, C., Lux, L., McClain, E., & Lohr, K. N. (2006). Systematic Review: Smoking Cessation Intervention Strategies for Adults and Adults in Special Populations. *Annals of Internal Medicine*, *145*(11), 845–856. https://doi.org/10.7326/0003-4819-145-11-200612050-00142

Reynolds, C. A., Barlow, T., & Pedersen, N. L. (2006). Alcohol, tobacco and caffeine use: Spouse similarity processes. *Behavior genetics*, *36*(2), 201–215. https://doi.org/10.1007/s10519-005-9026-7

Rose J. E. (2006). Nicotine and nonnicotine factors in cigarette addiction. *Psychopharmacology*, 184(3-4), 274–285. https://doi.org/10.1007/s00213-005-0250-x

Rothman, A. J., Simpson, J. A., Huelsnitz, C. O., Jones, R. E., & Scholz, U. (2020). Integrating intrapersonal and interpersonal processes: a key step in advancing the science of behavior change. Health Psychology Review, 14(1), 182–187. https://doi.org/10.1080/17437199.2020.1719183

Schaefer, D. R., Adams, J, & Haas, S. A. (2013). Social Networks and Smoking: Exploring the Effects of Influence and Smoker Popularity through Simulations. *Health Education & Behavior : The Official Publication of the Society for Public Health Education*, *40*(1 0), 24S-32S. https://doi.org/10.1177/1090198113493091

Scholz, U., Ochsner, S., Hornung, R., & Knoll, N. (2013). Does social support really help to eat a low-fat diet? Main effects and gender differences of received social support within the Health Action Process Approach: received support and dietary behavior. *Applied Psychology: Health and Well-Being*, *5*(2), 270–290. https://doi.org/10.1111/aphw.12010

Shoham V, Butler EA, Rohrbaugh MJ, et al. (2007) Symptom-system fit in couples: Emotion regulation when one or both partners smoke. Journal of Abnormal Psychology 116: 848–853.

Siqueira, L., Diab, M., Bodian, C., & Rolnitzky, L. (2000). Adolescents becoming smokers: the roles of stress and coping methods. *The Journal of adolescent health : Official Publication*

of the Society for Adolescent Medicine, *27*(6), 399–408. https://doi.org/10.1016/s1054-139x(00)00167-1

Slatcher, R., & Selcuk, E. (2017). A social psychological perspective on the links between close relationships and health. *Current Directions in Psychological Science*, *26*, 16–21. https://doi.org/10.1177/0963721416667444

Stevenson, J. G., Oliver, J. A., Hallyburton, M. B., Sweitzer, M. M., Conklin, C. A., & McClernon, F. J. (2017). Smoking Environment Cues Reduce Ability to Resist Smoking as Measured by a Delay to Smoking Task. *Addictive Behaviors*, *67*, 49–52. https://doi.org/10.1016/j.addbeh.2016.12.007

Tooley, E. M., & Borrelli, B. (2017). Characteristics of cigarette smoking in individuals in smoking concordant and smoking discordant couples. Couple and Family Psychology: Research and Practice, 6, 106–116. https://doi.org/10.1037/cfp0000078

Treur, J. L., Vink, J. M., Boomsma, D. I., & Middeldorp, C. M. (2015). Spousal resemblance for smoking: Underlying mechanisms and effects of cohort and age. *Drug and Alcohol Dependence, 153,* 221–228. https://doi.org/10.1016/j.drugalcdep.2015.05.018

Uchino, B. N., Cacioppo, J. T., & Kiecolt-Glaser, J. K. (1996). The relationship between social support and physiological processes: A review with emphasis on underlying mechanisms and implications for health. *Psychological Bulletin, 119*(3), 488–531. https://doi.org/10.1037/0033-2909.119.3.488

Urberg, K.A., Shyu, S-J., Jersey Liang, J. (1990). Peer influence in adolescent cigarette smoking, *Addictive Behaviors*, 15(3), 247-255. https://doi.org/10.1016/0306-4603(90)90067-8.

Vandenberg, S.G. (1972). Assortative mating, or who marries whom? *Behavior Genetics*, 2, 127–157. https://doi.org/10.1007/BF01065686

Watson, D., Klohnen, E. C., Casillas, A., Nus Simms, E., Haig, J., & Berry, D. S. (2004). Match makers and deal breakers: Analyses of assortative mating in newlywed couples. *Journal of Personality*, *72*(5), 1029–1068. https://doi.org/10.1111/j.0022-3506.2004.00289.x

Westmaas, J. L., Bontemps-Jones, J., & Bauer, J. E. (2010). Social support in smoking cessation: Reconciling theory and evidence. *Nicotine & Tobacco Research*, *12*(7), 695–707. https://doi.org/10.1093/ntr/ntq077

Wright, J. W. C., Wilcher, C., MacKillop, J., Beach, S. R. H., & vanDellen, M. R. (in progress). Comorbidity of social and behavioral risk factors in smoking.

vanDellen, M. R., Boyd, S. M., Ranby, K. W., MacKillop, J., Lipkus, I. M. (2016). Willingness to provide support for a quit attempt: A study of partners of smokers. *Journal of Health Psychology*. 21(9):1840-1849. doi:10.1177/1359105314567209

Young, V. J., Burke, T. J., & Curran, M. A. (2019). Interpersonal effects of health-related social control: Positive and negative influence, partner health transformations, and relationship quality. *Journal of Social and Personal Relationships, 36*(11-12), 3986–4004. https://doi.org/10.1177/0265407519846565

STUDY 1

COMORBIDITY OF SOCIAL AND BEHAVIORAL RISK FACTORS IN SMOKING[1]

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Substantial Overlap of Social Contextual and Behavioral Risk Factors among Adult Smokers

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Abstract

Close relationships play a critical role in an individual's smoking behaviors and quit attempts; however limited research has been conducted on the way in which the interpersonal context overlaps with specific smoking behaviors. We investigated the potential overlap of social risk factors with other behavioral risk factors for persistent smoking. Current cigarette smokers in the United States (N = 2,404) completed a survey about their smoking habits and close relationships. We evaluated the associations of close relationship factors with multiple smoking behaviors including smoking heaviness, vaping, and smoking in the house. Participants were likely to have and live with a romantic partner who also smokes. Smokers partnered with other smokers were significantly heavier smokers and were more likely to smoke in the house. Findings reveal high rates of dual-smoking couples and indicate potential consequences of living with another smoker. This work highlights comorbidities between social context and smoking behaviors. Interventions that do not account for the overlap of these risk factors may underperform in producing smoking abstinence.

Keywords: Smoking, smoker characteristics, close relationships, dual-smoker couples

Substantial Overlap of Social Contextual and Behavioral Risk Factors among Adult Smokers

Smoking cigarettes remains the leading cause of preventable disease and death in the United States, yet, as of 2020, 30.8 million American adults smoke cigarettes (Centers for Disease Control and Prevention (CDC), 2022). Given the public health costs of smoking (United States Public Health Service Office of the Surgeon General & National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health, 2020), substantial efforts have been invested into identifying and crafting recommendations for smoking cessation. The most recent Surgeon General report highlights key individual (e.g., NRT, psychological counseling) and public health (e.g., quit lines) evidence-based recommendations for promoting cessation (United States Public Health Service Office of the Surgeon General & National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health, 2020). Despite these efforts, several populations of smokers remain treatment-resistant and more likely to relapse. Included in these treatment-refractory populations are dual-smoker couples where both members of a couple smoke cigarettes (Ranby et al., 2013; Tooley & Borrelli, 2017), however, the extent to which partner and partner smoking status is related to risk factors associated with persistent smoking has not been systematically conducted. To the extent that social and behavioral risk factors for persistent smoking are related, interventions that do not account for social context may be ill-suited to produce lower cessation rates.

Several behaviors have been identified as contributors to the maintenance of smoking behavior. Nicotine dependence, characterized by the number of cigarettes smoked per day and time to first cigarette, demonstrates small but consistent links with early relapse and persistent smoking, especially among younger smokers (Baker et al., 2021; Coambs et al., 1992; Ussher et al., 2016; Vangeli et al., 2011). Additionally, household smoking (i.e., permission to smoke

inside one's home) is linked to facilitating persistent smoking (Mills et al., 2009). As vaping and e-cigarette use has increased over time, patterns of dual-use may contribute to cessation of combustible cigarettes or persistent dual-use (Coleman et al., 2022). Despite extensive research on the health risks of smoking, these behavioral risks for persistent smoking have not been systematically investigated in relation to *social* risks for persistent smoking.

Relationship factors, including the influence of romantic partners, family members, and friends, can also significantly impact smoking behavior (Christakis & Fowler, 2008; Christakis & Fowler, 2013; Etcheverry & Agnew, 2008; vanDellen, 2019; Westmaas et al., 2010). Indeed, people whose social networks smoke—and especially individuals who are members of a smoking dyad—are less likely to quit smoking and more likely to relapse if they do attempt to quit (Dollar et al., 2009; Hawkins et al., 2010; Manchón Walsh et al., 2007). A substantial number of smokers are in relationships, and their smoking behavior is influenced by their partner's smoking status (Homish & Leonard, 2005; Margolis & Wright, 2016).

Social influences are often overlooked as a risk factor for persistent smoking yet are connected to both motivation and ability to quit. Young adult smokers are more likely to initiate a romantic relationship with a smoker who approves of the behavior (Etcheverry & Agnew, 2008, 2009). Friends or family members who smoke may reduce the perceived stigma around smoking or prevent motivation to try to quit (Etcheverry & Agnew, 2008), suggesting these social risk factors may extend beyond only the romantic partner. Smoking cues may be more prevalent in households where multiple members smoke, making it harder to avoid smoking triggers—a recommended intervention strategy (Buczkowski et al., 2014; Cofta-Woerpel et al., 2007). Furthermore, people with smoking partners have to negotiate the tradeoffs between positive health benefits and potential negative interpersonal consequences of quitting. For

example, smoking sometimes serves strategic functions in relationships such as contributing to feelings of perceived similarity (Shoham et al., 2007; Singh & Tan, 1992; Tidwell et al., 2013), serving as a shared activity (Cottrell et al., 2007), and providing a route to managing interpersonal conflict (Rohrbaugh et al., 2009a). Normalization of smoking behavior and the enabling of smoking habits within the home environment (e.g., as exist among dual-smoker couples) create difficulties in avoiding smoking-related stimuli and cues, thus hindering cessation efforts (Escoffery et al., 2009; Farkas et al., 1999).

Other social contexts, such as having children in the home, may reduce risk factors for persistent smoking because they are associated with increased motivation to quit (Lin et al., 2020; Rosen et al., 2012) and bans against smoking in the household (Borland et al., 2006; Escoffery et al., 2009; Okechukwu et al., 2013). Having an infant in the home often serves as a stimulus for implementing bans to protect the child's health (Borland et al., 2006, Hawkins & Berkman, 2011; Okechukwu et al., 2013). Parents who smoke will often adapt their smoking habits by reducing their smoking frequency or change location (e.g., outside of the home), as well as implementing restrictions or total smoking bans to protect their children from secondhand smoke (Kegler et al., 2007; Hawkins & Berkman, 2011). This work suggests that the presence of children might serve as a protective buffer against persistent smoking because of reduced comorbidity with behavioral factors associated with increased smoking.

The Present Research

The purpose of this research was twofold. First, we examined the prevalence of close relationship risk factors among smokers in the United States. Current estimates of the number of dual-smoker couples in the United States range from 33% to 85% (Acquavita et al., 2014; Homish & Leonard, 2005), but this large range makes it difficult to know the importance of

developing interventions for partnered smokers relative to unpartnered ones, or for dual-smoker couples specifically. Furthermore, these estimates often come from small or niche samples, with an emphasis on samples of treatment-seeking individuals who are ready to quit. Given the known importance of smoking partners for quit rates and minimal research on this social risk factor in relation to behavioral risk factors, we emphasized relationship partner status in the investigation. We aimed to characterize relationships with partners in terms of length, cohabitation status, and prior smoking. However, we also explored whether living with other smokers and having children under 18 in the household would demonstrate similar or different patterns of overlap with behavioral risk factors. Second, we examined the overlap between social and behavioral risk factors for continued smoking. We identified three specific behavioral risk factors for examination in this work: smoking heaviness, household smoking, and dual-product use (i.e., vaping and smoking).

Method

Participants

We recruited a convenience sample in two waves of data collection through Prolific, an online research platform that allows for screening based on multiple factors, including location of residence and health behaviors[1]. We restricted the sample to participants living in the United States who had previously indicated currently smoking tobacco cigarettes. Participants were compensated the equivalent of minimum wage for their participation. Despite the prescreening measures put in place, 11% of participants reported that they were not currently smoking cigarettes, leaving a final sample of 2,404 individuals.

Table 1 shows the demographic breakdown of participants. We recruited evenly across gender (48.0% male, 51.2% female, 1.8% non-binary/gender fluid). Smokers were on average 41

years old (*SD* = 11.82) and most reported at least some college or technical school education (80.3%) and earned an individual income less than $60,000 (84.2%). 42% of participants reported having at least one child below the age of 18 in their house. Demographic information on race and ethnicity revealed a bias toward White participants and non-Hispanic or Latino participants. 11% of participants reported that they did not intend to quit smoking; 30% of smokers reported that their partner (if they were a smoker) did not intend to quit smoking.

Measures

Participants completed a survey about their smoking behaviors and social factors. The specific smoking behaviors we assessed were the average number of combustible cigarettes they smoked daily (categorized as less than 5, 5-10, 11-20, 20+), if they vape regularly (i.e., 4 or more days per week [yes/no]), and if they smoke combustible cigarettes inside their house (yes/no). For vaping status, we reasoned that vaping four days per week—more than half of the days in the week—reflected regular use. We did not ask about the substance being vaped (i.e., nicotine, cannabis).

For social factors, we assessed living with children under the age of 18 (yes/no), having a romantic partner (yes/no), and living with any other (nonromantic partner) smokers (yes/no). If participants indicated having a romantic partner, they additionally reported the length of their relationship (in months), if they lived with their partner (yes/no), if their partner smoked combustible cigarettes (yes/no) or vaped four or more days per week (yes/no), and if either person in the relationship smoked combustible cigarettes prior to the relationship (yes/no). If participants indicated living with a smoker other than their romantic partner, they reported their relationship to that person (e.g., mother, aunt, friend).

Data Analysis

Frequencies and descriptive statistics of relevant variables in the dataset were calculated. Because non-parametric tests were used, distributions were not examined for normality. Categorical variables were coded such that higher values reflected riskier behaviors. We conducted chi-square tests and ordinal regressions to compare the frequency of categorical responses. Participants had the option to skip questions and thus the exact sample size from test to test varies slightly due to missing data.

Results

Smoking Characteristics

As Table 2 shows, participants were less likely to a) be heavy (vs. light) smokers, b) be dual-product users (i.e., vape regularly) than smoke primarily cigarettes, and c) allow (vs. restrict) household smoking (i.e., smoke inside their home). As Figure 1 shows, both dual-product use and household smoking varied across smoking heaviness. Dual-product use was more likely among light smokers than heavy smokers, $\chi 2(3)= 85.86$, $p < .001$, OR = 0.42 [0.36, 0.50], and household smoking was more likely among heavy than light smokers, $\chi 2(3)= 123.72$, $p < .001$, OR = 2.1 [1.79, 2.47]. Dual-product use was associated with household smoking, $\chi 2(1)= 4.88$, $p =.027$, OR = 0.80 [0.67, 0.96].

Higher quit intentions were significantly associated with heavier smoking, $\chi 2(1)=4.14$, $p=.041$, OR=1.09[1.00, 1.19], and a greater likelihood of having children in the household, $\chi 2(1)=14.62$, $p<.001$, OR=1.20[1.09, 1.30]. Intending to quit smoking was not associated with dual-product use $\chi 2(1)=1.93$, $p=.164$, OR=1.07 [0.97, 1.18], household smoking $\chi 2(1)=0.91$, $p=.341$, OR=0.96 [0.87, 1.05], partner smoking status $\chi 2(1)=2.16$, $p=.142$, OR=0.92 [0.82, 1.03], or living with another smoker $\chi 2(1)=1.04$, $p=.522$, OR=1.05[0.96, 1.16]. Perceptions of a partner's quit intention was unrelated to social and/or behavioral risk factors.

Interpersonal Context of Smoking

As Table 3 shows, participants were more likely to have than not have a romantic partner and, if they had a romantic partner, to live with that partner and for that partner to be a smoker (vs. non-smoker). Participants reported that they and their partner were more likely to be smokers before they began their relationship than to have begun smoking after the relationship. Participants reported a greater likelihood of living with another smoker (including a romantic partner) than not living with another smoker. Smokers in a romantic relationship were more likely to live with another smoker than those not in a relationship, $\chi 2(1)= 99.11$, $p<.001$, OR =2.68 [2.20, 3.26]. Participants were also less likely to have (vs. not have) children under the age of 18 in the household, $\chi 2(1)= 212.11$, $p < .001$.

Associations with romantic partner characteristics

Having a romantic partner (vs. being unpartnered) was unrelated to heaviness of smoking, dual-product use, or household smoking, *p*'s >.19. However, as Figure 2 shows, smokers with a smoking partner reported heavier smoking compared to those partnered with a nonsmoker, $\chi 2(3)=45.26$, $p <.001$, OR = 0.59 [0.50, 0.69]. Smokers with a smoking partner (i.e., dual-smoker couples) were also more likely to report household smoking, $\chi 2(1)=38.21$, $p <.001$, OR = 1.98 [1.59, 2.46], and dual-product use, $\chi 2(1)=9.19$, $p=.002$, OR = 1.60 [1.33, 1.93].

Associations with cohabitant characteristics

We also considered two specific factors related to cohabitants in the household. First, we examined whether living with another smoker who was *not* a romantic partner was associated with behavioral risk factors. Second, we examined associations of behaviors with having children under the age of 18 in the home. Among un-partnered individuals, living with a smoking *non*-partner was associated with household smoking, $\chi 2(1)=6.32$, $p=.012$, OR=2.02

[0.29, 0.86], but not heavier smoking, $\chi 2(1)=1.54$, $p=.214$, OR=0.84 [0.63, 1.11], or dual-product use $\chi 2(1)=0.89$ $p=.346$, OR=1.30 [0.75, 2.26]. Having children in the home predicted lighter smoking (see Figure 1), $\chi 2(3)=8.00$, $p=.046$, OR=0.66 [0.55, 0.79], a lower likelihood of dual-product use, $\chi 2(1)=21.60$, $p<.001$, OR=0.60 [0.55, 0.79], and lower likelihood of household smoking, $\chi 2(1)=11.97$, $p<.001$, OR=1.37 [1.15, 1.64].

Exploratory Analysis of Racial Differences in Social Environments and Smoking Behaviors

We also explored whether the overlap between relationship contexts and behavioral risk factors varied across race. We systematically crossed participant race (White, non-White), partner smoking status (yes/no), and smoking risk factors to examine variability in these associations. Although we identified significant main effects of race on social risk factors, there were no significant interactions between participant race and partner smoking status on smoking behavior, *p's* > .05, indicating that the relationships between partner smoking status and smoking behavior were consistent regardless of participant race. Main effects of race suggested that White (vs. non-White) participants were *more likely* to live with other smokers $\chi 2(1)=12.27$, $p > .001$, OR=1.51 [1.20, 1.90], have a smoking partner (i.e., be in a dual-smoker couple) $\chi 2(1)=7.84$, $p=.005$, OR=1.46 [1.12, 1.91], and to have children under the age of 18 living in the home $\chi 2(1)=21.89$, $p<.001$, OR=1.68 [1.35, 2.09].

Discussion

The results demonstrate key findings about the social context of smokers. First, nearly 70 % of smokers were identified as being in a romantic relationship, with 52% of smokers in a dual-smoker relationship. Although these characteristics may be common to adults—smoking or not—they have specific implications for how smoking interventions might be implemented or effective. For instance, simply having a romantic partner was not associated with differences in

smoking behaviors. However, among partnered smokers, the smoking status of the partner was associated with different risk profiles of smoking behaviors. Members of dual-smoker couples reported greater behavioral risk factors for continued smoking. Living with a smoker was related to heavier smoking and a greater likelihood of smoking being permitted inside the home. Living with a smoking *partner* was associated with heavier smoking, household smoking, and dual-product use, whereas living with a smoking *non-partner* was only associated with household smoking. In our sample, 42% of smokers reported having children under 18 living in the home. Having children in the home was associated with lighter smoking, less vaping, and less household smoking.

These findings demonstrate the importance of considering how social and behavioral risk factors are comorbid among smokers. Partner smoking status and living with another smoker is associated with factors connected to persistent smoking. As a consequence, these smokers may not respond similarly to interventions as those who are not partnered with other smokers. Our findings are consistent with past research showing that smokers are often partnered with other smokers, including that these concordant health behaviors partially reflect assortative mating (Dollar et al., 2009; Manchón Walsh et al., 2007, Monden et al., 2003).

The present findings point to how motivations, challenges, and barriers faced by smokers may be linked to their close relationship environment. Having a smoking partner (and living with other smokers) increases the likelihood of household smoking, which in turn is associated with heavier smoking and a greater risk of relapse (Borland et al., 2006). Although implementing household smoking restrictions (e.g., partial limitations, designating smoking within certain areas within the home, or complete bans on smoking inside the home) has been shown to facilitate quitting and reduce relapse rates (Borland et al., 2006; Dollar et al., 2009; Escoffery et al., 2009;

Okechukwu et al., 2013), the presence of other smokers in the home can make enforcing these bans challenging. Given the large percentage of our sample who live with a smoking partner or a smoking non-partner, this recommendation may be challenging for many people trying to quit to implement.

The observed association between parenthood and household smoking behavior is consistent with past studies that have demonstrated that the presence of young children in the home is associated with lower rates of smoking inside the house (Borland et al., 2006). Smokers frequently implement total smoking bans to protect their children from secondhand smoke (Escoffery et al., 2009; Hawkins & Berkman, 2011). Thus, parenthood may act as a motivator for individuals to alter their smoking habits. These findings underscore the importance of understanding the social dynamics within households. Efforts to promote smoking cessation should consider these interpersonal factors, tailoring interventions to take advantage of the motivational challenges and benefits faced by individuals living with other smokers or young children.

Additionally, our findings underscore the critical need to better understand dual-product use among smokers. Although vaping is often used as a quitting strategy (Ashour, 2023), many smokers end up using both cigarettes and e-cigarettes concurrently, leading to dual-product use (Coleman et al., 2022; Kechter et al., 2021). This pattern can result in greater financial, addiction, and health burdens compared to single-product use (Chavez et al., 2021; Kristjansson et al., 2015; Park & Choi, 2019; Snell et al., 2020). Dual-product users face heightened nicotine dependence and increased health risks, including respiratory issues, cardiovascular disease, and cancer, due to exposure to harmful constituents from both tobacco smoke and aerosols from e-cigarettes (Choi et al., 2019; Wang et al., 2018). Regular assessment of basic social risk factors

could improve prediction of smoking cessation patterns of abstinence versus switching to vaping and contribute to the development of more tailored interventions with the potential to reduce nicotine addiction in the broader public.

Limitations

The racial and ethnic breakdown of our sample overrepresented White smokers and was not representative of the general population of smokers in the United States (Arrazola, 2023). To address this limitation, we examined the extent to which White and non-White participants differed in several interpersonal and smoking risk factors to understand how these factors contribute to smoking behaviors and patterns differently across groups. Although White (vs. non-White) participants were more likely to have a smoking partner, associations between smoking partners and behavioral risk factors remained consistent across race. This pattern suggests the associations between behavioral and smoking risk factors, specifically those associated with having a smoking partner, are robust across demographics. Thus, the representativeness of our sample is less likely to not constrain the generalizability of our results. Nonetheless, race may still be a determinant relevant to social risk factors, particularly among populations where smoking behavior is deeply embedded in social traditions. For instance, smoking rates among Native American and Indigenous populations often exceed the national average due to cultural factors, historical trauma, and limited access to culturally appropriate resources (Espey et al., 2014; Odani et al., 2017).

This research provides an overview of some of the interpersonal demographics of individuals who smoke in the United States but is not an exhaustive list. Future research could explore the associations between other social risk factors such as cultural influences, media exposure, workplace smoking norms, and additional behavioral risk factors for continued

smoking. For example, workplace smoking may prevent or reduce smoking cessation in similar ways as having a smoking partner or living with a smoker. Furthermore, the complexity of dual-product use (e.g., vaping nicotine vs. cannabis) was not examined, and may be related to relationship contexts. Although there are additional behavioral and social risk factors worth studying, our results demonstrate the utility of understanding how behavioral risks are comorbid with social risk factors. Furthermore, these findings suggest that researchers and practitioners might need to both collect interpersonal context data and take social influences into account in the design of new interventions.

Recommendations and Conclusion

This research meets a specific need of examining the prevalence of social risk factors in U.S. smokers and identifying co-occurrence among social and behavioral risk factors for persistent smoking. Living with other smokers and having a smoking partner were associated with factors connected to persistent smoking including smoking heaviness and permitting household smoking. More exhaustive consideration of these social risk factors may elucidate other mechanisms such that intervention and prevention efforts can be targeted to improve outcomes for treatment-refractory outcomes. Specifically, routinely measuring and reporting social contextual factors of (a) partner/relationship status, (b) partner smoking status, (c) household member/roommate smoking status and (d) presence of children in the household may illuminate differential risk profiles and trajectories based on social context.

The data underlying this article are available in Open Science Framework (OSF), at https://osf.io/s4zy6/?view_only=bdc70dc205b14328a299b180a2ba278d.

Footnotes

Participants were collected in two waves: Wave 1 included 1,741 participants, and Wave 2 included 658 participants. Eligibility criteria and measures were the same across both waves of data collection.

Supplemental Material

Supplemental materials are available online at https://osf.io/s4zy6/?view_only=bdc70dc205b14328a299b180a2ba278d.

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Disclosure Statement

James M. MacKillop is a principal and senior scientist in Beam Diagnostics, Inc. and has served as a consultant to Clairvoyant Therapeutics, Inc. No other authors have disclosures.

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References

Acquavita, S. P., McClure, E. A., Hargraves, D., & Stitzer, M. (2014). Environmental tobacco smoke exposure among smokers and non-smokers receiving outpatient substance abuse treatment. *Addictive Behaviors*, *39*(12), 1718–1722. https://doi.org/10.1016/j.addbeh.2014.07.016

Arrazola, R. A. (2023). US Cigarette smoking disparities by race and ethnicity—Keep going and going! *Preventing Chronic Disease*, *20*. https://doi.org/10.5888/pcd20.220375

Ashour, A. M. (2023). Use of vaping as a smoking cessation aid: A review of clinical trials. *Journal of Multidisciplinary Healthcare*, *16*, 2137–2144. https://doi.org/10.2147/JMDH.S419945

Baker, T. B., Piper, M. E., Smith, S. S., Bolt, D. M., Stein, J. H., & Fiore, M. C. (2021). Effects of combined Varenicline with nicotine patch and of extended treatment duration on smoking cessation: A randomized clinical trial. *JAMA, 326*(15), 1485–1493. https://doi.org/10.1001/jama.2021.15333

Borland, R., Yong, H. H., Cummings, K. M., Hyland, A., Anderson, S., & Fong, G. T. (2006). Determinants and consequences of smoke-free homes: findings from the International Tobacco Control (ITC) Four Country Survey. *Tobacco control*, *15 Suppl 3*(Suppl 3), iii42–iii50. https://doi.org/10.1136/tc.2005.012492

Buczkowski, K., Marcinowicz, L., Czachowski, S., & Piszczek, E. (2014). Motivations toward smoking cessation, reasons for relapse, and modes of quitting: Results from a qualitative

study among former and current smokers. *Patient Preference and Adherence, 1353*. https://doi.org/10.2147/PPA.S67767

Centers for Disease Control and Prevention (CDC) (2022, August). *Current cigarette smoking among adults in the United States.* Centers for Disease Control and Prevention. https://www.cdc.gov/tobacco/data_statistics/fact_sheets/adult_data/cig_smoking/index.ht

Chavez, J., Smit, T., Olofsson, H., Mayorga, N. A., Garey, L., & Zvolensky, M. J. (2021). Substance use among exclusive electronic cigarette users and dual combustible cigarette users: Extending work to adult users. *Substance Use & Misuse*, 56(6), 888–896. https://doi.org/10.1080/10826084.2021.1899234

Choi, H.S., Han, KD., Oh, T.R. *et al.* (2019). Smoking and risk of incident end-stage kidney disease in general population: A nationwide population-based cohort study from Korea. *Sci Rep* **9**, 19511. https://doi.org/10.1038/s41598-019-56113-7

Christakis, N. A., & Fowler, J. H. (2013). Social contagion theory: Examining dynamic social networks and human behavior. *Statistics in Medicine*, *32*(4), 10.1002/sim.5408. https://doi.org/10.1002/sim.5408

Christakis, N. A., & Fowler, J. H. (2008). The collective dynamics of smoking in a large social network. *The New England Journal of Medicine, 358*(21), 2249–2258. https://doi.org/10.1056/NEJMsa0706154

Coambs, R. B., Li, S., & Kozlowski, L. T. (1992). Age interacts with heaviness of smoking in predicting success in cessation of smoking. *American Journal of Epidemiology*, *135*(3), 240–246. https://doi.org/10.1093/oxfordjournals.aje.a116277

Cofta-Woerpel, L., Wright, K. L., & Wetter, D. W. (2007). Smoking cessation 3: Multicomponent interventions. *Behavioral Medicine*, *32*(4), 135–149. https://doi.org/10.3200/BMED.32.4.135-149

Coleman, S. R. M., Piper, M. E., Byron, M. J., & Bold, K. W. (2022). Dual use of combustible cigarettes and E-cigarettes: A narrative review of current evidence. *Current Addiction Reports*, *9*(4), 353–362. https://doi.org/10.1007/s40429-022-00448-1

Cottrell, L., Gibson, M., Harris, C., Rai, A., Sobhan, S., Berry, T., & Stanton, B. (2007). Examining smoking and cessation during pregnancy among an Appalachian sample: A preliminary view. *Substance Abuse Treatment, Prevention, and Policy*, *2*(1), 14. https://doi.org/10.1186/1747-597X-2-14

Dollar, K. M., Homish, G. G., Kozlowski, L. T., & Leonard, K. E. (2009). Spousal and alcohol-related predictors of smoking cessation: A longitudinal study in a community sample of married couples. *American Journal of Public Health*, *99*(2), 231–233. https://doi.org/10.2105/AJPH.2008.140459

Escoffery, C., Kegler, M. C., & Butler, S. (2009). Formative research on creating smoke-free homes in rural communities. *Health Education Research*, *24*(1), 76–86. https://doi.org/10.1093/her/cym095

Espey, D. K., Jim, M. A., Cobb, N., Bartholomew, M., Becker, T., Haverkamp, D., & Plescia, M. (2014). Leading causes of death and all-cause mortality in American Indians and Alaska Natives. *American Journal of Public Health*, *104 Suppl 3*(Suppl 3), S303-311. https://doi.org/10.2105/AJPH.2013.301798

Etcheverry, P. E., & Agnew, C. R. (2008). Romantic partner and friend influences on young adult cigarette smoking: Comparing close others' smoking and injunctive norms over

time. *Psychology of Addictive Behaviors*, *22*(3), 313–325. https://doi.org/10.1037/0893-164X.22.3.313

Etcheverry, P. E., & Agnew, C. R. (2009). Similarity in cigarette smoking attracts: A prospective study of romantic partner selection by own smoking and smoker prototypes. *Psychology of Addictive Behaviors*, *23*(4), 632–643. https://doi.org/10.1037/a0017370

Farkas, A. J., Distefan, J. M., Choi, W. S., Gilpin, E. A., & Pierce, J. P. (1999). Does parental smoking cessation discourage adolescent smoking? *Preventive Medicine: An International Journal Devoted to Practice and Theory, 28*(3), 213–218. https://doi.org/10.1006/pmed.1998.0451

Hawkins, S. S., & Berkman, L. (2011). Parental home smoking policies: the protective effect of having a young child in the household. *Preventive medicine, 53*(1-2), 61–63. https://doi.org/10.1016/j.ypmed.2011.05.016

Hawkins, J., Hollingworth, W., & Campbell, R. (2010). Long-term smoking relapse: A study using the British household panel survey. *Nicotine & Tobacco Research*, *12*(12), 1228–1235. https://doi.org/10.1093/ntr/ntq175

Homish, G. G., & Leonard, K. E. (2005). Spousal influence on smoking behaviors in a US community sample of newly married couples. *Social Science & Medicine, 61*(12), 2557–2567. https://doi.org/10.1016/j.socscimed.2005.05.005

Kechter, A., Cho, J., Miech, R.A., Barrington-Trimis, J.L., & Leventhal, A.M. (2021). Nicotine dependence symptoms in U.S. youth who use JUUL E-cigarettes, *Drug and Alcohol Dependence, 227*. https://doi.org/10.1016/j.drugalcdep.2021.108941.

Kegler, M. C., Escoffery, C., Groff, A., Butler, S., & Foreman, A. (2007). A qualitative study of how families decide to adopt household smoking restrictions. *Family & community health*, *30*(4), 328–341. https://doi.org/10.1097/01.FCH.0000290545.56199.c9

Kristjansson, A. L., Mann, M. J., & Sigfusdottir, I. D. (2015). Licit and illicit substance use by adolescent e-cigarette users compared with conventional cigarette smokers, dual users, and nonusers. *Journal of Adolescent Health*, 57(5), 562-564. https://doi.org/10.1016/j.jadohealth.2015.07.014

Lin, H., Chang, C., Liu, Z., Tan, H. (2020). The effect of the presence of children on adult smoking behaviour: Empirical evidence based on China family panel studies. *BMC Public Health 20*, 1448. https://doi.org/10.1186/s12889-020-09543-2

Lewis, M. A., & Rook, K. S. (1999). Social control in personal relationships: Impact on health behaviors and psychological distress. *Health Psychology*, *18*(1), 63–71. https://doi.org/10.1037/0278-6133.18.1.63

Manchón Walsh, P., Carrillo, P., Flores, G., Masuet, C., Morchon, S., & Ramon, J. M. (2007). Effects of partner smoking status and gender on long term abstinence rates of patients receiving smoking cessation treatment. *Addictive Behaviors*, *32*(1), 128–136. https://doi.org/10.1016/j.addbeh.2006.03.027

Margolis, R., & Wright, L. (2016). Better off alone than with a smoker: The influence of partner's smoking behavior in later life. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *71*(4), 687–697. https://doi.org/10.1093/geronb/gbu220

Mills, A. L., Messer, K., Gilpin, E. A., & Pierce, J. P. (2009). The effect of smoke-free homes on adult smoking behavior: A review. *Nicotine & Tobacco Research*, *11*(10), 1131–1141. https://doi.org/10.1093/ntr/ntp122

Monden, C. W. S., de Graaf, N. D., & Kraaykamp, G. (2003). How important are parents and partners for smoking cessation in adulthood? An event history analysis. *Preventive Medicine: An International Journal Devoted to Practice and Theory, 36*(2), 197–203. https://doi.org/10.1016/S0091-7435(02)00026-9

Odani, S., Armour, B. S., Graffunder, C. M., Garrett, B. E., & Agaku, I. T. (2017). Prevalence and disparities in tobacco product use among American Indians/Alaska Natives - United States, 2010-2015. *MMWR. Morbidity and Mortality Weekly Report*, 66(50), 1374–1378. https://doi.org/10.15585/mmwr.mm6650a2

Okechukwu, C. A., Dutra, L. M., Bacic, J., El Ayadi, A., & Emmons, K. M. (2013). Home matters: work and household predictors of smoking and cessation among blue-collar workers. *Preventive medicine, 56*(2), 130–134. https://doi.org/10.1016/j.ypmed.2012.12.005

Park, M. B., & Choi, J. K. (2019). Differences between the effects of conventional cigarettes, e-cigarettes and dual product use on urine cotinine levels. *Tobacco induced diseases*, 17, 12. https://doi.org/10.18332/tid/100527

Ranby, K. W., Lewis, M. A., Toll, B. A., Rohrbaugh, M. J., & Lipkus, I. M. (2013). Perceptions of smoking-related risk and worry among dual-smoker couples. *Nicotine & Tobacco Research, 15*(3), 734–738. https://doi.org/10.1093/ntr/nts210

Rohrbaugh, M. J., Shoham, V., Butler, E. A., Hasler, B. P., & Berman, J. S. (2009a). Affective synchrony in dual- and single-smoker couples: Further evidence of "symptom-system fit"? *Family Process*, *48*(1), 55–67. https://doi.org/10.1111/j.1545-5300.2009.01267.x

Rohrbaugh, M. J., Shoham, V., & Dempsey, C. L. (2009b). Gender differences in quit support by partners of health-compromised smokers. *Journal of Drug Issues, 39*(2), 329–346. https://doi.org/10.1177/002204260903900206

Rosen, L.J., Noach, M.B., Winickoff, J.P., & Hovell, M.F. (2012). Parental smoking cessation to protect young children: A systematic review and meta-analysis. *Database of Abstracts of Reviews of Effects (DARE): Quality-assessed Reviews* [Internet]. Centre for Reviews and Dissemination. https://www.ncbi.nlm.nih.gov/books/NBK84754/

Shoham, V., Butler, E. A., Rohrbaugh, M. J., & Trost, S. E. (2007). Symptom-system fit in couples: Emotion regulation when one or both partners smoke. *Journal of Abnormal Psychology, 116*(4), 848–853. https://doi.org/10.1037/0021-843X.116.4.848

Singh, R., & Tan, L. S. C. (1992). Attitudes and attraction: A test of the similarity-attraction and dissimilarity-repulsion hypotheses. *British Journal of Social Psychology*, *31*(3), 227–238. https://doi.org/10.1111/j.2044-8309.1992.tb00967.x

Snell, L. M., Barnes, A. J., & Nicksic, N. E. (2020). A longitudinal analysis of nicotine dependence and transitions from dual use of cigarettes and electronic cigarettes: Evidence from waves 1-3 of the PATH study. *Journal of Studies on Alcohol and Drugs*, 81(5), 595–603. https://doi.org/10.15288/jsad.2020.81.595

Tidwell, N. D., Eastwick, P. W., & Finkel, E. J. (2013). Perceived, not actual, similarity predicts initial attraction in a live romantic context: Evidence from the speed-dating paradigm. *Personal Relationships*, *20*(2), 199–215. https://doi.org/10.1111/j.1475-6811.2012.01405.x

Tooley, E. M., & Borrelli, B. (2017). Characteristics of cigarette smoking in individuals in smoking concordant and smoking discordant couples. *Couple & Family Psychology*, *6*(2), 106–116. https://doi.org/10.1037/cfp0000078

Ussher, M., Kakar, G., Hajek, P., & West, R. (2016). Dependence and motivation to stop smoking as predictors of success of a quit attempt among smokers seeking help to quit. *Addictive Behaviors*, *53*, 175–180. https://doi.org/10.1016/j.addbeh.2015.10.020

Vangeli, E., Stapleton, J., Smit, E. S., Borland, R., & West, R. (2011). Predictors of attempts to stop smoking and their success in adult general population samples: A systematic review. *Addiction, 106*(12), 2110–2121. https://doi.org/10.1111/j.1360-0443.2011.03565.x

Wang, J. B., Olgin, J. E., Nah, G., Vittinghoff, E., Cataldo, J. K., Pletcher, M. J., & Marcus, G. M. (2018). Cigarette and e-cigarette dual use and risk of cardiopulmonary symptoms in the Health eHeart Study. *PloS one, 13*(7), e0198681. https://doi.org/10.1371/journal.pone.0198681

vanDellen, M. R. (2019). Health behavior change in transactive systems. *Social and Personality Psychology Compass, 13*(11), e12505. https://doi.org/10.1111/spc3.12505.

Westmaas, J. L., Bontemps-Jones, J., & Bauer, J. E. (2010). Social support in smoking cessation: Reconciling theory and evidence. *Nicotine & Tobacco Research, 12*(7), 695–707. https://doi.org/10.1093/ntr/ntq077

Tables

Table 1.1

Participant Demographic Information and Smoking Characteristics

Variable	% Total Sample (N=2,404)
Gender (%)	
Male	48.0
Female	51.2
Non-Binary/Gender Fluid	1.8
Race (%)	
White or Caucasian	82.0
Black or African American	11.1
American Indian or Alaska Native	1.9
East Asian	2.2
South Asian	1.0
Native Hawaiian or Pacific Islander	0.3
Middle Eastern or North African	0.3
Mixed or Multiple Races	1.1
Ethnicity (%)	
Hispanic or Latino	9.35
Not Hispanic or Latino	90.65
Education (%)	
< High school graduate	22.36

High school graduate	19.8
Some college/technical school	35.1
College/technical school graduate	40.9
Post-college education graduate	4.5
Household Income (%)	8.7
Less than $20,000	22.4
$20,001 to $40,000	29.7
$40,001 to $60,000	24.1
$60,001 to $80,000	16.8
$80,001 to $100,000	7.3
$100,001 or over	10.62
Daily Number of Cigarettes Smoked (%)	
Less than 5	21.2
5-10	28.7
10-20	37.0
20+	13.2
Vaping Status (%)	
Vapes 4 or more days a week	37.2
Does not vape 4 or more days a week	62.8

Note. Participants were on average 41.6 years old (*SD* = 39.82). Immigration status was only collected in wave 1 of data collection; 11.4% of this subsample reported first or second-generation immigrant status.

Table 1.2

Interpersonal Context Variables

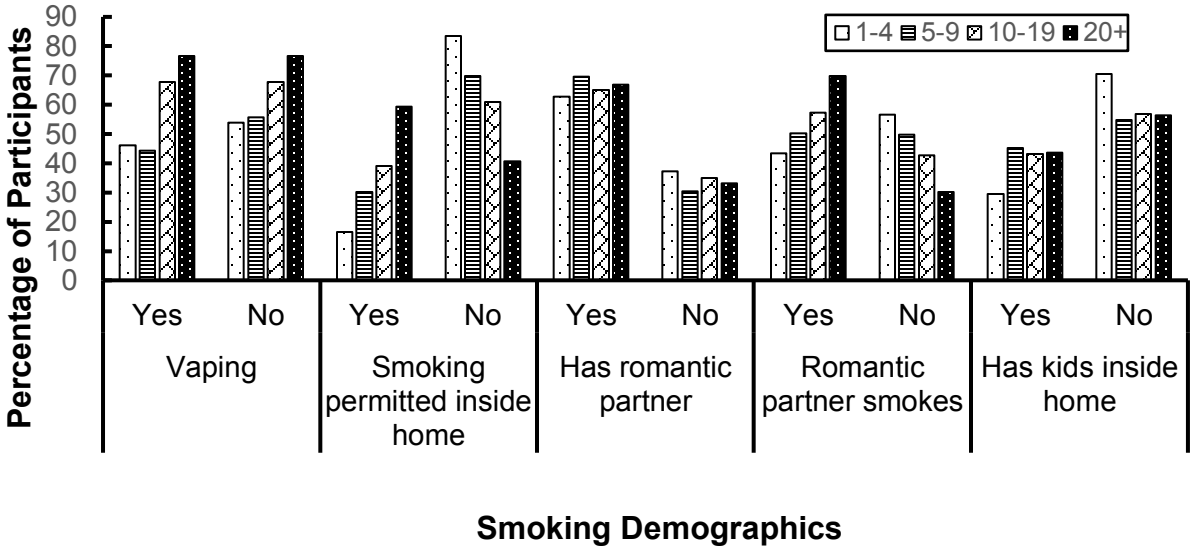
Variable	% Total Sample	% Subsample
Relationship Status (%)***		
No Romantic Partner	33.4	
Other Smokers in the Household***		
Yes		74.5
No		25.5
Romantic Partner	66.7	
Relationship length (years), *M* (*SD*)	9.9 (8.9)	
Living Status (%)***		
Lives with a Romantic Partner		81.8
Does not live with a Romantic Partner		18.2
Romantic Partner Smoking Status (%) **		
Smokes Tobacco		52.2
Does not Smoke Tobacco		47.8
Smoking Cigarettes before Relationship? (%)***		
Yes		89.7
No		10.3
Partner Smoking Cigarettes before Relationship? (%)***		
Yes		60.1
No		39.4

Smokers (other than partner) in the Household (%)***		
Yes		10.9
No		89.1
Do you live with a smoker?***		
Yes	40.4	
No	59.6	
Children <18 in Home Status (%)***		
Yes	42.8	
No	57.5	

Note. Chi-square tests were used to compare distribution of characteristics to that based on chance. ** $p < .01$, *** $p < .001$

Figure 1.1

Participant Relationship Characteristics and Smoking Behaviors



Note. Participant smoking characteristics including relationship demographics (has romantic partner, has kids inside the home) and smoking behaviors (vaping, smoking permitted inside the home, romantic partner smokes). Figure bars represent smoking heaviness reflected in the number of cigarettes smoked per day.

STUDY 2

ROMANTIC PARTNERS AS AUTOMATIC CUES TO SMOKING[2]

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Romantic Partners as Automatic Cues to Smoking

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Abstract

In two studies, we investigated automatic responses to a smoker's romantic partner. Additionally, we explored how smoking behavior, motivation, partner characteristics, and relationship quality are related to these automatic responses. The findings of Study 1 (N = 82 smoking adults) underscore social contexts as strong cues for smoking behavior, with both romantic partners and other social figures evoking craving and heightened emotional responses relative to neutral control stimuli. The findings of Study 2 (N = 240 smokers who were currently in a romantic relationship) demonstrate that romantic partners are associated with smoking in both dual-smoker and single-smoker contexts and characterize individual and relationship factors moderating these associations. These findings highlight that other smokers in a smoker's social environment, including a romantic partner, serve as strong cues for smoking behavior, evoking cravings and emotional responses. This underscores the need to address social influences in smoking cessation strategies to enhance their effectiveness.

Keywords: smoking, smoking cues, dual-smoker couples, close relationships, social cognition

Romantic Partners as Automatic Cues to Smoking

The beliefs and behaviors of a smoker's romantic partner play a key role in the uptake, maintenance, and cessation of smoking (Christakis & Fowler, 2008; Okechukwu et al., 2010; Etcheverry & Agnew, 2008). Of partnered smokers, ~1/3 are in single-smoker couples (i.e., in a relationship with a non-smoker, SSCs) whereas ~2/3 are in dual-smoker couples (i.e., in a relationship with another smoker, DSCs) (Margolis & Wright, 2016; Wright et al., Under Review). Compared to smokers in SSCs, smokers in DSCs smoke more combustible cigarettes, make less frequent quit attempts, and are less likely to stay abstinent (Homish & Leonard, 2005; Margolis & Wright, 2016; Wright et al., Under Review). Living with a smoking partner while trying to quit presents a number of challenges to successful cessation (Cobb et al., 2014; Derrick et al., 2013; Westmaas et al., 2010), and is more common among DSCs (Wright et al., under review). The mechanisms by which romantic partners influence cessation have not been thoroughly examined. Drawing on past research, we examined one plausible mechanism—that romantic partners are associated with smoking and so serve as automatic cues for craving and smoking behavior.

Automatic Processes in Smoking

Smoking is characterized by automaticity, where the behavior is triggered by contextual cues, routines, or other associated activities (Baxter & Hinson, 2001). Smokers form cognitive associations between stimuli (i.e., smoking-related cues) and rewarding effects of nicotine over time, with these associations contributing to nicotine addiction (Engelmann et al., 2012; Kaplan et al., 1983; Ludwig et al., 1974; Shiffman, 1986; Tiffany, 1990; Payne et al., 2007). One approach to understanding automatic cognitive processes underlying tobacco addiction has been to use timed reaction time tasks (Waters and Sayette, 2005; Wiers et al., 2002). Implicit

Association Tasks (IATs; Greenwald et al., 1998) examine implicit attitudes in smokers by assessing automatic affective associations with drug cues (de Houwer et al., 2006; Huijding & de Jong, 2006; Robinson et al., 2005; Swanson et al. 2001; Waters & Sayette, 2005), the relative strength of which are formed through experience, exposure, and socialization. In the IAT, faster and more accurate categorization represents stronger connections. Automatic implicit attitudes about smoking explain variation in addictive behavior beyond controlled processes (Wiers et al., 2002) and are associated with smoking heaviness, cravings, nicotine dependence, and cessation motivation (Huijding & de Jong, 2006; Sherman et al., 2003; Waters and Sayette, 2005; Waters et al., 2012).

Implicit attitudes about smoking capture *affective* associations with smoking, likely reflecting operant condition processes where cues become associated with rewards from nicotine. However, given the importance of cued behavior in smoking, it may be useful to consider not only affective associations but also the more basic non-evaluative associations that exist between environmental, and specifically social, stimuli with smoking. Cues encompass a wide range of stimuli, including environmental, social, and sensory factors, and evoke psychological and physiological responses, leading to increased cravings or the desire to smoke (Conklin, 2006; Conklin et al., 2012). Through classical conditioning, environmental stimuli become associated with smoking through repeated pairing, triggering cravings and physical responses. Cues for smoking behavior develop through contextual pairings (Berridge, 2004; Robinson & Berridge, 1993), sensory stimuli pairings (Martin-Soelch et al., 2007; Stippekohl et al., 2010), and implicit learning mechanisms (Payne et al., 2007). Personal relevance strengthens these associations, making them harder to disrupt (Ferguson & Shiffman, 2009; Shiffman et al., 2014). These cues can be proximal (directly related to smoking) or distal (indirectly linked), with both types

capable of inducing cravings and affecting smoking behavior. In the present work, we focus specifically on the potential for one's romantic partner to become cognitively associated with smoking.

Smoking Cues Trigger Changes in Cravings and Smoking Behavior

Automatic responses to smoking-related cues include intensified cravings, increased arousal, and attentional bias, even without the drug present (Bindra, 1974; Carter & Tiffany, 1999; Field & Duka, 2001; Winkler et al., 2011; Sayette, 2016). Exposure to smoking-related cues also predicts increased smoking behavior (e.g., latency to smoke, puff volume, number of puffs; Betts et al. 2021; Conklin et al., 2015; Shiffman et al., 2012). Smokers experience heightened attention to cues, making it difficult to ignore cravings (Begh et al., 2016; Waters et al., 2003) and often cite cues as major obstacles to quitting (Ferguson & Shiffman, 2009). Cues not directly linked to smoking (i.e., distal cues) evoke similar reactions, indicating that smokers react to both direct and indirect smoking-related cues (Conklin, 2008; Stöffelmayr et al., 2003).

Social Cues

Just as certain stimuli and environmental cues influence smoking behavior, preliminary evidence indicates that *other people* might also serve as powerful triggers capable of affecting smoking intentions and behaviors. The presence of other smokers, especially friends who smoke, can trigger cravings and lead to smoking behavior (Shiffman, 1986; Shiffman et al., 1996). Exposure to individuals around whom one usually smokes has been shown to lead to higher levels of subjective cravings, increased negative affect, and excitement, as well as shorter smoking latency (Conklin et al., 2013). Socializing with non-smokers can help quit attempts (Tedeschi et al., 2020; Zhu et al., 2006), potentially because non-smokers are less associated with smoking. These patterns indicate that people can become cues and trigger cravings and

smoking behavior, even in the absence of the drug. Over time, conditioned responses develop, leading to the association of the individual's presence with smoking, which can lead the predisposed individual to experience cravings or the urge to smoke. DSCs might be particularly at risk of having strong associations with their partner and smoking due to their partner's association with many types of triggers and the frequency of shared smoking while in their company.

Romantic Partners as Potentially Salient Smoking Cues

Foundational studies on topics including spousal similarity, spousal influence, and assortative mating indicate that a smoker's romantic partner exerts substantial influence on their behavior within their social network (Etcheverry, Hoffman, & Agnew, 2010; Houts, Robins, & Huston, 1996; Sutton, 1993). This influence is heightened by the frequency of time spent together and the increased level of intimacy that occurs in romantic relationships. Concordance in health beliefs and behaviors between romantic partners (e.g., sharing cigarettes or smoking together) exacerbates initial similarity, leading to similar smoking patterns (Huelsnitz et al., 2022; Cornelius et al., 2016; Tooley & Borelli, 2017). Shared smoking environments and experiences within romantic partnerships create a dynamic interplay of proximal and distal cues, such as shared sensory stimuli and joint smoking rituals (e.g., smell and taste of tobacco, smoking cigarettes together while talking about their day), as well as shared external triggers like social situations or stress. Empirical evidence implicates but has not directly examined the capacity for romantic partners to serve as salient smoking cues. Research by Conklin and colleagues (2013) was the first to demonstrate that like other smoking-related stimuli, exposure to individuals around whom one usually smokes leads to increased cravings, negative affect, and excitement (Conklin et al., 2013). These findings did not specify the specific *social role* of the

social stimuli, but there is a compelling rationale to believe that a smoker's romantic partner might function as an especially salient cue. In the present study, we specifically investigate *romantic partners* as smoking triggers, as well as correlates of these automatic associations.

The Present Study

The present research serves as an empirical replication and theoretical extension of prior research on how people serve as cues to smoke. In two studies, we investigated automatic associations between partners and smoking among partnered smokers. In Study 1, we used a cue-reactivity task to determine the extent to which a smoker's romantic partner serves as a smoking trigger relative to others around whom they do not smoke and relative to a neutral cue. We modified past research (Conklin et al., 2013) to invoke cues through a visualization task. In Study 2, we employed an Implicit Association Task (IAT) to examine implicit associations between a romantic partner and smoking stimuli. Whereas past nicotine IATs have captured *affective* associations between positivity and smoking, we created an IAT that captured *cognitive* associations between one's partner and smoking.

We hypothesized that romantic partners would elicit stronger reactions relative to the other stimuli (Study 1) and would elicit craving beyond usual level of urges to smoke. We also hypothesized that automatic responses to romantic partners would be associated with smoking behavior (e.g., nicotine dependence) and relationship dynamics (e.g., satisfaction and support) (Study 2), and that these patterns would emerge more strongly for partners who are heavier smokers themselves. We also explored the degree to which participant smoking patterns, partner smoking characteristics, and relationship dynamics related to the intensity of partner associations with smoking.

Study 1

Method

Participants

We recruited 82 smoking adults who had previously completed an eligibility screener for research on smoking in couples. Eligibility requirements were determined through this screener and included a) currently or recently smoked cigarettes b) 18+ years old, and c) romantically partnered for >6 months. Participants received a $10.00 virtual gift card. Participant smoking characteristics are reported in **Table 2**. Most participants were light smokers (5-10 cigarettes/day) and partnered with another smoker who was also a light smoker.

Procedure

Participants completed an online survey on their smoking history, smoking behavior, relationship quality, and their partner's smoking behavior. We then utilized a within-subjects cue-reactivity design to assess partner associations with smoking. Participants completed three visualization tasks for 60 seconds in counterbalanced order. In the visualization tasks, participants reflected on: a) the physical features of their romantic partner, b) the physical features of someone they see but do not smoke around (i.e., the *unexposed* condition), and c) a bowl of fruit. Following prior research (Conklin et al., 2013), participants reported negative affect, positive affect, excitement, cravings to smoke, and calmness on a scale from 0 (*low*) to 100 (*high*) after each visualization. Finally, participants completed measures of their readiness and confidence to quit smoking within the next month.

Measures

Nicotine Dependence

Nicotine dependence was measured using the Fagerstrom Scale of Nicotine Dependency (Heatherton et al., 1991), a 6-item scale that reflects how much nicotine dominates participants' thoughts and behaviors.

Partner Support

Support was measured in three ways comprising positive support, negative support, and responsive support. *Positive and negative support* were measured using the Partner Interaction Questionnaire (PIQ; Mermelstein et al., 1983) comprising 10 items assessing frequency of negative support (α = .89) and 10 items assessing frequency of positive support (α = .92), *Responsive support* (α = .88) was measured using an 18-item scale (1=*Strongly Disagree,* 7=*Strongly Agree*; Leckfor et al., under review). Example statements include "I respect my partner's decisions when it comes to quitting tobacco" and "I understand the challenges my partner would face trying to quit tobacco."

Relationship Dynamics

Communal orientation (α=.79) was measured using 8-items (e.g., "My partner is willing to endure a lot of stress in order to help me quit smoking" (1=*Strongly Disagree,* 7=*Strongly Agree*). *Relationship satisfaction* (α = .65) was measured using the 4-item Couple Satisfaction Index ***(****CSI-4;* Funk & Rogge, 2007). Participants responded to items on 1 (*Not at all True*) to 7 scale (*Completely True*).

Smoking Urges

The urge to smoke was measured with the 10-item Questionnaire of Smoking Urges (α=.94; Tiffany & Drobes, 1991). This scale was included as a potential covariate to control for

momentary cravings affecting responses outside of the visualization task. Sample questions include “nothing would be better than smoking a cigarette right now” and “I could control things better right now if I could smoke.”

Motivation for Self and Partner Quit

Participants responded to the three-item Motivation Rulers (Boudreaux et al., 2012) about a) their motivation to quit smoking and b) their perceptions of their partner’s motivation to quit smoking using a 10-point scale (1=*Not at all*, 10=*Very*). Partner motivation was measured by adapting the scale items (e.g., "How confident are you that your partner will quit smoking within the next month?"

Results

Analyses were conducted using SAS version 9.4. Prior to analysis, data were cleaned to address missing values, outliers, and to verify the integrity of responses. Descriptive statistics including means and standard deviations for measured variables are reported in **Table 3**. We ran a repeated measures analysis of variance (ANOVA) to examine the effects of the three conditions. Post hoc tests were conducted to further explore pairwise differences between conditions. Mean cravings, negative affect, calmness, and excitement across condition are presented in **Table 4.**

Cravings

There was not a main effect of condition on cravings, $F(2, 220)=2.69$, $p=.070$, $R^2=.024$. However, pairwise differences did emerge. Participants reported higher cravings in the romantic partner compared to the control condition, $t(220)=2.32$, $p=.021$, $d=0.38$, but not compared to the unexposed condition, $t(220)=1.04$, $p=.300$, $d=0.17$. The unexposed and control conditions did not differ, $t(220)=1.27$, $p=.205$, $d=0.21$. Because craving was also associated with general “urges

to smoke (r = .50), we also examined the effect of condition controlling for general urges to smoke, potentially eliminating condition independent variance. The main effect of condition became significant when controlling for urges, $F(2, 215)=3.56$, $p=.030$, $d=0.18$. When controlling for urges, participants in the romantic partner condition reported significantly higher cravings compared to the control condition $t(212)=2.66$, $p=.008$, $d=0.44$, but not compared to the unexposed condition, $t(212)=1.17$, $p=.242$, $d=0.20$. Craving levels did not differ between the unexposed and the control conditions when controlling for urges, $t(212)=1.50$, $p=.138$, $d=0.25$.

Positive and Negative Emotions

Analyses revealed a main effect of condition on excitement, $F(2, 220)=9.43$, $p<.001$, $R^2=.077$. Participants reported higher levels of excitement in the romantic partner condition compared to both the unexposed, $t(220)=3.40$, $p<.001$, $d=0.55$, and the control conditions, $t(220)=4.04$, $p< .001$, $d=0.65$. The unexposed condition and the control condition did not differ, $t(220)=0.62$, $p=.534$, $d=0.10$. Additionally, we found a significant main effect of condition on negative affect, $F(2, 220)=6.86$, $p=.002$, $R^2=.063$. Participants reported significantly higher levels of negative affect in the romantic partner condition compared to the control condition, $t(220)=3.63$, $p<.001$, $d=0.63$. Participants in the unexposed condition reported significantly higher levels of negative affect compared to the control condition, $t(220)=2.49$, $p=.014$, $d=0.42$. Negative affect did not differ between the romantic partner condition and unexposed condition $t(220)=1.21$, $p=.226$, $d=0.20$. Analyses revealed no main effect of condition on positive affect, $F(2, 220)=0.99$, $p=.372$, $R^2=.009$. Lastly, there was a significant main effect of condition on calmness, $F(2, 220)=3.71$, $p=.026$, $R^2=.032$. Participants reported higher levels of calmness in the control than in the unexposed condition, $t(220)= -2.70$, $p=.007$, $d=0.44$. The romantic partner

condition did not differ from the unexposed, $t(220)=1.07$, $p=.286$, $d=0.17$, or control conditions, $t(220)= -1.64$, $p=.102$, $d=0.44$.

Associations with Cue Reactivity

Because we were particularly interested in reactions to a smoker's romantic partner, we examined associations between reactivity in the romantic partner condition with smoking behaviors and relationship dynamics. **Table 3** shows these associations for reactivity in the romantic partner condition only. Level of cravings following the romantic partner cue were positively correlated with general smoking urges as well as level of partner positive support, and negatively correlated with nicotine dependence. Calmness following the romantic partner cue was associated with one's own importance to quit, received negative and responsive support, and partner's communal orientation. Excitement following the romantic partner cue was positively correlated with responsive support, partner's communal orientation, and responsive support and negatively correlated with negative support. Positive affect following a romantic partner cue was positively associated with partner communal orientation and received responsive support.

Discussion

Romantic partners served as a cue to evoke both smoking cravings and other affective responses relative to a neutral control condition, even when controlling for momentary urgers. This suggests that romantic partners (most of whom smoke themselves) may play a role in prompting smoking, and given their frequent presence their role may be outsized relative to other automatic cues. Romantic partners and other people around whom smokers did not smoke (i.e., the unexposed condition) elicited similar craving responses, suggesting that although romantic partners may serve as a strong cue, they may not be unique. Rather, it may be that social context is a common cue for craving.

Additionally, results from this study provide insight into how cravings in response to a romantic partner cue are linked to individuals' smoking and relationship characteristics. The positive correlation with general level of smoking urges suggests that the experience of urges is a common experience, but controlling for general level of urges strengthen the association of craving in the presence of romantic partner cue. Moreover, the positive association with cue strength and positive support indicates that supportive behaviors from a partner may influence the experience of cravings, paradoxically making the partner a stronger automatic cue for smoking. The negative association with nicotine dependence highlights that individuals with higher levels of dependence may experience fewer cravings in response to partner-related cues. For highly dependent smokers, their strong physical dependence on nicotine might diminish the sensitivity or reactivity to cues associated with their partner, potentially due to their greater habituation to smoking triggers more broadly.

Study 2

In Study 2, we aimed to address limitations and extend findings from Study 1. First, we recruited a larger sample to increase generalizability and improve reliability of results. Second, we recruited smokers partnered with another smoker and smokers partnered with a non-smoker. This process allowed us to compare results between single and dual-smoker couples, enabling a more comprehensive understanding of how romantic partners are associated with smoking. Third, we used a different methodological approach—the Implicit Association Task (IAT)—to measure cognitive associations between a romantic partner and smoking-related stimuli, complementing the self-report measures of cravings and mood used in Study 1.

Method

Participants

U.S. smokers were recruited via Prolific and compensated the equivalent of minimum wage (USD) for participation. We recruited 240 smokers who were currently in a romantic relationship. Participants had to be over the age of 18, currently smoking at least 5 cigarettes per day, and in a romantic relationship for at least 3 months. Individuals could be partnered with either a non-smoker (SSC) or smoker (DSC) to be eligible. Twenty-one participants were excluded because of missing data or because they requested to withdraw their data, resulting in a final sample of 219. Slightly more participants reported being married (67.6%) than in a committed relationship (32.4%). Participants had been together between 5 months and 42 years (M=14.93 months, SD=11.28) and nearly all (91.5%) were cohabitating. More participants were partnered with a smoker (n =119) than with a non-smoker (n =94). **Table 5** presents smoking characteristics for participants.

Procedure

Participants completed an IAT designed to measure cognitive associations between a smoker's romantic partner and smoking-related stimuli. After completing the IAT, participants reported on their smoking behaviors and motivation, their partner's smoking behaviors and motivation, and their romantic relationship.

Implicit Associations Task

The IAT (Greenwald et al., 1998) is a psychological research tool for measuring cognitive associations between target pairs and a category dimension by measuring the speed with which participants can categorize target stimuli under various conditions. In this study, the IAT was generated using the IAT gen software (Carpenter et al., 2024) and employed to assess

implicit associations between one's romantic partner and smoking. The IAT consisted of seven blocks (i.e., sets of trials), each manipulating the pairing of target concepts to assess the strength and direction of automatic associations. In each trial, participants were presented with a series of stimuli (e.g., words) on the screen. Stimuli represent "targets" (e.g., insects, flowers) or categories (e.g., pleasant, unpleasant).

The seven blocks consisted of 1) Practice of categorization for the target concept (smoking/not smoking); 2) Practice of categorization for the category (romantic partner/not romantic partner); 3) Trial block of combined categorization task (Task 1) (smoking + romantic partner/not smoking + not romantic partner); 4) Main block for Task 1; 5) Practice of categorization for the target concept but with the response keys reversed from the 1) assignment (not smoking/smoking); 6) Trial block of alternative combined categorization task (Task 2) (e.g., not smoking + romantic partner/smoking + not romantic partner); 7) Main block for Task 2. The order in which participants perform the combined categorization blocks (i.e., 3–4, and 6–7) was counterbalanced across participants. When stimuli appeared, the participant was instructed to sort the stimulus into predefined categories as rapidly as possible by pressing the E or I keys with either their left (E key) or right (I key) hands. The sides with which one should press were indicated in the upper left and right corners of the screen. Response speed was measured in milliseconds.

Measures

Explicit measures

Daily Cigarettes. Participants reported their average number of cigarettes smoked per day as well as perceptions of their partner's average daily cigarettes smoked.

Nicotine Dependence. Nicotine dependence was measured using the Fagerstrom Scale of Nicotine Dependency (Heatherton et al., 1991), a 6-item scale that reflects how much nicotine dominates participants' thoughts and behaviors.

Smoking Urges. The urge to smoke was measured with the 10-item Questionnaire of Smoking Urges (Tiffany & Drobes, 1991). Participants responded to items that represented the desire to smoke (α = .96; 1 = *Strongly Disagree* to 100 = *Strongly agree*).

Motivation for Self and Partner Quit. As in Study 1, participants responded to the three-item Motivation Rulers (Boudreaux et al., 2012) about a) their smoking motivation and b) their perceptions of their partner's smoking motivation using a 10-point scale (1= *Not at all*, 10 = *Very*). Additionally, participants responded to the single-item *Motivation to Stop Scale* (MTSS; Kotz et al., 2013) for themselves and perceptions of their partner (if their partner was a smoker).

Joint Smoking Behavior. Participants responded to three items about their shared smoking habits with their partner. Participants indicated the frequency with which they smoke with their partner, "How often do you smoke cigarettes together with your partner" on a 1 *(Never)* to 5 scale *(Always).* Next, they indicated if they had a special place to smoke together, "Do you have a special place where you smoke cigarettes with your partner"?*(Yes/No).* "Do you smoke the same brand of cigarette as your partner?" *(Yes/No).* Lastly, they reported if they had previously tried to quit together*,* "Have you and your partner ever tried to quit cigarette smoking together?" *(Yes/No).*

Partner Support. Partner support was measured in the same three ways as in Study 1. Participants reported positive support, negative support, and responsive support. *Partner support* was measured using the Partner Interaction Questionnaire (PIQ; Mermelstein et al., 1983). Participants reported the frequency of specific positive and negative partner behaviors. It is

comprised of 10 items that assess negative support (α = .93) and 10 items that assess positive support (α = .93). *Responsive support* (α = .96) was measured using an 18-item scale (Leckfor et al., in preparation).

Relationship Dynamics. Relationship influence and quality were captured with measures of communal orientation, partner influence, smoking interdependence, and relationship satisfaction. *Communal orientation* (α = .92) was measured using 8-items as described in Study 1. *Partner influence* was measured using 27-items about how their romantic partner influences their thoughts, feelings, and behaviors on a 1 (*Strongly Disagree*) to 7 scale (*Strongly Agree*). "My partner influences the values that I hold" and "My partner influences how I spend my free time." *Smoking interdependence* was measured using 20-items (Tooley et al., 2023). Participants reported how often various events occurred in relation to smoking in situations with their partner during the last month on a 1 (*Never*) to 5 (*Always*) scale. Events included "I feel like smoking when I am relaxing with my partner," "I feel like smoking when I feel like I have let my partner down," and "I feel like smoking when my partner criticizes my smoking." *Relationship satisfaction* (α = .75) was measured using the 4-item Couple Satisfaction Index **(**CSI-4***;*** Funk & Rogge, 2007).

Implicit measures

Participants completed a survey-based IAT in Qualtrics comparing "smoking" and "non-smoking" targets on a "romantic partner" versus "not romantic partner" dimension (stimuli in Appendix B) with the goal of assessing relative smoking urges for a romantic partner over others. Error feedback was provided by displaying an "X" for 300 ms (Greenwald et al., 1998). We used 13 cigarette (e.g., lighter, menthol, ashtray, nicotine, pack, carton) and 13 neutral words (e.g., fruit, movie, shoes, tv, book, exercise, church) for the smoking and not smoking categories

respectively. We used 13 words to capture the romantic partner concept (e.g., date, spouse, marriage, partner, intimacy, love) and 13 words to capture the social but not-romantic partner concept (e.g., acquaintance, colleague, platonic, peer, friend, alone, pal). Smoking stimuli were chosen to be related to the specific context of smoking (i.e., reflect external stimuli or actions associated with consumption of combustible cigarettes) and are similar to the words used in past IAT research on smoking (Robinson et al., 2005; Waters & Feyerabend, 2000; Waters et al., 2008). Words for the romantic partner category were chosen to capture specific cognitive representations above and beyond what would be expected for a platonic relationship. Neutral words (non-smoking stimuli and non-romantic partner category) were chosen to capture aspects of daily life but were not related to smoking behavior or primarily to the romantic relationship context. Content experts reviewed the stimuli and suggested alternates prior to compiling the final list (see Appendix C). The premise of the IAT is that sorting words will be easier—and therefore someone will be faster—when words that are associated with each other (e.g., romantic partner + smoking) are paired in the same location for sorting. When associated category pairings are reversed (and therefore sorted in different locations), people should have to work to override their automatic reaction, and their response time should thus be slower. Because participants complete the sorting task in both combined formats; the degree to which one is faster in one section or the other is a measure of the strength of their implicit cognitive associations between categories.

Results

Analyses were conducted using SAS version 9.4. Descriptive statistics including means and standard deviations for measured variables are reported in **Table 6**.

IAT Data Preparation

The IAT compared responses between two conditions, one involving stimuli related to romantic partners and the other involving stimuli related to other people (not romantic partners). IAT data were processed using the *D*-score data cleaning and scoring algorithm recommended to derive the IAT effect (Greenwald et al., 2003, Lane et al., 2007). This scoring algorithm involves computing the difference score between mean response times per trial on Task 1 and Task 2 and dividing the difference score by the pooled standard deviation of response times. The resulting IAT effect, D, reflects the relative strength of association of constructs, in this case, the degree to which romantic partners are paired with smoking to a greater extent than non-partners are paired with smoking. The timeout rate was low at 0.28% of trials, and 14 participants were excluded due to excessive speed. The overall error rate was 12.6%. Errors were replaced with participant block means of correct trials plus 600 ms (i.e., D600 procedure; Greenwald et al., 2003). The analysis of the IAT data involved 219 participants.

A Cronbach's alpha coefficient was calculated to assess the internal consistency of responses within the IAT to ensure that trials measured the same underlying construct consistently. IAT Gen uses the De Houwer and De Bruyker (2007) procedure in which trials are sorted by target/category and then scored based on odd/even trials to ensure an even distribution of stimuli in both halves. Correlations are then calculated between the two, with a split-half spearman-brown correction (Carpenter et al., 2024). IAT reliability tends to fall between .70 and .90 (Hofmann et al., 2005). The observed Cronbach's alpha of .87 indicates a high level of reliability in how participants in the present study associated these concepts as smoking or non-smoking related.

IAT Results

The results showed a significant difference in the tendency to associate a romantic partner with smoking relative to the tendency to associate platonic relationships with smoking, $D = 0.73$ ($SD = 0.40$), $t(197)=25.70$, $p < .001$, $d = 1.83$). D scores did not differ between participants in DSCs ($M=0.74$, $SD=0.40$) or SSCs ($M=0.72$, $SD=0.40$), $t(211)=0.71$, $p=.480$, $d=0.10$.

Associations with Cue Reactivity

To assess associations with the IAT scores, we calculated correlations between these IAT scores and various smoking-related behaviors and motivations, as well as relationship variables available in our dataset. **Table 6** reports correlations for the full sample, with constructs that were only assessed among DSCs indicated as such. Correlations show that implicit association scores were significantly associated with partner daily cigarettes smoked, smoking interdependence, responsive support, couples' smoking together, and partner influence.

Discussion

Results from Study 2 provide insight into the automatic cognitive connections between a smoker's romantic partner and smoking-related stimuli. The strong, positive *D*-score indicates participants were significantly faster at associating their partners with smoking-related concepts compared to control-stimuli. Because these associations may operate outside of conscious awareness, individuals may not be fully aware of how their romantic partners serve as cues. Unexpectedly, these associations were similarly strong among DSCs and SSCs.

Results also revealed correlations between the IAT effect and relationship dynamics. The pattern of associations revealed a consistent pattern: as smoking interdependence and supportive behaviors increased, so did the strength of the association between a romantic partner and

smoking. Smoking or non-smoking partners who accept or encourage smoking behaviors and offer positive support related to smoking, can become a trigger for cravings and smoking urges. These results echo the pattern observed in Study 1 where positive support for smoking cessation was associated with *greater* cue strength from the partner. In DSCs, smoking partners who share smoking cues and engage in smoking activities together are more likely to reinforce each other's smoking habits, Conversely, feeling more controlled by the partner was associated with a slightly weaker association, suggesting perceived control or pressure from a partner to quit smoking might reduce the automatic association between the partner and smoking, potentially because such dynamics introduce a negative aspect to the relationship that disrupts the positive reinforcement cycle.

General Discussion

Across two studies, we found evidence of automatic associations between smoking and smokers' romantic partners. In Study 1, participants exhibited higher levels of craving, negative affect, and excitement in the romantic partner condition compared to a control condition. Cue reactivity to cravings, negative affect, positive affect, and calmness were similar for the romantic partner condition and the unexposed condition. In Study 2, the IAT further corroborated these findings, revealing a significant association between a smoker's romantic partner and smoking cues. IAT results demonstrate that smokers have a strong cognitive link between their romantic partners and smoking-related stimuli, indicating that these associations may be automatic and may operate at a subconscious level.

Social influences, particularly the people smokers spend significant time with impact smoking behavior in oftentimes imperceptible ways. Friends, family members, and potentially especially romantic partners can either reinforce or discourage smoking habits. When smokers

are surrounded by other smokers, the social environment normalizes and perpetuates the behavior through shared activities and support. Conversely, being around non-smokers can create social pressure to quit or reduce smoking due to less acceptance of the habit. This dynamic extends to romantic relationships. Results from the present research suggest that a smoker's romantic partner can function as a smoking trigger, influencing emotional responses and craving levels. Findings indicate that partners who smoke, engage in heavier smoking, cohabitate, and engage in smoking activities together (e.g., smoking together, in the same location, or the same brand of cigarettes) are more likely to reinforce each other's smoking habits. Partners with these characteristics may serve as more potent cues due to the repeated paired association between them and smoking-related stimuli, strengthening automatic associations. Additionally, relationships that are longer, and more interdependent, may function as stronger cues because of the increased opportunities, and motivation (Fitzsimons et al., 2015) for individuals to influence each other's smoking behavior, and for triggers to become deeply embedded within the interdependent system. Across both studies, positive support for quitting was associated with greater cue strength. This entrenchment means that partners not only influence each other's smoking behavior but also become significant cues that trigger smoking-related thoughts and behaviors.

The findings of Study 1 are interesting in light of recent research by Zayas and colleagues (2014) on implicit bivalence in romantic relationships which demonstrates that within romantic relationships, individuals can hold conflicting attitudes (i.e., both positive and negative feelings) toward their romantic partners at a subconscious level (Zayas & Shoda, 2015; Zayas et al., 2022). Our results demonstrate that individuals experienced these mixed feelings as well, including positive (e.g., calmness) and negative affect in response to romantic partner cues,

suggesting the presence of conflicting feelings about their romantic partner. Correlations also revealed that cue-reactions to a romantic partner were associated with both positive support and smoking urges. Combined, these results indicate that romantic partners may play a dual role as both triggers and sources of support in smoking cessation efforts. These attitudes could lead to mixed signals and inconsistent support, creating unpredictability and tension that complicate decision-making and conflict resolution in relationships. Partners may not fully recognize these subtle influences, making it challenging to address issues effectively. Future research could employ experience sampling methodology where couples report their feelings towards each other, cravings, and smoking behavior. This approach would allow for the examination of daily fluctuations in implicit attitudes and their immediate impact on smoking-related behaviors and relationship dynamics. Additionally, longitudinal research might examine how implicit bivalent attitudes in romantic relationships (e.g., partner is both supporter and cue to smoke) affect the success rates of joint smoking cessation attempts over time. By tracking changes in these variables, the study would help uncover how the reconciliation of conflicting feelings between partners influences their ability to support each other in quitting smoking.

Associations between smoking and one's romantic partner could influence smoking behavior in several ways. They may contribute to the maintenance of smoking habits by reinforcing the link between smoking and positive aspects of the relationship such as intimacy or shared activities. Additionally, these implicit associations may influence smoking cessation efforts. For individuals trying to quit smoking, the presence of their partner—who is intricately linked with smoking—may act as an automatic cue that triggers cravings, making it more difficult to resist the temptation to smoke. Furthermore, the associations with cue-reactivity and various smoking-related variables, suggest that these implicit associations may have broader

implications for the development of smoking behavior within relationships. For example, individuals with stronger implicit associations may be more likely to adopt similar smoking behaviors as their partner, leading to greater smoking interdependence within the relationship. By uncovering these automatic processes, this study highlights the need to consider the social context in understanding and addressing smoking behavior.

In Study 2, we found evidence that implicit associations did not differ between DSCs and SSCs, suggesting that regardless of smoking status, a smoker's romantic partner can become entrenched in smoking behaviors and could trigger or promote smoking behavior. Other mechanisms besides partner smoking status may be important to consider in the development of associations between a romantic partner and smoking-related stimuli. First, normalization of smoking behavior might lead to perceived norms and attitudes toward smoking within the relationship that strengthen implicit associations (Etcheverry et al., 2008; Etcheverry et al., 2009). Partners who tolerate or accept smoking (e.g., smoking inside the home) might become associated with these activities, regardless of whether they also smoke. Second, shared environmental cues might contribute to the habituation and desensitization of smoking due to frequent exposure. The emotional significance of a partner in the context in which smoking takes place (e.g., individuals who accompany their partner on smoke breaks) could be enough to develop associations. Third, in both DSCs and SSCs, relational and emotional factors of the relationship itself might play a role. For example, smoking behavior that is tied to anticipation of and/or reactions to a romantic partner (e.g., intimate moments, conflict, or as a way to cope with relationship stress) could become embedded in the relationship. Lastly, support and influence from a partner could inadvertently become tied with smoking activities. Frequent communication about smoking—even language focused on quitting–could reinforce cognitive associations with

smoking. Understanding how these automatic processes develop and operate in SSCs and DSCs can inform more effective smoking cessation interventions that consider the influence of close relationships on smoking.

Limitations and Future Research

There are several limitations of this work that should be acknowledged and addressed in future research. Firstly, the use of the IAT in Study 2 presents challenges in interpreting the results within the context of smoking behavior. While the IAT is valuable for assessing implicit associations, it relies on participants' response times to categorize stimuli, which can be influenced by factors like attention, motivation, and familiarity with the task. Additionally, the IAT measures associations at a specific point in time and may not capture the dynamic nature of implicit attitudes and behaviors over time. The IAT has been subject to criticism regarding its validity and reliability, despite initial evidence supporting its reliability, convergent validity, and discriminant validity. Concerns have been raised regarding its construct validity, risk for implicit bias, test-retest reliability, measurement error, response bias, and generalizability across populations and contexts (Fiedler et al., 2006; Vianello & Bar-Anan, 2021). However, these criticisms often pertain to interpretations of IATs assessing implicit bias and racial attitudes, which may not directly apply to the present topic. Despite these limitations, the IAT remains a valuable tool for exploring implicit associations and their potential impact on smoking behavior. However, findings should be interpreted cautiously and in conjunction with other methods to provide a more comprehensive understanding.

Additionally, while this study’s focus on romantic partners highlights a novel target, dynamics between other types of close relationships (i.e., roommates, friends, family members) warrant additional investigation. Future work should investigate how people in the same

environment serve as cues. For example, exploration of different environments where cues might be inevitable (i.e. coworkers in a work environment) might elucidate the development of unintentional cue exposure in a place where people spend much of their time. Lastly, although we collected it in Study 2, the lack of participant demographic data in Study 1 limits generalizability.

Conclusion

This study provides evidence of automatic associations between smoking-stimuli and smokers' romantic partners. These associations are likely explained, in part, by the integral role a romantic partner plays in an individual's daily life. Furthermore, it suggests that these associations can impact smokers' craving, emotional responses, and smoking behavior. These findings highlight the dual role romantic partners (and other smokers in their social network) play in both supporting and triggering smoking, complicating smoking cessation efforts. Future research should continue to explore these dynamics across both single- and dual-smoker couples, to develop tailored strategies that address the unique challenges posed by these automatic processes in romantic relationships. For example, interventions aimed at leveraging the relationship dynamics of DSCs to promote joint quitting as a means to address smoking cues and foster mutually conducive environments for quitting.

References

Aschbrenner, K. A., Patten, C. A., & Brunette, M. F. (2018). Feasibility of a support person intervention to promote smoking cessation treatment use among smokers with mental illness. *Translational Behavioral Medicine*, *8*(5), 785–792. https://doi.org/10.1093/tbm/ibx033

Baxter, B. W., & Hinson, R. E. (2001). Is smoking automatic? Demands of smoking behavior on attentional resources. *Journal of Abnormal Psychology*, *110*(1), 59–66. https://doi.org/10.1037/0021-843X.110.1.59

Begh, R., Smith, M., Ferguson, S. G., Shiffman, S., Munafò, M. R., & Aveyard, P. (2016). Association between smoking-related attentional bias and craving measured in the clinic and in the natural environment. *Psychology of Addictive Behaviors: Journal of the Society of Psychologists in Addictive Behaviors*, *30*(8), 868–875. https://doi.org/10.1037/adb0000231

Betts, J. M., Dowd, A. N., Forney, M., Hetelekides, E., & Tiffany, S. T. (2021). A meta-analysis of cue reactivity in tobacco cigarette smokers. *Nicotine & Tobacco Research*, *23*(2), 249–258. https://doi.org/10.1093/ntr/ntaa147

Bindra, D. (1974). A motivational view of learning, performance, and behavior modification. *Psychological Review*, *81*(3), 199–213. https://doi.org/10.1037/h0036330

Bowdring, M. A., Loftus, P., Wang, S. D., Pang, R. D., & Kirkpatrick, M. G. (2023). Interactive associations between abstinence plans and romantic partner conflict and support with

cigarette smoking. Drug and alcohol dependence, 243, 109756. https://doi.org/10.1016/j.drugalcdep.2022.109756

Carpenter, T. P., Pogacar, R., Pullig, C., Kouril, M., Aguilar, S., LaBouff, J., Isenberg, N., & Chakroff, A. (2019). Survey-software implicit association tests: A methodological and empirical analysis. *Behavior research methods,* 51(5), 2194–2208. https://doi.org/10.3758/s13428-019-01293-3

Carter, B. L., & Tiffany, S. T. (1999). Meta-analysis of cue-reactivity in addiction research. *Addiction*, 94(3), 327-340. https://doi.org/10.1046/j.1360-0443.1999.9433273.x

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. https://doi.org/10.1037//1064-1297.9.2.183

Center, T. T. U. R., Workgroup, T. D. P., Baker, T., Piper, M., McCarthy, D., Bolt, D., Smith, S., Kim, S.-Y., Colby, S., Conti, D., Giovino, G., Hatsukami, D., Hyland, A., Krishnan-Sarin, S., Niaura, R., Perkins, K., & Toll, B. (2007). Time to first cigarette in the morning as an index of ability to quit smoking: Implications for nicotine dependence. *Nicotine & Tobacco Research*, *9*, 555–570. https://doi.org/10.1080/14622200701673480

Christakis, N. A., & Fowler, J. H. (2008). The collective dynamics of smoking in a large social network. *New England Journal of Medicine*, *358*(21), 2249–2258. https://doi.org/10.1056/NEJMsa0706154

Cobb, L. K., McAdams-DeMarco, M. A., Huxley, R. R., Woodward, M., Koton, S., Coresh, J., & Anderson, C. A. M. (2014). The association of spousal smoking status with the ability to quit smoking: The atherosclerosis risk in communities study. *American Journal of Epidemiology*, *179*(10), 1182–1187. https://doi.org/10.1093/aje/kwu041

Conklin, C. A., McClernon, F. J., Vella, E. J., Joyce, C. J., Salkeld, R. P., Parzynski, C. S., & Bennett, L. (2019). Combined smoking cues enhance reactivity and predict immediate subsequent smoking. *Nicotine & Tobacco Research*, *21*(2), 241–248. https://doi.org/10.1093/ntr/nty009

Conklin, C. A., Parzynski, C. S., Salkeld, R. P., Perkins, K. A., & Fonte, C. A. (2012). Cue reactivity as a predictor of successful abstinence initiation among adult smokers. *Experimental and Clinical Psychopharmacology*, *20*(6), 473–478. https://doi.org/10.1037/a0029599

Conklin, C. A., Robin, N., Perkins, K. A., Salkeld, R. P., & McClernon, F. J. (2008). Proximal versus distal cues to smoke: The effects of environments on smokers' cue-reactivity. *Experimental and Clinical Psychopharmacology*, *16*(3), 207–214. https://doi.org/10.1037/1064-1297.16.3.207

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. https://doi.org/10.1093/ntr/ntt104

Conklin, C. A., & Tiffany, S. T. (2002). Cue-exposure treatment: Time for change. *Addiction*, *97*(9), 1219–1221. https://doi.org/10.1046/j.1360-0443.2002.00205.x

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. https://doi.org/10.1037/a0038826

Cornelius, T., Desrosiers, A., & Kershaw, T. (2016). Spread of health behaviors in young couples: How relationship power shapes relational influence. *Social Science & Medicine (1982)*, *165*, 46–55. https://doi.org/10.1016/j.socscimed.2016.07.030

De Houwer, J., Custers, R., & De Clercq, A. (2006). Do smokers have a negative implicit attitude toward smoking? *Cognition and Emotion*, 20(8), 1274–1284. https://doi.org/10.1080/02699930500484506

De Houwer, J., & De Bruycker, E. (2007). The implicit association test outperforms the extrinsic affective Simon task as an implicit measure of inter-individual differences in attitudes. *The British Journal of Social Psychology*, 46(Pt 2), 401–421. https://doi.org/10.1348/014466606X130346

Derrick, J. L., Leonard, K. E., & Homish, G. G. (2013). Perceived partner responsiveness predicts decreases in smoking during the first nine years of marriage. *Nicotine & Tobacco Research,* 15(9), 1528–1536. https://doi.org/10.1093/ntr/ntt011

Elash, C. A., Tiffany, S. T., & Vrana, S. R. (1995). Manipulation of smoking urges and affect through a brief-imagery procedure: Self-report, psychophysiological, and startle probe responses. *Experimental and Clinical Psychopharmacology*, *3*(2), 156–162. https://doi.org/10.1037/1064-1297.3.2.156

Engelmann, J. M., Versace, F., Robinson, J. D., Minnix, J. A., Lam, C. Y., Cui, Y., Brown, V. L., & Cinciripini, P. M. (2012). Neural substrates of smoking cue reactivity: A meta-analysis of fMRI studies. *NeuroImage*, *60*(1), 252–262. https ://doi.org/10.1016/j.neuroimage.2011.12.024

Etcheverry, P. E., & Agnew, C. R. (2008). Romantic partner and friend influences on young adult cigarette smoking: Comparing close others' smoking and injunctive norms over

time. *Psychology of Addictive Behaviors*, 22(3), 313–325. https://doi.org/10.1037/0893-164X.22.3.313

Etcheverry, P. E., Hoffman, N. G., & Agnew, C. R. (2010). Romantic partner influence on young adult cigarette smoking: Testing a behavioral mechanism. *Social Influence*, 5(4), 289-305. https://doi.org/10.1080/15534510.2010.502044

Ferguson, S. G., & Shiffman, S. (2009). The relevance and treatment of cue-induced cravings in tobacco dependence. *Journal of Substance Abuse Treatment*, *36*(3), 235–243. https://doi.org/10.1016/j.jsat.2008.06.005

Fiedler, K., Messner, C., & Bluemke, M. (2006). Unresolved problems with the "I", the "A", and the "T": A logical and psychometric critique of the Implicit Association Test (IAT). *European Review of Social Psychology* *17*(1), 74–147. https://doi.org/10.1080/10463280600681248

Field, M., & Duka, T. (2001). Smoking expectancy mediates the conditioned responses to arbitrary smoking cues. *Behavioural Pharmacology*, *12*(3), 183.

Funk, J. L. & Rogge, R. D. (2007). Testing the ruler with item response theory: Increasing precision of measurement for relationship satisfaction with the Couples Satisfaction Index. *Journal of Family Psychology,* 21, 572-583. https://doi.org/10.1037/t01850-000

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology*, 74(6), 1464–1480. https://doi.org/10.1037/0022-3514.74.6.1464

Heatherton, T. F., Kozlowski, L. T., Frecker, R. C., & Fagerström, K. O. (1991). The Fagerström Test for Nicotine Dependence: a revision of the Fagerström Tolerance Questionnaire.

British journal of addiction, 86(9), 1119–1127. https://doi.org/10.1111/j.1360-0443.1991.tb01879.x

Hofmann, W., Gawronski, B., Gschwendner, T., Le, H., & Schmitt, M. (2005). A meta-analysis on the correlation between the implicit association test and explicit self-report measures. *Personality and Social Psychology Bulletin*, 31(10), 1369–1385. https://doi.org/10.1177/0146167205275613

Homish, G. G., & Leonard, K. E. (2005). Spousal influence on smoking behaviors in a US community sample of newly married couples. *Social Science & Medicine*, *61*(12), 2557–2567. https://doi.org/10.1016/j.socscimed.2005.05.005

Houts, R. M., Robins, E., & Huston, T. L. (1996). Compatibility and the development of premarital relationships. *Journal of Marriage and the Family*, *58*(1), 7–20. https://doi.org/10.2307/353373

Huelsnitz, C. O., Jones, R. E., Simpson, J. A., Joyal-Desmarais, K., Standen, E. C., Auster-Gussman, L. A., & Rothman, A. J. (2022). The dyadic health influence model. *Personality and Social Psychology Review*, *26*(1), 3–34. https://doi.org/10.1177/10888683211054897

Huijding, J., & de Jong, P. J. (2006). Automatic associations with the sensory aspects of smoking: Positive in habitual smokers but negative in non-smokers. *Addictive Behaviors*, 31(1), 182–186. https://doi.org/10.1016/j.addbeh.2005.04.014

Kaplan, R. F., Meyer, R. E., & Stroebel, C. F. (1983). Alcohol dependence and responsivity to an ethanol stimulus as predictors of alcohol consumption. *British Journal of Addiction,* 78(3), 259–267. https://doi.org/10.1111/j.1360-0443.1983.tb02510.x

Kotz, D., Brown, J., & West, R. (2013). Predictive validity of the Motivation to Stop Scale (MTSS): A single-item measure of motivation to stop smoking. *Drug and Alcohol Dependence*, 128(1-2), 15–19. https://doi.org/10.1016/j.drugalcdep.2012.07.012

Lane, K. A., Banaji, M. R., Nosek, B. A., & Greenwald, A. G. (2007). Understanding and using the Implicit Association Test: IV: What we know (So Far) about the method. In B. Wittenbrink & N. Schwarz (Eds.), Implicit measures of attitudes (pp. 59–102). The Guilford Press.

Leckfor, C. M., vanDellen, M. R., Wright, J. W. C., Slatcher, R. B., & Lipkus, I. M. (in preparation). Responsive support for smoking scale: Development and validation for provided and received support in single- and dual-smoker couples.

Ludwig, A., Wikler, A., & Stark, L. H. (1974). The first drink: Psychobiological aspects of craving. *Archives of General Psychiatry*, 30(4), 539–547. https://doi.org/10.1001/archpsyc.1974.01760100093015

Margolis, R., & Wright, L. (2016). Better off alone than with a smoker: The influence of partner's smoking behavior in later life. *The Journals of Gerontology: Series B*, *71*(4), 687–697. https://doi.org/10.1093/geronb/gbu220

McMillen, R. C., Winickoff, J. P., Klein, J. D., & Weitzman, M. (2003). US adult attitudes and practices regarding smoking restrictions and child exposure to environmental tobacco smoke: Changes in the social climate from 2000–2001. *Pediatrics*, *112*(1), e55–e60. https://doi.org/10.1542/peds.112.1.e55

Martin-Soelch, C., Linthicum, J., & Ernst, M. (2007). Appetitive conditioning: neural bases and implications for psychopathology. *Neuroscience and biobehavioral reviews*, 31(3), 426–440. https://doi.org/10.1016/j.neubiorev.2006.11.002

McMillen, R. C., Winickoff, J. P., Klein, J. D., & Weitzman, M. (2003). US adult attitudes and practices regarding smoking restrictions and child exposure to environmental tobacco smoke: Changes in the social climate from 2000–2001. *Pediatrics,* 112(1), e55–e60. https ://doi.org/10.1542/peds.112.1.e55

Mermelstein, R., Lichtenstein, E., & McIntyre, K. (1983). Partner support and relapse in smoking-cessation programs. *Journal of Consulting and Clinical Psychology*, *51*(3), 465–466. https://doi.org/10.1037/0022-006X.51.3.465

Okechukwu, C. A., Nguyen, K., & Hickman, N. J. (2010). Partner smoking characteristics: Associations with smoking and quitting among blue-collar apprentices. *American Journal of Industrial Medicine*, *53*(11), 1102–1108. https://doi.org/10.1002/ajim.20890

Patten, C. A., Boyle, R., Tinkelman, D., Brockman, T. A., Lukowski, A., Decker, P. A., D'Silva, J., Lichtenstein, E., & Zhu, S. H. (2017). Linking smokers to a quitline: randomized controlled effectiveness trial of a support person intervention that targets non-smokers. *Health education research*, 32(4), 318–331. https://doi.org/10.1093/her/cyx050

Payne, B. K., McClernon, F. J., & Dobbins, I. G. (2007). Automatic affective responses to smoking cues. *Experimental and Clinical Psychopharmacology*, *15*(4), 400–409. https://doi.org/10.1037/1064-1297.15.4.400

Robinson, M., Meier, B., Zetocha, K., & Mccaul, K. (2005). Smoking and the implicit association test: When the contrast category determines the theoretical conclusions. *Basic and Applied Social Psychology*, *27*, 201–212. https://doi.org/10.1207/s15324834basp2703_2

Sayette, M. A. (2016). The role of craving in substance use disorders: Theoretical and methodological issues. *Annual Review of Clinical Psychology*, *12*(1), 407–433. https://doi.org/10.1146/annurev-clinpsy-021815-093351

Sherman, S.J., Rose, J.S., & Koch, K. (2003). Implicit and explicit attitudes toward cigarette smoking: the effects of context and motivation. *Journal of Social and Clinical Psychology,* 22,13–39. https://doi.org/10.1521/jscp.22.1.13.22766

Shiffman, S., Dunbar, M., Kirchner, T., Li, X., Tindle, H., Anderson, S., & Scholl, S. (2013). Smoker reactivity to cues: Effects on craving and on smoking behavior. *Journal of Abnormal Psychology*, *122*(1), 264–280. https://doi.org/10.1037/a0028339

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. https://doi.org/10.1037//0022-006x.64.2.366

Stippekohl, B., Winkler, M., Mucha, R. F., Pauli, P., Walter, B., Vaitl, D., & Stark, R. (2010). Neural responses to BEGIN- and END-stimuli of the smoking ritual in nonsmokers, nondeprived smokers, and deprived smokers. *Neuropsychopharmacology: Official Publication of the American College of Neuropsychopharmacology*, 35(5), 1209–1225. https://doi.org/10.1038/npp.2009.227

Stöffelmayr, B., Wadland, W., & Pan, W. (2003). An examination of the process of relapse prevention therapy designed to aid smoking cessation. *Addictive Behaviors*, 28(7), 1351–1358. https://doi.org/10.1016/S0306-4603(02)00250-2

Sutton, G. C. (1993). Do men grow to resemble their wives, or vice versa?. *Journal of Biosocial Science*, 25(1), 25–29. https://doi.org/10.1017/s0021932000020253

Swanson, J. E., Rudman, L. A., & Greenwald, A. G. (2001). Using the Implicit Association Test to investigate attitude–behaviour consistency for 87ssential87d behaviour. *Cognition and Emotion,* 15(2), 207–230. https://doi.org/10.1080/0269993004200060

Tedeschi, G. J., Zoref, L. S., Cummins, S. E., & Zhu, S.-H. (2020). Targeting Nonsmokers to Help Smokers Quit: Features of a Large-scale Intervention. *Tobacco Use Insights*, *13*, 1179173X20943565. https://doi.org/10.1177/1179173X20943565

Tiffany, S.T. (1990). A cognitive model of drug urges and drug-use behavior: Role of automatic and nonautomatic processes *Psychological Review*. 97: 147-168. PMID 2186423 DOI: 10.1037/0033-295X.97.2.147

Tooley, E. M., & Borrelli, B. (2017). Characteristics of Cigarette Smoking in Individuals in Smoking Concordant and Smoking Discordant Couples. *Couple & Family Psychology*, *6*(2), 106–116. https://doi.org/10.1037/cfp0000078

Tooley, E. M., Fava, J. L., & Borrelli, B. (2023). The relationship antecedents of smoking (RAS) scale: A new scale to assess couple-focused triggers to smoke. *Health Behavior Research*, 6(2), 4. https://doi.org/10.4148/2572-1836.1162

Waters, A. J., Carter, B. L., Robinson, J. D., Wetter, D. W., Lam, C. Y., & Cinciripini, P. M. (2007). Implicit attitudes to smoking are associated with craving and dependence. *Drug and Alcohol Dependence*, *91*(2–3), 178–186. https://doi.org/10.1016/j.drugalcdep.2007.05.024

Vianello, M., & Bar-Anan, Y. (2021). Can the Implicit Association Test measure automatic judgment? The validation continues. *Perspectives on Psychological Science, 16*(2), 415-421. https ://doi.org/10.1177/1745691619897960

Waters, A. J., Carter, B. L., Robinson, J. D., Wetter, D. W., Lam, C. Y., & Cinciripini, P. M. (2007). Implicit attitudes to smoking are associated with craving and dependence. *Drug and Alcohol Dependence, 91*(2–3), 178–186. https://doi.org/10.1016/j.drugalcdep.2007.05.024

Waters, A. J., & Feyerabend, C. (2000). Determinants and effects of attentional bias in smokers. *Psychology of Addictive Behaviors, 14*(2), 111–120. https://doi.org/10.1037/0893-164X.14.2.111

Waters, A. J., Shiffman, S., Bradley, B. P., & Mogg, K. (2003). Attentional shifts to smoking cues in smokers. *Addiction*, *98*(10), 1409–1417. https://doi.org/10.1046/j.1360-0443.2003.00465.x

Westmaas, J. L., Bontemps-Jones, J., & Bauer, J. E. (2010). Social support in smoking cessation: Reconciling theory and evidence. *Nicotine & Tobacco Research*, *12*(7), 695–707. https://doi.org/10.1093/ntr/ntq077

Wiers, R.W., van Woerden, N., Smulders, F.T. Y., & de Jong, P.J. (2002). Implicit and explicit alcohol-related cognitions in heavy and light drinkers. *Journal of Abnormal Psychology,* 111(4), 648-658 https://doi.org/10.1037/0021-843X.111.4.648

Winkler, M. H., Weyers, P., Mucha, R. F., Stippekohl, B., Stark, R., & Pauli, P. (2011). Conditioned cues for smoking elicit preparatory responses in healthy smokers. *Psychopharmacology*, *213*(4), 781–789. https://doi.org/10.1007/s00213-010-2033-2

Wright, J. W. C., Wilcher, C., MacKillop, J., Beach, S. R. H., vanDellen, M. R. (in preparation). Comorbidity of social and behavioral risk factors in smoking.

Zayas, V., & Shoda, Y. (2015). Love you? Hate you? Maybe it's both: Evidence that significant others trigger bivalent-priming. *Social Psychological and Personality Science*, 6(1), 56-64. https://doi.org/10.1177/1948550614541297

Zayas, V., Wang, A. M., & McCalla, J. D. (2022). Me as good and me as bad: Priming the self triggers positive and negative implicit evaluations. *Journal of Personality and Social Psychology*, 122(1), 106–134. https://doi.org/10.1037/pspp0000332

Zhu, S., Nguyen, Q. B., Cummins, S., Wong, S., & Wightman, V. (2006). Non-smokers seeking help for smokers: A preliminary study. *Tobacco Control*, *15*(2), 107–113. https://doi.org/10.1136/tc.2005.012401

Tables

Table 2.1

Participant Demographic Information

Variable	% Study 2 (*N*=219)
Gender (%)	
Male	44.6
Female	53.1
Non-Binary/Gender Fluid	2.4
Age (years), *M* (*SD*)	45.04 (11.75)
Race (%)	
White/Caucasian	75.6
Black/African American	17.2
American Indian/Alaska Native	0.8
Asian	2.6
Mixed or Multiple Races	3.8
Ethnicity (%)	
Hispanic or Latino	6.9
Not Hispanic or Latino	93.1
Education (%)	
< High school graduate	1.7
High school graduate	16.9
Some college/technical school	30.9

College/technical school graduate	38.7
Post-college education z	11.9
Income (%)	
<$20,000	17.5
$20,001-$40,000	22.5
$40,001-$60,000	24.2
$60,001-$80,000	15.7
$80,001-$100,000	7.2
$100,001+	13.0

Note. Participants were at least 18 years old, currently in a romantic relationship, and partnered with their romantic partner for at least 6 (Study 1) or 3 months (Study 2). Additional demographic information was not collected in Study 1.

Table 2.2

Smoking Characteristics

	Study 1		*Study 2*	
	n	*%*	*n*	*%*
Smoking status				
Current smoker	72	91.14	214	100
Recently quit smoker	7	8.86	0	0
Cigarettes per day				

Recently quit smoking	4	5.06	0	0
< 5	4	5.06	31	14.55
5-10	48	60.76	81	38.03
11-20			67	31.46
< 20	23	29.11	34	15.96
Partner smoking status				
Smoker	68	86.08	119	55.61
Non-smoker	11	13.92	95	44.39
Partner cigarettes per day				
< 5	8	11.76	52	43.70
5-10	23	33.82	48	40.34
> 20	25	36.76	19	15.97

Table 2.3

Means, standard deviations, and correlations of cue-reactivity to romantic partner prompt for Study 1.

Variable	*M*	*SD*	1	2	3	4	5
1. Craving	49.15	33.16					
2. Excitement	71.82	25.66	.09				

3. Negative Affect	27.09	27.48	.19	-.44**			
4. Positive Affect	75.80	23.16	-.07	.69**	-.57**		
5. Calmness	66.96	26.21	-.06	.45**	-.36**	.70**	
6. Daily Cigarettes Smoked	2.34	0.66	-.03	.04	-.01	.07	.09
7. Smoking Urges	51.20	27.10	.50**	.19	.19	.01	.18
8. Nicotine Dependence	1.67	0.38	-.34**	-.09	-.12	.14	.12
9. Importance to Quit	6.43	2.41	.17	.20	.15	.19	.26*
10. Confidence to Quit	3.43	2.79	.01	.05	.13	.03	.02
11. Readiness to Quit	4.29	3.05	-.10	.15	-.01	.21	.17
12. MTSS	4.13	1.98	-.14	.04	-.06	.08	.09
13. Partner Importance to Quit	5.75	2.87	.23	.07	.24	.07	.08
14. Partner	3.62	3.17	-.17	.16	-.02	.04	.11

Confidence to Quit							
15. Partner Readiness to Quit	5.41	3.05	.11	.15	-.06	.14	.02
16. Positive Support	2.10	0.85	.26*	-.07	.28*	-.17	-.00
17. Negative Support	2.63	0.95	.10	.27*	-.03	.14	.30**
18. Communal Orientation	5.27	0.96	-.08	.44**	-.25*	.39**	.42**
19. Responsive Support	5.91	0.72	-.10	.33**	-.26*	.36**	.28*
20. Relationship Satisfaction	4.61	1.81	.01	.00	.03	.08	-.02

Note. M and *SD* are used to represent mean and standard deviation, respectively. * indicates $p <$ .05. ** indicates $p < .01$.

Table 2.4

Means and standard deviations for reactions across experimental condition.

	Romantic Partner *M* (SD)	Unexposed *M* (SD)	Control *M* (SD)
Craving	49.13 (32.59)$_a$	43.65 (33.78)$_{ab}$	36.86 (30.51)$_b$
Excitement	71.09 (25.58)$_a$	55.87 (28.05)$_b$	53.08 (29.29)$_b$

Negative Affect	27.09 (27.48)$_a$	22.30 (23.70)$_a$	12.39 (17.85)$_b$
Positive Affect	75.17 (23.12)$_a$	70.62 (22.45)$_a$	75.14 (23.25)$_a$
Calmness	67.66 (25.97)$_{ab}$	63.28 (25.40)$_a$	74.34 (24.31)$_b$

Note. Within row, means with different subscripts differ from each other, $p < .05$.

Table 2.5

Participant smoking characteristics for Study 2

Variable	Frequency	Percentage (%)
Cohabitation		
Yes	193	91.53%
No	18	8.53%
Participant Smoking Behavior		
Cigarettes Smoked Per Day		
< 5	26	11.98%
5-10	73	33.64%
11-20	76	35.02%
20+	40	18.43%
Partner Smoking Behavior		
Current Smoker		
Yes	119	55.87%
No	94	44.13%
Average Cigarettes Smoked Per Day*		
5-10 cigarettes	52	43.7%
11-20 cigarettes	48	40.34%

> 20 cigarettes	19	15.97%
Tried to Quit Previously*		
Yes	31	32.98%
No	63	67.02%
Joint Smoking Behavior		
Smoke the Same Brand of Cigarettes *		
Yes	96	45.07%
No	117	54.93%
Have a "Special Place" for Smoking*		
Yes	67	31.60%
No	145	68.40%
Smoke Cigarettes Together*		
Always	62	29.95%
Most of the time	28	13.53%
Some of the time	49	23.67%
Rarely	58	28.02%
Never	10	4.83%
Have Tried to Quit Together*		
Yes	68	31.92%
No	145	68.08%

Note. Participants were at least 18 years old, currently in a romantic relationship, and partnered with their romantic partner for at least 6 months. The mean relationship length was 14.93 years (*SD* = 11.28). * indicates variable was only measured among DSCs.

Table 2.6

Means, standard deviations, and correlations with D-scores for Study 2 (from all participants)

Variable	*M*	*SD*	Correlation with *D*-Score from the IAT
Daily Cigarettes	2.49	0.93	.17*
Nicotine Dependence	1.74	0.43	-.20*
Urges	39.53	29.89	.08
Confidence	2.99	2.92	-.10
Readiness	4.10	3.20	-.08
Importance	5.57	2.89	-.04
MTSS	3.54	1.77	.09
Partner MTSS [+]	6.53	2.26	.16
Smoke Together [+]	1.85	1.15	-.22*
Special Place to Smoke [+]	1.79	0.41	.09
Smoke Same Brand [+]	1.73	0.45	.12
Tried to Quit Together [+]	1.71	0.46	-.04
Influence	4.24	1.07	-.05
Communal Orientation	5.11	1.29	-.00
Responsive Support	5.85	1.29	.16
Smoking Interdependence [+]	3.32	1.56	-.26**
Relationship Satisfaction	4.82	2.05	.02

Note. [+] indicates variable was only measured among DSCs. *M* and *SD* are used to represent mean and standard deviation, respectively. * indicates $p < .05$. ** indicates $p < .01$.

STUDY 3

SATISFACTION TO CESSATION: THE IMPACT OF RELATIONSHIPS DYNAMICS ON QUITTING SMOKING IN DUAL-SMOKER COUPLES[1]

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Support to Cessation: The Impact of Relationship Dynamics on Quitting Smoking in Dual-Smoker Couples

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Abstract

Relationship dynamics are crucial in smoking cessation, particularly for dual-smoker couples who face unique challenges in their quit attempts. Despite the recognized importance of partner support in smoking cessation, there has been limited research on how the quality of the romantic relationship itself, specifically satisfaction, influences quitting. We investigated associations between relationship factors, individual abstinence and the effectiveness of partner-involved interventions. Using data from a pilot RCT of 95 dual-smoker couples, we examined how relationship quality and support influenced quitting. Specifically, we used multilevel modeling to examine pathways through which individual relationship satisfaction, positive partner support, and negative partner support impacted the likelihood of individual point-prevalent abstinence over time. Analyses revealed an indirect effect of satisfaction through positive support on quitting, such that higher relationship satisfaction at baseline led to greater positive support at follow-up, which in turn was associated smoking abstinence. These findings inform research on smoking cessation interventions and dual-smoker couples by suggesting that both partners' perceptions of the relationship impact quit outcomes.

Keywords: relationship satisfaction, support, smoking, dual-smoker couples.

Introduction

Smoking remains one of the leading causes of preventable death and disease worldwide (CDC, 2022). Despite widespread awareness of the health risks and long-term effects of smoking, many individuals struggle to quit (CDC, 2022). In addition to the well-cited physical challenges of quitting (e.g., withdrawal), the process of quitting can negatively affect smoker's relationships. Among partnered smokers, cessation efforts can introduce relationship strain, as partners cope with increased tension and conflict. These challenges are even more pronounced among individuals in dual-smoker couples (DSCs), where both partners smoke cigarettes. These couples often experience mutual reinforcement of smoking behaviors, making it harder to break the habit. Compared to single-smoker couples (SSCs), DSCs smoke more cigarettes, make less frequent quit attempts, and are less likely to stay abstinent (Cobb et al., 2014; Homish & Leonard, 2005). DSCs experience weaker motivation to quit (Etcheverry & Agnew, 2008; Jackson et al., 2015), are often not in the same stage of readiness to quit as their partner (Derrick et al., 2013; Ranby et al., 2013), frequently fail to recognize each other's quit attempts (Ranby et al., 2013), and offer less support for each other's quit attempts (Buitenhuis et al., 2021; McBride et al., 1998; Scholz et al., 2016).

Social and Relational Dynamics in Smoking Cessation

Extensive research has demonstrated the general influence of relational dynamics in smoking cessation. Numerous studies have demonstrated that individuals attempting to quit smoking are more likely to succeed when they have a robust support network (Christakis & Fowler, 2008; Hitchman et al., 2014). For instance, foundational research by Mermelstein and colleagues (1986) found that social support significantly increased the likelihood of successful quitting by providing both emotional encouragement and practical assistance. Although support

can come from various sources, including family, and healthcare professionals, a smoker's romantic partner is perhaps the most prominent (Coppotelli & Orleans, 1985; Homish & Leonard, 2005).

In romantic relationships, partners often serve as primary sources of support. Research by van den Brand and colleagues (2019) showed that smokers who received strong support from their partners were more likely to remain abstinent over a two-month period. Smokers turn to their romantic partners for support during quit attempts, relying on them for both emotional backing and tangible help (i.e., managing cravings and stress) (Homish & Leonard, 2005; vanDellen et al., 2016). A meta-analysis conducted by Park and colleagues (2004) highlighted that the quality of the partner's support—enhancing supportive behaviors while minimizing behaviors critical of smoking—is crucial in predicting successful quit outcomes.

High relationship satisfaction has been associated with better emotional well-being and supportive behaviors, which are conducive to successful smoking cessation. For example, individuals in satisfying relationships are more likely to engage in positive health behaviors and support their partner's efforts to quit smoking (vanDellen et al., 2015). Researchers have explored the association between relationship satisfaction and support through various approaches, often revealing a reciprocal relationship between these facets of relationship dynamics. High relationship satisfaction often leads to more effective support behaviors, which in turn enhance relationship outcomes. For instance, individuals who receive more emotional support from their partner experience greater satisfaction with their relationship (Righetti et al., 2022; Xu & Burleson, 2004). This satisfaction is further reinforced when partners perceive each other as supportive, creating a positive feedback loop (Cutrona et al., 2007; Brown et al., 2003). Conversely, couples with low satisfaction often experience miscommunication,

misunderstanding, or conflict related to support behaviors. High-quality relationships, however, handle differences constructively, buffering stress and maintaining long-term stability (Cramer, 2004; Pasch & Bradbury, 1998; Scholz et al., 2016). In satisfied relationships, partners use accumulated knowledge about each other's challenges and preferences to recognize when support is needed and tailor their support accordingly (Lüscher et al., 2018). These partners are more responsive and attentive to each other's needs (Britton et al., 2019). Effective communication in these relationships enables partners to provide and receive support more effectively. Working together cooperatively not only strengthens relational bonds but also fuels intrinsic motivation, which is crucial for maintaining satisfaction and achieving shared goals (Carr & Walton, 2014). Moreover, progress towards relationship goals mediates the association between relationship motivation and satisfaction (Holding et al., 2021), underscoring the importance of collaborative efforts in fostering a supportive and satisfying relationship.

Satisfaction and Cessation Among DSCs

Social factors play a significant role in goal pursuit and health behavior change. Among these factors, relationship satisfaction has emerged as a key variable capable of influencing goal achievement. High relationship quality has been shown to be a critical contributor in a couple's ability to accomplish joint health goals. (Toma et al., 2023; Wilson & Novak, 2022; Ungar et al., 2021). Having high satisfaction and low feelings of dissatisfaction within a relationship have been shown to promote greater goal success outside of the health domain (Cappuzzello & Gere, 2018; Fincham & Beach, 2006; Hofmann et al., 2015), and better health outcomes (Coyne et al., 2001; Eaker et al., 2007; Kiecolt-Glaser & Newton, 2001; King & Reis, 2012; Knoll et al., 2012; Shrout et al., 2020; Smith et al., 2019).

In the context of smoking cessation, relationship quality has been considered influential in an individual's ability to quit. Positive relationship dynamics have been consistently linked to greater cessation rates (Britton et al., 2019; Foulstone et al., 2016). Relationship satisfaction specifically has been shown to both directly and indirectly influence a smokers' ability to quit (Foulstone et al., 2017; Foulstone et al., 2019). A study by Foulstone and colleagues (2017) found that both men and women were more likely to quit smoking when they were highly satisfied with their relationship. Research by vanDellen and colleagues (2016) also links relationship satisfaction to support, finding that the greater the relationship satisfaction, the more individuals intended to support their partner's quit attempt.

Few studies have examined how quitting smoking might impact a smoker's relationship quality, how these processes unfold in DSCs, or how these processes unfold during dyadic interventions. Regardless of whether both members of a DSC are ready and motivated to quit smoking concurrently, the interconnectedness of their environments, smoking behaviors, and shared outcomes, suggests that their feelings of relationship satisfaction should play a pivotal role in their likelihood of quitting smoking. Higher satisfaction within the relationship might itself facilitate improved outcomes, or act as a buffer against some of the negative consequences that go along with quitting smoking. Better relationship quality might serve as a protective barrier by facilitating motivational and support processes, making it easier to focus on the goal and be more likely to engage in efforts to quit. Accordingly, there are compelling reasons to believe that features of the relationship might influence if and how couples attempt to quit smoking, and the effectiveness of quitting strategies on cessation outcomes.

Use of Partner-Involved Interventions to Promote Abstinence

Financial Incentive Treatments (FITs)—a common category of health behavior intervention—are effective in promoting smoking cessation. These treatments provide rewards (often monetary) for achieving specific smoking-related goals, such as reducing cigarette consumption or maintaining abstinence. Previous studies have demonstrated that financial incentives can significantly increase quit rates, particularly when combined with other supportive interventions (Volpp et al., 2009). Financial incentives enhance motivation and commitment to quit smoking by providing tangible rewards for success. FITs have become a useful approach for clinicians and researchers because they are often easier to implement and less labor-intensive than other forms of contingency management interventions.

Ongoing research by vanDellen and colleagues (vanDellen, et al., 2023) focuses on dyadic adaptations of FITs as one potential strategy to address the unique challenges experienced by the treatment-resistant population of DSCs. When couples engage in quit attempts with financial incentives, they may experience a sense of shared goals and mutual support, which might improve relationship satisfaction and subsequently, cessation outcomes (Heckman et al., 2012). Additionally, quitting can foster social support. Notably, dyad-level factors may change the effectiveness of dyadic interventions. In a study of DSCs, couple-focused framing of smoking cessation increased motivation to quit—but only for individuals who reported receiving low levels of negative support from their partner (vanDellen et al., 2019).

Despite the potential for dyadic adaptations of FITs to decrease smoking in DSCs, it is important to note that a recent meta-analysis by Choi (2022) found that current literature does not support the effectiveness of couple-based smoking interventions. However, this review also highlights the lack of research available on couple-based smoking cessation interventions. Given

this lack of research, it could be that current strategies to encourage partner involvement and support fail to address key issues. The relative weakness of current approaches could be due to factors such as the intervention content or format, or failure to address relational dynamics that hinder intervention effectiveness. Nonetheless, conclusions from this meta-analysis indicate more research is needed to understand the role of partners in facilitating effective support to ensure success and the underlying mechanisms at play, especially in DSCs where smoking is highly interdependent.

The Present Research

This study investigates the influence of relationship satisfaction and support on smoking cessation outcomes. Specifically, we considered the effects of relationship satisfaction, positive partner support and negative partner support on individual point-prevalence. Relationship dynamics were measured at two time-points (baseline and 3-month follow-up) and assessed using multiple dimensions: target self-reported satisfaction, partner self-reported satisfaction, target self-reported positive and negative support, as well as partner self-reported positive and negative support. By examining these dimensions, we aim to provide a comprehensive understanding of how features of relationship quality influences smoking cessation. First, we examined how relationship satisfaction influence FITs effectiveness in promoting quitting. We expected that the relationship between incentive condition and condition effectiveness (i.e., quitting/abstinence) would be moderated by relationship satisfaction where these interventions will be more successful for couples with high (vs. low) satisfaction. We conducted this research in the context of a pilot trial. Although pilot trials can be useful in identifying potential mechanisms of effects—a critical step in further intervention development (Fletcher et al., 2016; Kazdin, 2007; Lewis et al., 2021; Pearson et al., 2020)—they should be interpreted cautiously.

Next, we conducted path analyses to examine associations between relationship dynamics and quit outcomes. For individual quitting, we conducted exploratory mediation analyses using multilevel modeling (MLM) to examine direct and indirect effects of relationship satisfaction, positive partner support for quitting, and negative partner support for quitting on individual point-prevalent abstinence.

Method

Participants

We enrolled 95 DSCs (total *n*=190). Eligibility requirements were (a) smoking 5+ cigarettes daily, (b) 18+ years of age, and (c) romantically partnered and cohabiting with another eligible participant. We excluded individuals with psychosis risk, recent hospitalization, or who were pregnant. Figure 1 shows the CONSORT diagram of enrollment. Participant average current income was $36,305.24. On average, participants were 42.40 years old (*SD*=10.57), and in a relationship for 8.06 years (*SD*=8.12). Table 1 shows the characteristics of enrolled participants.

Participants were not required to be treatment-seeking (i.e., ready to quit) to enroll. Participants reported smoking their first cigarette at 15.72 years old (*SD*=7.05). 29% of participants smoked 5-10 cigarettes/day, 48% smoked 10-20/day, and 23% smoked over 20/day. 10 participants reported that they were currently in smoking cessation treatment. Full recruitment methods and participant characteristics are available in the report of primary study findings (vanDellen et al. 2023).

Design

The study design involved a pilot trial that enrolled DSCs in a three-arm feasibility RCT. Couples were randomly assigned (with stratification described below) to one of three FITs:

single FIT condition (34 couples), dyadic FIT condition (32 couples), control condition (29 couples). In the single target partner-involved FIT (PIF-ST), partners jointly learned about the incentives for the target participant. In this condition, partners were brought into the potential quit attempt at the same time as the targets, hearing about the intervention and the incentives together. In the dyad target partner-involved FIT (PIF-DT), partners jointly learned about incentives for both targets and partners. This condition resembled the PIF-ST in that it may address communication and perceptual barriers, but added an explicit focus on the non-target partner given that both individuals were eligible to receive incentives for behavior change. In both partner-involved adaptations of FIT, targets and partners became aware of any offered incentives during a video conference with both members of the dyad present.

Procedure

The trial consisted of a) a baseline video conference with surveys and biochemical verification of smoking, b) ten weeks of brief surveys, c) four weeks of optional online psychoeducation, and d) a 3-month follow-up video conference with surveys (all self-reported abstinence was biochemically confirmed). Participants in all conditions were offered nicotine replacement and psychoeducation. Data was collected via a screener survey, baseline and follow-up questionnaire, and weekly surveys.

Baseline and Post-Baseline Survey

Prior to the baseline video conference, both partners in the couple completed surveys to assess smoking history, relationship quality, and smoking variables. During the video conference, a research assistant conducted a breath test using an IcoQuit Smokerlyzer to measure expired CO (delivered to their home prior to the session). The levels of expired CO were recorded to verify smoking status. Following this, the research assistant explained the remaining

study procedures, including the administration of the experimental condition. Participants were randomly assigned to one of three conditions: a) No-FIT control, b) PIF-ST, or c) PIF-DT. In the partner-involved FIT conditions, either the target (PIF-ST) or both the target and the partner (PIF-DT) were offered compensation of $100 for completing the psychoeducation training and $100 for being quit at follow-up. Participants could receive either or both incentives; partners could earn different amounts of incentives. Randomization was supplemented with stratification, resulting in slightly different sample sizes across conditions. Couples were stratified based on a) target gender, b) target smoking heaviness (<20 cigarettes per day, 20+ cigarettes per day), and c) same- or different-gender couple status. In the no-FIT control, no participants were offered financial incentives. All participants received treatment as usual.

Treatment as Usual

All participants had access to an optional psychoeducation program. All participants received weekly links to a four-module (~ 1 hour weekly) online psychoeducation program combining behavioral change coaching with information about addiction and quitting. The psychoeducation modules included topics such as stages of change and making a quit plan, health benefits of quitting smoking, managing triggers, preparing for and preventing relapse, health consequences of smoking, reasons for quitting, and setting a quit plan. The program began one week after baseline; participants could access links at any time during the study. Participants were also offered on-request home delivery of combination NRT (patch + gum) calibrated to their quantity of smoking (patches) or time to first cigarette (gum).

Follow-Up and Post-Follow-Up Survey

During the baseline video conference, we scheduled the three-month follow-up session with participants. One week prior to the scheduled session, participants completed the same

survey as they did following the baseline session. During the video conference, we debriefed participants and biochemically verified point-prevalence abstinence for any individual who self-reported abstinence for at least the past seven days.

Measures

Demographic information including age, race, income, education, and relationship length were assessed at Baseline only. Other measures than relationship satisfaction and support were collected but are not considered in this analysis. Full measures included in this RCT are available at https://osf.io/ctswk/?view_only=ce6b013f887248e6aa2107d28a4b2b60.

Relationship Satisfaction

Relationship satisfaction was measured at baseline (α=.97) and follow-up (α=.97) using the 4-item version of the Couple Satisfaction Index (CSI-4; Funk & Rogge, 2007). This scale is scored on a 7-point Likert Scale (1=*Not at all True*, 7=*Completely True*) and contains indices for communication, intimacy and overall relationship quality, and happiness.

Support

Support was measured at baseline and follow-up. The 20-item Partner Interaction Questionnaire (Cohen & Lichtenstein, 1990) was used to measure positive (α=.94) and negative support (α=.90) at baseline, and positive (α=.96) and negative support[1] (α=.94) at follow-up. Participants reported how much their partners engage in influencing behaviors on a scale from 0 (*never*) to 4 (*very often*) scale. Item responses for 10 positive support items (e.g., Compliment you on not smoking) and 10 negative support items (e.g., Criticize your smoking) were separately averaged to create two indexes of support.

Smoking Outcomes

Smoking outcomes were assessed at follow-up. Smoking variables included *individual quitting* (point-prevalent abstinence) and *joint abstinence*. Participants self-reported abstinence during the follow-up survey. For individuals who self-reported being abstinent for at least the past 7 days, we verified abstinence using expired carbon monoxide collected via ICOquit breath sensors sent to each dyad at the beginning of the study. We used a standard of =<5 ppm (Cropsey et al., 2014) to confirm abstinence. Joint abstinence was measured using calendars to assess concurrent non-smoking and at least 7 prior days with no smoking for both members of the couple. Full analyses of smoking outcomes in this RCT have been previously reported in vanDellen et al. (2023). The scope of this work is restricted to individual quitting.

Data Analytic Plan

Primary Smoking Outcomes

For smoking outcomes, we analyzed data using an intent-to-treat sample such that participants with missing data were coded as smoking (vs. abstinent). We treated individual point-prevalent abstinence as a categorical variable. Effects of FIT conditions were not considered in the present study but are reported for the purpose of interpreting primary smoking outcomes. Condition was modeled as a categorical variable where PIF=1 and no-FIT (control)=0. Thus, both partner-involved FIT conditions were combined. We first report Chi Square tests examining the effects of condition on our primary outcome of individual point-prevalent abstinence, conducting these analyses separately among targets and partners.

Direct Effects of Relationship Satisfaction on Quitting

Next, we conducted a moderation model with random intercepts to test our hypothesis that relationship satisfaction would moderate the association between FIT condition and

abstinence. To test for main effects we entered relationship satisfaction, condition and quitting into the model with a random intercept for the dyad. We then entered the relationship satisfaction by condition term into the model to test the interaction.

Path Analyses for Individual Quitting

Finally, we used *Mplus* (Muthén & Muthén, 2007) to conduct exploratory path analyses to model associations between relationship satisfaction, positive partner support, negative partner support, and quitting. To adhere to statistical assumptions of MLM, we focused on individual point-prevalent abstinence as our outcome of interest, rather than joint quitting. This decision was based on the need to model variables at the same level, as joint quitting represents a dyad-level variable which would not align with our individual-focused analytic approach. For relationship satisfaction and support, some missing data existed, resulting in variation in sample size. We computed intraclass correlations (Table 4) to estimate the proportions of between and within-dyad variability for each outcome variable. We used individual mean scores as predictors. To account for the interdependence within dyads, we used MLM by fitting linear mixed-effects models with random intercepts to assess between-person outcomes (Level 1) nested within dyads (Level 2; Kashy & Snyder, 1995; Kenny et al., 2020) over time.

Results

Primary Smoking Outcomes

Primary results from this trial have been previously reported in vanDellen et al. (2023) but are re-reported here briefly to provide context for the examination of relationship satisfaction and support. As Table 2 shows, we observed significant effects of partner-involved FITs on both abstinence, $\chi^2_{targets}$ (83)=7.35, p=.007, OR = 5.29 [1.44, 19.28]; $\chi^2_{partners}$ (79)=8.12, p=.004, OR=7.22 [1.58, 33.11]. Individual abstinence was more common in the PIF conditions than the

control condition for both targets, $\chi^2(83)=7.35$, $p=.007$, OR=5.29 [1.45, 19.28], and partners, $\chi^2(79)=8.12$, $p=.004$, OR=7.22 [1.58, 33.11].

Direct Effects of Satisfaction on Quitting

Generalized linear mixed models (GLMM) were conducted to examine the effect of condition, mean relationship satisfaction, and their interaction on quitting smoking, with a random intercept for dyads. For individual quitting as the outcome, the model was fit using maximum likelihood estimation. The model fit statistics were as follows: AIC=140.1, BIC=156.2, log-likelihood=-65.1. The fixed effects revealed no significant predictors of quitting smoking. Standardized beta coefficients, *p*-values, confidence intervals and effect sizes for the linear mixed-effects models are summarized in Table 5.

Path Analysis for Individual Quitting

We conducted a MLM to examine the effects of relationship satisfaction, positive partner support, and negative partner support on quitting. We used Mplus (Muthén & Muthén, 2007) to conduct exploratory path analyses with 5,000 bootstrapped confidence intervals. Fixed effects were included for all independent variables and random intercepts were specified for the categorical variable of dyad. To account for the interdependence within dyads, we used a complex sampling design to estimate effects with robust standard errors for all pathways (Asparouhov & Muthén, 2017).

The pathways for the mediation model were estimated as follows: satisfaction at baseline predicting satisfaction at follow-up, positive support at baseline, positive support at follow-up, negative support at baseline, and negative support at follow-up, and quitting; positive support at baseline predicting positive support at follow-up, satisfaction at baseline, negative support at baseline, satisfaction at follow-up, negative support at follow-up, and quitting. Negative support

at baseline predicting negative support at follow-up, positive support at follow-up, satisfaction at follow-up and quitting. Finally, we estimated several indirect effects: The indirect effect of satisfaction at baseline through positive support at follow-up to quitting, the indirect effect of satisfaction at baseline through negative support at follow-up, the indirect effect through satisfaction, the indirect effect through positive support, and the indirect effect through negative support. Table 3 shows descriptive statistics of relationship satisfaction and support measures assessed at each time point. There was no significant difference in relationship satisfaction between targets and partners at baseline or follow-up (*p's* > .05).

Correlations revealed that satisfaction at baseline was significantly correlated with positive support at baseline, r=.723, p=.004. Satisfaction at follow-up was significantly correlated with positive support at follow-up, r=.386, p<.001. Positive support at baseline was significantly correlated with negative support at baseline, r=.318, p<.001. Positive support at follow-up was significantly correlated with negative support at follow-up, r=.481, p=.001).

The standardized parameters and bootstrapped confidence intervals for the individual pathways, total effects, and total indirect effects for each model are reported in Table 6. There was a significant direct effect of satisfaction at baseline on satisfaction at follow-up, and positive support at follow-up. Positive support at baseline was related to positive support at follow-up. Negative support at baseline was related to negative support at follow-up, and quitting. Positive support at follow-up was associated with quitting. Negative support at follow-up was related to quitting. There were no significant direct effects of satisfaction at follow-up on quitting.

Results revealed that there was a significant indirect effect of satisfaction at baseline through positive support at follow-up on quitting. This effect suggests that higher satisfaction at the beginning of the study led to more positive support, which in turn was associated with better

quit outcomes. There was also an indirect effect of positive support at baseline through positive support at follow-up, indicating that higher reports of positive support at baseline led to more positive support at follow-up which in turn was associated with better quit outcomes. There was also an indirect effect through negative support. In other words, higher reports of negative support at baseline led to more negative support at follow-up ultimately resulting in poorer quit outcomes.

Discussion

Relationship Satisfaction Moderating FITs on Quit Outcomes

Results indicated that relationship satisfaction did not significantly moderate the relationship between FIT condition on individual quitting.

Significant Pathways to Abstinence

Results from the path analyses revealed three direct effects on individual abstinence: Negative partner support for quitting at baseline, negative partner support for quitting at follow-up and positive partner support for quitting at follow-up. Additionally, we found three significant indirect effects: An indirect pathway through positive support at baseline and follow-up, through negative support at baseline and follow-up, and from satisfaction at baseline through positive support at follow-up. Figure 2 shows the results of the saturated path analysis model.

Surprisingly, there were no direct effects of relationship satisfaction on quitting. However, we did find a significant indirect pathway from satisfaction through positive support. This path indicates that individuals who feel content with their relationship were more likely to report that their partner provided support for quitting, ultimately increasing their odds of quitting. This route aligns with past research suggesting that individuals in satisfying relationships are more willing and better able to support one another in their goals. However, it suggests that

though being satisfied in a relationship might be a helpful starting point or pre-requisite, support—particularly positive partner support—is a key factor in facilitating quitting.

There was a direct effect of positive support at follow-up on abstinence such that more positive support at the end of study duration was associated with a greater likelihood of quitting. Furthermore, the strongest indirect path was through positive support. This aligns with past research showing that positive reinforcement and supportive behaviors from a partner increase the likelihood of quitting smoking (van den Brand et al., 2019). Positive support reinforces commitment, enhances self-efficacy, buffers stress, improves relationship quality fostering a conducive environment for quitting. Feeling that one's partner is available to support can reinforces the commitment to quit smoking. Positive support behaviors can also strengthen an individual's belief in their (and the couples) ability to quit. Partner support for quitting can buffer against stress (a common trigger for relapse) and reduce the likelihood of turning to smoking as a means of coping. Lastly, positive support improves relationship quality which could reflect a more cooperative and encouraging environment. Interestingly, positive support at baseline was not directly associated with quitting. One explanation for this null finding is that positive support may not have been relevant for the couple or individual prior to enrolling in the pilot. Desire and/or readiness to quit was not an eligibility criterion for study participation so it is possible that positive support only became meaningful when an individual and/or couple decided to quit smoking and as they attempted to maintain abstinence and resist relapse.

Negative partner support was associated with quitting in multiple ways. We found a direct positive pathway from negative support at baseline to quitting, indicating that negative support from a partner before or at the beginning of the quit process may be beneficial for quit outcomes. Interestingly, this pattern did not replicate for negative support at follow-up, which

was negatively associated with quitting, such that greater reports of negative partner support at follow-up was associated with poorer quit outcomes. The indirect path through negative support showed that greater reports of negative support at baseline led to more negative support at follow-up which was associated with a lower likelihood of being abstinent at follow-up. It is possible that negative support aimed at smoking behavior may serve a motivational purpose that is helpful when an individual is beginning the process, however, becomes detrimental later and leads to worse outcomes. It is also possible that the same negative support behaviors (e.g., nagging or criticism related to smoking) are interpreted differently during various stages of the quit process (i.e., as motivation vs. criticism). Negative support behaviors could increase stress within the relationship, reduce motivation, erode relationship quality, and incite resistance, creating a challenging environment for maintaining abstinence. Negative support such as criticism or nagging could lead to conflict within the relationship and undermine the emotional resources (e.g., effective communication) needed to quit smoking. The use of negative support might reflect underlying conflicts and communication issues present within the couple. Individuals who feel criticized or unsupported might experience less motivation to keep pursuing the goal or even turn to smoking as a coping mechanism. Negative support might foster resentment and erode feelings of trust within the relationship, an essential component of collaborative quit efforts. Within our sample, these results indicate that if a partner did not feel supported at the beginning of the quit process, the couple was unlikely to successfully quit together.

In addition to the potential consequences of negative support, an individuals' negative reactions to receiving support can hinder their ability to change behavior effectively. A meta-analysis on social control in close relationships conducted by Craddock and colleagues (2015),

showed that attempts to influence others' behavior sometimes backfires. How recipients perceive other's efforts affects how they behave and whether it has the intended beneficial effect. Our results suggest that relationship satisfaction at the beginning of a quit attempt buffers those perceptions, such that changes in how a partner is providing support are perceived more positively. In other words, when an individual is satisfied in their relationship, instead of resisting a partner's influence, they are more accepting of influence strategies and translate it into behavior change (e.g., quitting). Additionally, these findings align with work by Joel and colleagues (2020) on the predictors of relationship quality. They found that in most relationships research, outcomes are driven by actor effects such that individual differences and partner reports had no predictive effects beyond actor-reported variables (Joel et al., 2020). This is consistent with our findings, wherein actor-reports of satisfaction and support were most influential in driving effects. Much of the observed dynamics within dyadic relationships appear to stem from an individuals' perceptions and interpretations. A person's own judgement about the relationship (e.g., how satisfied they are, how they interpret and utilize support from a partner) is the determining factor for behavior change and outcomes.

The pathways to individual quitting highlight potential within-level and between-level factors that can either facilitate or hinder smoking cessation success. At the individual level, perceptions, and behaviors such as motivation, readiness to quit, and perceived social support play a pivotal role. Concurrently, the dynamics and characteristics of the couple, including relationship satisfaction, supportive behaviors, collective quitting activities, and the influence of FITs, might impact the cessation process. Understanding and addressing these multi-level factors are essential for developing effective interventions and supporting sustained quit efforts.

Limitations & Future Directions

The present research was a part of a pilot study and as such is limited in its ability to draw conclusions from traditional analyses (Kraemer et al., 2006; Leon et al., 2011). Further research is needed to test and draw conclusions about individual and couple-level mechanisms influencing quit outcomes. Several limitations are worth noting and addressing in future work.

First, the lack of a significant effect of relationship satisfaction was notable. One explanation for this could be related to our measurement approach. Some recent evidence suggests that self-reported perceptions of relationship satisfaction are not always reliable predictors of longitudinal changes in satisfaction (Righetti et al., 2022). Future researchers should consider supplementing self-reported satisfaction with additional metrics including implicit evaluations, other relationship demographics, and life events. Additionally, researchers could examine other relationship features that could be influential in the quit process. For instance, we measured individuals' perceptions of their partners positive and negative support behaviors for quitting, but future work could examine perceptions of provided (vs. received) support or other aspects of support such as partner responsiveness.

Second, we used MLM to model individual level predictors on the individual outcome of quitting. This approach allowed us to examine effects at the individual level while accounting for the interdependence of couples. In DSCs, partners often influence each other's smoking behaviors and quitting efforts through mutual support, shared motivations, and coordinated strategies. The interdependence between partners means that their success in quitting is not solely an individual endeavor but a collaborative process. Addressing this acknowledges the couple's dynamic and leverages the strengths of their relationship, potentially leading to more effective and sustained smoking cessation outcomes.

Third, the timeframe was a limitation in several ways. First, having two (vs. three or more) time points for data collection would have allowed us to test longitudinal models to see how relationship factors change and influence quitting over time. It is also possible that a 3-month timeframe was not sufficient to see changes in the relationship that were related to quitting. Second, because follow-up measures were reported simultaneously with quitting outcomes, we must be cautious when interpreting causal direction. Third, we assessed short-term smoking outcomes, but we do not know if these effects hold over longer periods of time. Longer-term assessments of smoking status are necessary to examine the sustained effects of relationship dynamics and partner-involved FITs on smoking cessation. We are currently collecting new data that will address this concern. Despite these limitations, this study has the potential to enhance intervention strategies as well as advance theoretical models of health behavior change by incorporating relational factors into frameworks traditionally focused on individual behaviors.

Conclusion

This study aims to provide valuable insights into the role of relationship satisfaction in smoking cessation, potentially informing the development of more effective, relationship-focused interventions for DSCs. Preliminary results indicate that FITs, as well as relational dynamics such as partner support for quitting can influence abstinence. When both partners are incentivized to quit together and their relationship satisfaction improves, they are more likely to quit smoking both individually and as a couple.

References

Berli, C., Bolger, N., Shrout, P. E., Stadler, G., & Scholz, U. (2018). Interpersonal processes of couples' daily support for goal pursuit: The example of physical activity. *Personality and Social Psychology Bulletin*, *44*(3), 332–344. https://doi.org/10.1177/0146167217739264

Berli, C., Schwaninger, P., & Scholz, U. (2021). "We feel good": Daily support provision, health behavior, and well-being in romantic couples. *Frontiers in Psychology*, *11*, 622492. https://doi.org/10.3389/fpsyg.2020.622492

Britton, M., Haddad, S., & Derrick, J.L. (2019). Perceived partner responsiveness predicts smoking cessation in single-smoker couples, *Addictive Behaviors*, *88,* 122-128. https://doi.org/10.1016/j.addbeh.2018.08.026.

Brown, S. L., Nesse, R. M., Vinokur, A. D., & Smith, D. M. (2003). Providing social support may be more beneficial than receiving it: Results from a prospective study of mortality. *Psychological science*, 14(4), 320-327. https://doi.org/10.1111/1467-9280.1446

Bühler, J. L., Krauss, S., & Orth, U. (2021). Development of relationship satisfaction across the life span: A systematic review and meta-analysis. *Psychological Bulletin*, *147*(10), 1012–1053. https://doi.org/10.1037/bul0000342

Buitenhuis, A. H., Tuinman, M. A., Stadler, G., & Hagedoorn, M. (2021). Daily support and negative control during a quit attempt in single-smoking couples. *Health Psychology*, *40*(3), 207–216. https://doi.org/10.1037/hea0000969

Cappuzzello, A. C., & Gere, J. (2018). Can you make my goals easier to achieve? Effects of partner instrumentality on goal pursuit and relationship satisfaction. *Personal Relationships*, *25*(2), 268–279. https://doi.org/10.1111/pere.12238

Carr, P. B., & Walton, G. M. (2014). Cues of working together fuel intrinsic motivation. *Journal of Experimental Social Psychology*, *53*, 169–184. https://doi.org/10.1016/j.jesp.2014.03.015

Centers for Disease Control and Prevention (CDC) (2022, August). Current cigarette smoking among adults in the United States. Centers for Disease Control and Prevention. https://www.cdc.gov/tobacco/data_statistics/fact_sheets/adult_data/cig_smoking/index.ht

Chan, S.S.C., Cheung, Y.T.D., Fong, D.Y.T., Emmons, K., Leung, A.Y.M., Leung, D.Y.P., & Lam, T.H. (2017). Family-based smoking cessation intervention for smoking fathers and nonsmoking mothers with a child: A randomized controlled trial, *The Journal of Pediatrics, 182*, 260-266.e4, https://doi.org/10.1016/j.jpeds.2016.11.021

Choi, S. H. (2022). A systematic review and narrative summary of couple-based smoking cessation interventions. *Journal of Social and Personal Relationships, 39*(7), 1901-1916. https://doi.org/10.1177/02654075211070272

Christakis, N. A., & Fowler, J. H. (2008). The collective dynamics of smoking in a large social network. *New England Journal of Medicine*, *358*(21), 2249–2258. https://doi.org/10.1056/NEJMsa0706154

Cobb, L. K., McAdams-DeMarco, M. A., Huxley, R. R., Woodward, M., Koton, S., Coresh, J., & Anderson, C. A. M. (2014). The association of spousal smoking status with the ability to quit smoking: The atherosclerosis risk in communities study. *American Journal of Epidemiology*, *179*(10), 1182–1187. https://doi.org/10.1093/aje/kwu041

Cohen, S., & Lichtenstein, E. (1990). Partner behaviors that support quitting smoking. *Journal of Consulting and Clinical Psychology, 58*, 304-309.

Coppotelli, H. C., & Orleans, C. T. (1985). Partner support and other determinants of smoking cessation maintenance among women. *Journal of Consulting and Clinical Psychology*, *53*, 455–460. https://doi.org/10.1037/0022-006X.53.4.455

Craddock, E., vanDellen, M. R., Novak, S. A., & Ranby, K. W. (2015). Influence in relationships: A meta-analysis on health-related social control. *Basic and Applied Social Psychology*, 37(2), 118–130. https://doi.org/10.1080/01973533.2015.1011271

Cramer, D. (2004). Emotional support, conflict, depression, and relationship satisfaction in a romantic partner. *The Journal of Psychology: Interdisciplinary and Applied, 138*(6), 532–542. https://doi.org/10.3200/JRLP.138.6.532-542

Cropsey, K. L., Trent, L. R., Clark, C. B., Stevens, E. N., Lahti, A. C., & Hendricks, P. S. (2014). How low should you go? Determining the optimal cutoff for exhaled carbon monoxide to confirm smoking abstinence when using cotinine as reference. *Nicotine & Tobacco Research, 16*(10), 1348–1355. https://doi.org/10.1093/ntr/ntu085

Cutrona, C. E., Shaffer, P. A., Wesner, K. A., & Gardner, K. A. (2007). Optimally matching support and perceived spousal sensitivity. *Journal of family psychology*, 21(4), 754. https://doi.org/10.1037/0893-3200.21.4.754

Derrick, J. L., Leonard, K. E., & Homish, G. G. (2013). Perceived partner responsiveness predicts decreases in smoking during the first nine years of marriage. *Nicotine & Tobacco Research, 15*(9), 1528–1536. https://doi.org/10.1093/ntr/ntt011

de Vries, H., Bakker, M., Mullen, P.D., & van Breukelen, G.(2006). The effects of smoking cessation counseling by midwives on Dutch pregnant women and their partners, *Patient Education and Counseling, 63* (1-2), 177-187. https://doi.org/10.1016/j.pec.2005.10.002.

Eaker, E. D., Sullivan, L. M., Kelly-Hayes, M., D'Agostino, R. B., Sr, & Benjamin, E. J. (2007). Marital status, marital strain, and risk of coronary heart disease or total mortality: The Framingham Offspring Study. *Psychosomatic medicine*, *69*(6), 509–513. https://doi.org/10.1097/PSY.0b013e3180f62357

Etcheverry, P. E., & Agnew, C. R. (2008). Romantic partner and friend influences on young adult cigarette smoking: Comparing close others' smoking and injunctive norms over time. *Psychology of Addictive Behaviors*, *22*(3), 313–325. https://doi.org/10.1037/0893-164X.22.3.313

Fincham, F. D., & Beach, S. R. H. (2006). Relationship Satisfaction. In A. L. Vangelisti & D. Perlman (Eds.), *The Cambridge handbook of personal relationships* (pp. 579–594). *Cambridge University Press*. https://doi.org/10.1017/CBO9780511606632.032

Fletcher, A., Jamal, F., Moore, G., Evans, R. E., Murphy, S., & Bonell, C. (2016). Realist complex intervention science: Applying realist principles across all phases of the Medical Research Council framework for developing and evaluating complex interventions. *Evaluation, 22*(3), 286-303. https://doi.org/10.1177/1356389016652743

Foulstone, A. R., Kelly, A. B., & Kifle, T. (2017). Partner influences on smoking cessation: A longitudinal study of couple relationships. *Journal of Substance Use*, *22*(5), 501–506. https://doi.org/10.1080/14659891.2016.1255791

Foulstone, A. R., Kifle, T., & Kelly, A. B. (2019). The influence of partner smoking, relationship satisfaction and parental stress on tobacco use. *Journal of Smoking Cessation*, *14*(3), 155–160. https://doi.org/10.1017/jsc.2018.37

Funk, J. L., & Rogge, R. D. (2007). Testing the ruler with item response theory: Increasing precision of measurement for relationship satisfaction with the Couples Satisfaction Index. *Journal of Family Psychology*, *21*(4), 572–583. https://doi.org/10.1037/0893-3200.21.4.572

Gaine, G. S., & La Guardia, J. G. (2009). The unique contributions of motivations to maintain a relationship and motivations toward relational activities to relationship well-being. *Motivation and Emotion*, 33(2), 184–202. https://doi.org/10.1007/s11031-009-9120-x

Heckman, B. W., Ditre, J. W., & Brandon, T. H. (2012). The restorative effects of smoking upon self-control resources: a negative reinforcement pathway. *Journal of abnormal psychology*, *121*(1), 244–249. https://doi.org/10.1037/a0023032

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. https://doi.org/10.1037/a0036483

Hofmann, W., Finkel, E. J., & Fitzsimons, G. M. (2015). Close relationships and self-regulation: How relationship satisfaction facilitates momentary goal pursuit. *Journal of Personality and Social Psychology*, *109*(3), 434–452. https://doi.org/10.1037/pspi0000020

Holding, A. C., Barlow, M., Koestner, R., & Wrosch, C. (2020). Why are we together? A dyadic longitudinal investigation of relationship motivation, goal progress, and adjustment. *Journal of personality*, 88(3), 464-477. https://doi.org/10.1111/jopy.12503

Homish, G. G., & Leonard, K. E. (2005). Spousal influence on smoking behaviors in a US community sample of newly married couples. *Social Science & Medicine*, *61*(12), 2557–2567. https://doi.org/10.1016/j.socscimed.2005.05.005

Jackson, S.E., Steptoe, A., & Wardle, J. (2015). The influence of partner's behavior on health behavior change: The English longitudinal study of ageing. *JAMA Intern Med.* 175(3)385–392. https://doi:10.1001/jamainternmed.2014.7554

Joel, S., Eastwick, P. W., Allison, C. J., Arriaga, X. B., Baker, Z. G., Bar-Kalifa, E., Bergeron, S., Birnbaum, G. E., Brock, R. L., Brumbaugh, C. C., Carmichael, C. L., Chen, S., Clarke, J., Cobb, R. J., Coolsen, M. K., Davis, J., de Jong, D. C., Debrot, A., DeHaas, E. C., Derrick, J. L., … Wolf, S. (2020). Machine learning uncovers the most robust self-report predictors of relationship quality across 43 longitudinal couples studies. *Proceedings of the National Academy of Sciences of the United States of America*, 117(32), 19061–19071. https://doi.org/10.1073/pnas.1917036117

Kashy, D. A., & Kenny, D. A. (1999). The analysis of data from dyads and groups. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social psychology*. New York: Cambridge University Press.

Kazdin A. E. (2007). Mediators and mechanisms of change in psychotherapy research. *Annual Review of Clinical psychology*, *3*, 1–27. https://doi.org/10.1146/annurev.clinpsy.3.022806.091432

Kenny, D. A. (1996). Models of non-independence in dyadic research. *Journal of Social and Personal Relationships*, 13(2), 279–294. https://doi.org/10.1177/0265407596132007

Kiecolt-Glaser, J. K., & Newton, T. L. (2001). Marriage and health: His and hers. *Psychological Bulletin*, *127*(4), 472–503. https://doi.org/10.1037/0033-2909.127.4.472

King, K. B., & Reis, H. T. (2012). Marriage and long-term survival after coronary artery bypass grafting. *Health Psychology, 31*(1), 55–62. https://doi.org/10.1037/a0025061

Knoll, N., Burkert, S., Scholz, U., Roigas, J., & Gralla, O. (2012). The dual-effects model of social control revisited: Relationship satisfaction as a moderator. *Anxiety, Stress & Coping*, *25*(3), 291–307. https://doi.org/10.1080/10615806.2011.584188

Leon, A. C., Davis, L. L., & Kraemer, H. C. (2011). The role and interpretation of pilot studies in clinical research. *Journal of Psychiatric Research*, *45*(5), 626–629. https://doi.org/10.1016/j.jpsychires.2010.10.008

McBride, C. M., Curry, S. J., Grothaus, L. C., Nelson, J. C., Lando, H., & Pirie, P. L. (1998). Partner smoking status and pregnant smoker's perceptions of support for and likelihood of smoking cessation. *Health Psychology, 17*(1), 63–69. https://doi.org/10.1037/0278-6133.17.1.63

Mermelstein, R., Cohen, S., Lichtenstein, E., Baer, J. S., & Kamarck, T. (1986). Social support and smoking cessation and maintenance. *Journal of Consulting and Clinical Psychology*, *54*(4), 447–453. https://doi.org/10.1037//0022-006x.54.4.447

Moore, C. G., Carter, R. E., Nietert, P. J., & Stewart, P. W. (2011). Recommendations for planning pilot studies in clinical and translational research. *Clinical and Translational Science*, *4*(5), 332–337. https://doi.org/10.1111/j.1752-8062.2011.00347.x

Muthén, L.K., & Muthén, B.O., (1998-2022). Mplus User's Guide. Eighth Edition. Los Angeles, CA: Muthén & Muthén.

Pasch, L. A., & Bradbury, T. N. (1998). Social support, conflict, and the development of marital dysfunction. *Journal of Consulting and Clinical Psychology, 66*(2), 219–230. https://doi.org/10.1037/0022-006X.66.2.219

Pearson, N., Naylor, P. J., Ashe, M. C., Fernandez, M., Yoong, S. L., & Wolfenden, L. (2020). Guidance for conducting feasibility and pilot studies for implementation trials. *Pilot and Feasibility studies*, *6*(1), 167. https://doi.org/10.1186/s40814-020-00634-w

Ranby, K. W., Lewis, M. A., Toll, B. A., Rohrbaugh, M. J., & Lipkus, I. M. (2013). Perceptions of smoking-related risk and worry among dual-smoker couples. *Nicotine & Tobacco Research, 15*(3), 734–738. https://doi.org/10.1093/ntr/nts210

Righetti, F., Faure, R., Zoppolat, G., Meltzer, A., & McNulty, J. (2022). Factors that contribute to the maintenance or decline of relationship satisfaction. *Nature Reviews Psychology, 1*(3), 161-173. https://doi.org/10.1038/s44159-022-00026-2

Scholz, U., Stadler, G., Ochsner, S., Rackow, P., Hornung, R., & Knoll, N. (2016). Examining the relationship between daily changes in support and smoking around a self-set quit date. *Health Psychology, 35*(5), 514–517. https://doi.org/10.1037/hea0000286.

Shrout, M. R., Renna, M. E., Madison, A. A., Alfano, C. M., Povoski, S. P., Lipari, A. M., Agnese, D. M., Yee, L. D., Carson, W. E., 3rd, & Kiecolt-Glaser, J. K. (2020). Relationship satisfaction predicts lower stress and inflammation in breast cancer survivors: A longitudinal study of within-person and between-person effects. *Psychoneuroendocrinology,* 118, 104708. https://doi.org/10.1016/j.psyneuen.2020.104708

Slatcher, R. B. (2010). Marital functioning and physical health: Implications for social and personality psychology. *Social and Personality Psychology Compass*, *4*(7), 455–469. https://doi.org/10.1111/j.1751-9004.2010.00273.x

Slatcher, R. B., & Selcuk, E. (2017). A social psychological perspective on the links between close relationships and health. *Current Directions in Psychological Science*, *26*(1), 16–21. https://doi.org/10.1177/0963721416667444

Smith, V. A., Lindquist, J., Miller, K. E. M., Shepherd-Banigan, M., Olsen, M., Campbell-Kotler, M., Henius, J., Kabat, M., & Van Houtven, C. H. (2019). Comprehensive family caregiver support and caregiver well-being: Preliminary evidence from a pre-post-survey study with a non-equivalent control group. *Frontiers in Public Health*, *7*, 122. https://doi.org/10.3389/fpubh.2019.00122

Snyder, D. K., & Costin, S. E. (1994). Marital satisfaction inventory. *The Use of Psychological Testing for Treatment Planning and Outcome Assessment* (pp. 322–351). Lawrence Erlbaum Associates, Inc.

Sterba, K. R., Rabius, V., Carpenter, M. J., Villars, P., Wiatrek, D., & McAlister, A. (2011). Dyadic efficacy for smoking cessation: Preliminary assessment of a new instrument. *Nicotine & Tobacco Research*, *13*(3), 194-201. https://doi.org/10.1093/ntr/ntq236

Toma, A. M., Rusu, P. P., & Podina, I. R. (2023). The role of goal interdependence in couples' relationship satisfaction: A meta-analysis. *Journal of Social and Personal Relationships, 40*(6), 1740-1769. https://doi.org/10.1177/02654075221128994

Ungar, N., Michalowski, V. I., Baehring, S., Pauly, T., Gerstorf, D., Ashe, M. C., Madden, K. M., & Hoppmann, C. A. (2021). Joint goals in older couples: Associations with goal progress, allostatic load, and relationship satisfaction. *Frontiers in Psychology*, *12*. https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2021.623037

vanDellen, M. R. (2019). Health behavior change in transactive systems. *Social and Personality Psychology Compass*, *13*(11), e12505. https://doi.org/10.1111/spc3.12505

vanDellen, M. R., Boyd, S. M., Ranby, K. W., MacKillop, J., & Lipkus, I. M. (2016). Willingness to provide support for a quit attempt: A study of partners of smokers. *Journal of Health Psychology*, *21*(9), 1840–1849. https://doi.org/10.1177/1359105314567209

vanDellen, M. R., Wright, J. W. C., Zhao, B., Cullinan, C., Beach, S. R. H., Shen, Y., Haskins, L. B., Schiavone, W. M., & MacKillop, J. M. (2024). Partner-involved financial incentives for smoking cessation in dual-smoker couples: A randomized pilot trial. *Nicotine and Tobacco Research*, *26*(2), 229–236. https://doi.org/10.1093/ntr/ntad183

van den Brand, F. A., Nagtzaam, P., Nagelhout, G. E., Winkens, B., & van Schayck, C. P. (2019). The Association of peer smoking behavior and social support with quit success in employees who participated in a smoking cessation intervention at the workplace. *International journal of environmental research and public health*, *16*(16), 2831. https://doi.org/10.3390/ijerph16162831

Volpp, K. G., Troxel, A. B., Pauly, M. V., Glick, H. A., Puig, A., Asch, D. A., Galvin, R., Zhu, J., Wan, F., DeGuzman, J., Corbett, E., Weiner, J., & Audrain-McGovern, J. (2009). A randomized, controlled trial of financial incentives for smoking cessation. *The New England Journal of Medicine*, *360*(7), 699–709. https://doi.org/10.1056/NEJMsa0806819

Wilson, S. J., & Novak, J. R. (2022). The implications of being "in it together": Relationship satisfaction and joint health behaviors predict better health and stronger concordance between partners. *Annals of Behavioral Medicine*, *56*(10), 1014–1025. https://doi.org/10.1093/abm/kaab099

Xu, Y., & Burleson, B. R. (2004). The association of experienced spousal support with marital satisfaction: Evaluating the moderating effects of sex, ethnic culture, and type of support.

The Journal of Family Communication, 4(2), 123-145.

https://doi.org/10.1207/s15327698jfc0402_3

Tables

Table 3.1

Summary of individual participant characteristics

	No-FIT Control (n=58)	PIF-ST (n=68)	PIF-DT (n=64)	Total (n=190)
Age	41.67 (10.42)	43.00 (10.90)	42.40 (10.50)	42.40 (10.57)
Gender				
Male	48.28%	48.53%	46.88%	47.89%
Female	51.72%	51.47%	53.13%	52.11%
Cigarettes per day				
5-9 cigarettes/day	23.21%	32.35%	30.64%	29.03%
10-19 cigarettes/day	57.14%	42.65%	46.77%	48.39%
>20 cigarettes/day	19.64%	25.00%	22.58%	22.58%
Vape				
No	67.31%	77.19%	68.42%	71.08%
Yes	32.69%	22.81%	31.58%	29.92%
Race				
American Indian or Alaska Native	3.45%	0.00%	0.00%	1.06%
Asian	0.00%	1.49%	0.00%	0.53%
Black or African American	13.79%	7.46%	20.63%	13.83%
White or Caucasian	77.59%	79.10%	73.02%	76.60%

Mixed Race	3.44%	4.48%	3.17%	3.72%
Other	1.72%	5.97%	1.59%	3.19%
N/A	0.00%	1.49%	1.59%	1.06%
Education				
< College degree	74.14%	60.61%	57.14%	63.63%
College/technical school graduate	24.14%	33.33%	33.33%	30.48%
Post-college education graduate	1.72%	6.06%	9.52%	5.88%
Income*	$32000 [13000, 52000]	$27000 [14400, 45000]	$30000 [3500, 43000]	$30000 [11306, 46000]
Relationship Length (years)	7.86 (8.48)	7.44 (7.31)	8.91 (8.65)	8.06 (8.12)

Notes. Data are presented as (%) or mean ± std unless otherwise indicated. There were no significant differences in participant characteristics across conditions.

**Median [quantile]*

Table 3.2

Smoking Outcomes by Condition

	No-FIT Control	PIF-ST	PIF-DT
Abstinence*			
Targets	10.34% (2.19%, 27.35%)	47.06% (29.78%, 64.87%)	28.13% (13.75%, 46.75%)

Partners	6.90% (0.85%, 22.77%)	38.24% (22.17%, 56.44%)	31.25% (16.12%, 50.01%)

*Variable registered as primary preliminary efficacy outcome

Note: Results in this table were previously reported in vanDellen et al. (2023) but are presented here as they are relevant to understanding indirect effects.

Table 3.3

Means and Standard Deviations of Relationship Satisfaction and Support Measures Assessed at Each Time Point

Measure	Baseline	Baseline	3-Month Follow-Up	3-Month Follow-Up
	Targets	Partners	Targets	Partners
Relationship Satisfaction	3.97 (1.03)	4.14 (0.94)	3.86 (1.17)	4.09 (1.03)
Positive Support	1.46 (1.10)	1.54 (1.12)	1.71 (1.34)	2.01 (1.26)
Negative Support	0.90 (0.86)	0.92 (0.89)	1.05 (12)	1.07 (1.08)

Table 3.4

Bivariate Correlations for Target and Partner

Variable	1	2	3	4	5	6	7	8	9	10
1.Target Baseline RS										
2.Parter Baseline RS	.47**									
3.Target Follow-up RS	.73**	.49**								
4. Partner Follow-up RS	.60**	.72**	.79**							

5. Target Baseline PS	.20	.00	.12	-.01						
6. Partner Baseline PS	.05	.24*	.10	.18	.26*					
7. Target Follow-up PS	.35**	.23*	.46**	.38**	.49**	.39**				
8. Partner Follow-up PS	.23*	.08	.25*	.27*	.34**	.44**	.63**			
9. Target Baseline NS	-.20	-.19	-.05	-.12	.40**	.06	.34**	.31**		
10. Partner Baseline NS	-.04	-.07	-.05	-.10	.16	.52**	.13	.27*	.21	
11. Target Follow-up NS	.02	-.02	.07	.04	.45**	.37**	.49**	.47**	.61**	.40*
12. Partner Follow-up NS	-.04	-.07	-.12	-.16	.32**	.35**	.30**	.48**	.40**	.60*

Note. RS = relationship satisfaction, PS = positive support, NS = negative support. *$p < .05$. ** $p < .01$

Table 3.5

Regression Coefficients for Generalized Linear Mixed Model

	Estimate (β)	*SE*	*p*-value
Individual Abstinence			
Condition	-4.27	8.67	.662
Relationship Satisfaction	1.89	2.75	.492
Condition x Relationship Satisfaction	1.80	2.84	.525

Note. Regression coefficients are reported. The model includes a random intercept for dyad to account for couple interdependence. Condition refers to FIT condition (PFIT vs. Control).

Table 3.6

Regression Coefficients for Relationship Satisfaction, Positive Support, and Negative Support on Quitting

Variable	Estimate (β)	*SE*	95% CI	*p*

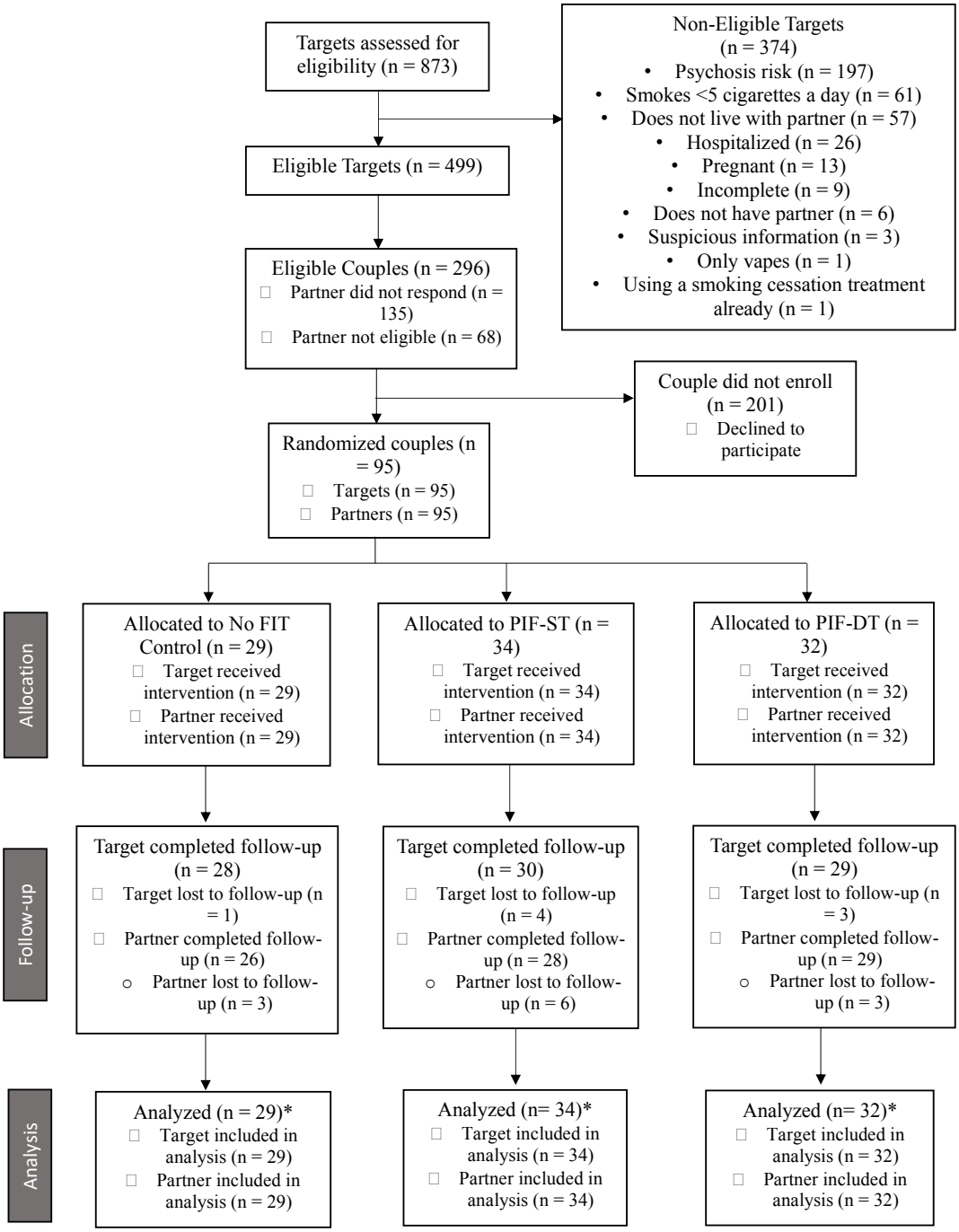
RS Follow-Up				
RS Baseline	0.82	.08	[0.661, 0.977]	<.000
PS Baseline	-0.03	.08	[-0.189, 0.135]	.743
NS Baseline	0.05	.12	[-0.175, 0.283]	.642
PS Follow-Up				
PS Baseline	0.41	.11	[0.190, 0.626]	<.000
NS Baseline	0.27	.15	[-0.010, 0.557]	.059
RS Baseline	0.23	.11	[0.019, 0.450]	.033
NS Follow-Up				
NS Baseline	0.71	.12	[0.465, 0.946]	.000
PS Baseline	0.14	.10	[-0.042, 0.327]	.129
RS Baseline	0.03	.10	[-0.159, 0.210]	.787
Quitting				
RS Baseline	-0.10	.18	[-0.455, 0.265]	.606
RS Follow-Up	0.02	.18	[-0.334, 0.377]	.905
PS Baseline	-0.17	.10	[-0.0375, 0.030]	.095
PS Follow-Up	0.54	.09	[0.360, 0.717]	<.000
NS Baseline	0.36	.15	[0.071, 0.647]	.015
NS Follow-Up	-0.26	.13	[-0.509, -0.018]	.036
RS Baseline				
PS Baseline	0.24	.08	[0.074, 0.400]	.004
NS Baseline	-0.12	.08	[-0.279, 0.039]	.138
RS Follow-Up				

PS Follow-Up	0.31	.07	[0.172, 0.456]	<.000
NS Follow-Up	-0.04	.06	[-0.197, 0.089]	.583
PS Follow-Up				
NS Follow-Up	0.33	.10	[0.127, 0.531]	.001
NS Baseline				
PS Baseline	0.45	. 09	[0.265, 0.625]	.000

Note. Regression coefficients and their respective confidence intervals are reported. CI = confidence interval, RS = relationship satisfaction, NS = negative support, PS = positive support.

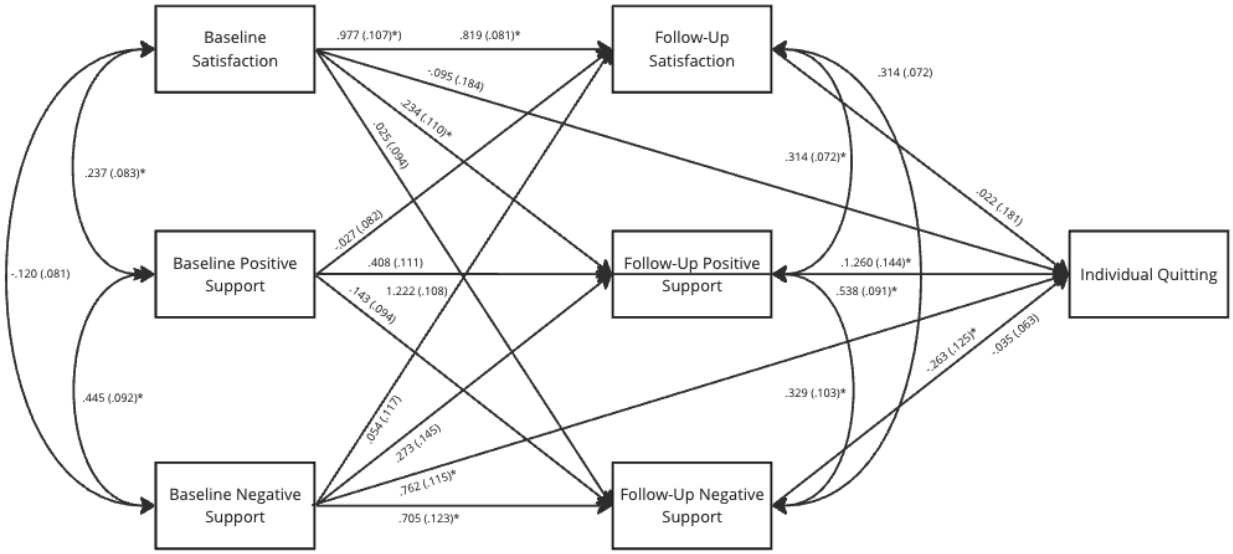
Figures

Figure 1. CONSORT Diagram



*Only participants who completed follow-up were included in tolerability analyses

Figure 2. MLM with random intercept for dyad.



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Disclosure Statement

James M. MacKillop is a principal and senior scientist in Beam Diagnostics, Inc. and has served as a consultant to Clairvoyant Therapeutics, Inc. No other authors have disclosures.

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CHAPTER 5

GENERAL DISCUSSION

CHAPTER 5

GENERAL DISCUSSION

The purpose of the present research was to investigate the interdependent nature of smoking behavior and smoking cessation. The goal of this discussion is to synthesize the findings across three related projects. Given the significant health implications of smoking and the role of social influences, this research sought to uncover how social influences impact smoking behaviors, and how they could be leveraged to facilitate rather than hinder quitting.

Summary of Findings

Chapter 1 utilized samples of partnered and unpartnered smokers to capture the social environment of current cigarette smokers. Results from two studies provided updated metrics on the social demographics of smokers, particularly the comorbidity between social and behavioral risk factors for persistent smoking. Smokers were more likely to have a romantic partner, live with a partner, and be in a dual-smoker relationship. Living with another smoker (a romantic partner or not) was related to greater risks for persistent smoking including heavier smoking and greater likelihood of smoking being permitted inside the home. Data from these studies provide updated demographic information about current smokers that should be used in future research as well as to inform the development of treatment interventions.

Chapter 2 expanded on the social context as a determinant of smoking behavior by examining automatic associations between close relationships and smoking-related stimuli. Using two methodologies, we tested whether other people in a smoker's social environment, including their romantic partner, serve as powerful cues to smoke. Study 1 used a cue-reactivity paradigm to compare participant's cravings, negative affect, positive affect, excitement and

calmness in response to a romantic partner, other person, or control condition. Study 2 employed an Implicit Association Task to assess associations between a smoker's romantic partner and smoking-related triggers. Results across these studies showed evidence of automatic cognitive associations between smoking and smokers' romantic partners.

Chapter 3 expanded on findings related to the social nature of smoking by adopting a relationships-perspective to explore relationship satisfaction is related to support and smoking abstinence. We used data from a pilot study (R21CA241570-01A1) of 95 dual-smoker couples to examine associations between relationship satisfaction, positive partner support, negative partner support and individual quitting over time. A saturated multilevel model using random intercepts was used to map pathways between variables while accounting for the interdependence of smoking couples. Results from the path analysis revealed several direct and indirect pathways through which relationship factors influenced quitting behavior among dual-smoker couples. Direct effects included negative support at baseline, negative support at follow-up, and positive support at follow-up. Indirect effects included satisfaction through positive support, as well as indirect paths through positive partner support (baseline to follow-up) and negative partner support (baseline to follow-up) respectively. Results across studies indicate that a smoker's social environment influences their smoking habits (e.g., smoking heaviness, cravings) as well as their ability to quit smoking and maintain abstinence.

The Impact of Social Networks on Smoking Habits

Based on past research on dual-smoker couples, we expected partner smoking status to be a key differentiator for smoking behaviors and quit outcomes. However, results from both Chapters 1 and 2 revealed similar associations between other smokers, whether they were a romantic partner or not, as well as similarities between romantic partners who were smokers or

non-smokers. Participant smoking characteristics and comorbidities in Chapter 1 indicated that living with another smoker, regardless of relationship-type, was associated with smoking-related risk factors. Findings from both studies in Chapter 2 provide further evidence that other people influence smoking behavior regardless of relationship type or smoking status. In Study 1, cue-reactivity did not differ significantly between a romantic partner and another person not smoked around. Additionally, results from the IAT task in Study 2 showed that partner smoking status did not influence automatic associations between a smoker's romantic partner and smoking-stimuli, although characteristics of the partner were associated with differentially strong links to smoking.

Rethinking the Distinctiveness of Dual-Smoker Couples

Dual-smoker couples may not be as unique as we expected them to be. Although past research has outlined the challenges faced by this population of smokers (Cobb et al., 2014; Derrick et al., 2013; Ferguson et al., 2005; Margolis & Wright, 2016; Ranby et al., 2013; Westmaas et al., 2010), our results indicate that smokers partnered with non-smokers or even unpartnered smokers may face similar barriers to quitting. The consistent patterns found among smokers living with another smoker in Chapter 1, combined with the lack of effect for partner smoking status in the implicit association task in Chapter 2, demonstrate that smoking influences and social triggers are pervasive across smoking populations. Perhaps a lack of attention on a smoker's romantic relationships has contributed to some of the commonalities between dual and single-smokers couples being masked. There are reasons to assume that dual and single-smoker couples might experience similar challenges and outcomes as it relates to smoking. Both couple-types could share environmental factors such as living with other smokers, or smoking inside the home which could lead to similar experiences. It is also possible that dynamics of the

relationship itself such as support, and communication might be more influential than the smoking status of the partner. Perhaps having a supportive partner (smoker or not) who encourages quitting and helps to foster an environment conducive for quitting matters more than smoking status. Similarly, social norms and acceptance of smoking behavior within the relationship may lead to similar outcomes. Lastly, both single and dual-smoker couples exist within a larger social context in which their romantic partner is a significant but not sole influence. It is possible that we found similarities between partnered smokers due to the strength of the external social influences around them.

Our initial assumptions regarding the distinctiveness of single and dual-smoker couples shaped the focus of our research. As a result, the present studies were not set up to test direct comparisons between these groups. This limitation underscores the need for future work to revisit the meaningful differences (if any) between these populations. Despite this limitation, our findings consistently highlight the importance of considering romantic partners in influencing smoking behavior. Romantic partners are frequently exposed to smoking activities through shared living spaces and daily routines. This repeated exposure to smoking behaviors provides opportunities to normalize and shape their partner's behavior. The acceptance of smoking by a romantic partner is a deciding factor that can significantly impact smoking behavior and cessation efforts. If a partner tolerates or even encourages smoking, it can normalize the behavior within the relationship and reduce the perceived social pressure to quit. Social acceptance of smoking within a relationship may explain some of the similarities we observed between dual-smoker and single-smoker couples. It is possible that approval of smoking plays a larger role than partner smoking status in driving quitting motivation and outcomes. Non-smoking partners who are accepting of their partner's smoking behavior may reinforce smoking habits and

undermining cessation efforts. While the present research did not directly address the acceptance of smoking by non-smoking partners, this remains an important and unanswered question. Future research could delve deeper into how acceptance or rejection of smoking by a non-smoking partner impacts the smoking behavior of the individual and the dynamics within the relationship.

The Impact of Social Networks on Smoking Habits

Consistent patterns emerged across studies revealing the scope and reach of social influence on smoking. The social dynamics of smokers, whether it was their romantic partner, children, or other smoker's vicinity, repeatedly impacted smoking behavior and quit outcomes. An initial aim of this research was to investigate the unique experience of dual-smoker couples and the power of a smoker's romantic partner in shaping smoking behavior. However, findings from this work have implications that extend beyond this close relationship to a smoker's broader social network. Our results are consistent with previous research on the mechanisms underlying the spread of smoking through social networks (Christakis & Fowler, 2008; Denney et al., 2022; Homish & Leonard, 2005; Park et al., 2004; Schaefer et al., 2013). It is well-established that smoking behavior spreads through close and distant social ties (Christakis & Fowler, 2008). Factors such as social norms, peer-influence, support (Roberts et al., 2015) and reinforcement, and access to smoking-related products and activities have been associated with greater adoption of smoking among non-smokers and continued smoking among smokers (Cornelius & Loretan, 2023; Doubeni et al., 2008). Conclusions from the present research suggest that other people (whether a romantic partner or not, or a smoker or not) can become associated with smoking-activities and become triggers capable of inducing cue-responses. At the same time, these processes could enable certain people or influences to become non-smoking cues capable of facilitating abstinence. Being in social environments that approve versus

disapprove of smoking is a determining factor in a smoker's ability to stay and maintain abstinence (Etcheverry & Agnew, 2008; Etcheverry et al., 2010). While a smoker's romantic partner remains a significant factor in the quit process, the present research highlights the wider social determinants of smoking behavior.

Navigating Relationships While Quitting Smoking

While Chapters 1 and Chapter 2 indirectly examined several relationship dynamics of smokers, Chapter 3 provided directly investigated how relationship quality is related to quit outcomes. We found that relationship satisfaction, positive partner support, and negative partner support were all related to smoking abstinence. Overlooking the role of a smoker's social context in smoking cessation can have unintended consequences that impact both the effectiveness of treatment and the quality of the smoker's relationships. Our findings in Chapter 4 indicate that individuals may require varying forms of support throughout the quitting process, and that the significance or implications of supportive behaviors can evolve over time. We observed contrasting results regarding the impact of negative support on individual quitting: a positive direct path from negative support at baseline to quitting, and a negative indirect path through negative support at follow-up to individual quitting. This suggests that identical supportive behaviors might be perceived as motivational at one juncture, facilitating quitting, while seen as critical at another, potentially resulting in less successful quitting outcomes. Despite the limited research examining the associations between relationship quality and dyadic health behavior change, the quitting process could provide opportunities to facilitate relationship improvement. These opportunities include setting shared goals, improving communication, matching support behaviors with partner needs, navigating conflict and stress, and developing new habits and routines. Relationship dynamics may also influence which approach to quitting is best (e.g.,

individual or joint), and which treatments are most effective for different groups. For example, a smoker who is motivated to quit to improve their relationship with their non-smoking partner may need different interventions compared to a smoker who is primarily motivated by personal health concerns. Social factors, such as social norms, attitudes, and behaviors of close others, can significantly impact smoking behavior. If treatment plans do not account for these influences, they may not effectively address the underlying reasons for smoking. Underestimating the impact of social factors could result in inadvertent strain on relationships, missed opportunities for support, and increased risk of relapse.

Strengths, Limitations and Future Directions

One strength of this research lies in its use of multiple methods to capture the dynamic nature of smokers' experiences. We employed several methodological approaches including the cue-reactivity task and adaptation of the Implicit Association Task in Chapter 2, as well as the path analysis approach in context of an RCT in Chapter 3. Using multiple approaches to assess participants smoking behaviors, their relationships, and the comorbidities between them, added to the robustness of our results.

Another strength of the present studies is the use of multiple data sources and demographics of smokers. The samples used in these studies were predominantly large and representative of U.S. smokers and thus the findings can be generalized to real world populations. While previous research had examined smokers generally, or small subsets of smokers (e.g., single-smoker couples, adolescent smokers), the scope of this research encompasses many demographics including single-smoker couples, dual-smoker couples and non-partnered smokers, making our methodology more representative. Future research could explore additional demographics and contexts of individual smokers and smoking couples. For

example, across studies, our measures focused primarily on the impact of close relationships within home settings. Future research could expand on this work by gathering data on social influences and smoking behaviors within their work environments. Understanding the effect of colleagues, normed workplace smoking behaviors and work-related cues, as well as how they differ from other types of social influences could be a useful future direction.

Finally, the use of data from a RCT pilot study on dual-smoker couples was also a strength. Data from this sample allowed us to directly examine the experiences of dual-smoker couples during cessation efforts. Broadly, this research provides initial insights into the associations between relationship satisfaction and quit outcomes over time. However, because this research was a part of a pilot study, we are limited in our ability to test mechanisms and draw conclusions (Kraemer et al, 2006; Leon et al., 2011). The 3-month study duration of this pilot may not have been long enough to get an accurate understanding of how relationship dynamics change during the quitting process and/or how smoking cessation may in turn impact the relationship. As such, the present studies are limited in their ability to predict long-term smoking or relational outcomes. Future research could investigate relationship quality, support behaviors and quitting over a more sustained timeframe. There are many opportunities for further work on this topic. For example, a future study could investigate how the relationship dynamics of dual-smoker couples change at various stages of quitting, relapse, and maintenance over a sustained period (e.g., a 1-year follow-up versus a 3-month follow-up).This would also provide opportunities to compare couples' experiences to inform more tailored approaches to cessation interventions aimed at promoting quitting while maintaining or even improving relationship quality.

Conclusion

The purpose of this research was to investigate the impact of a smoker's social environment and smoking behavior by examining comorbidities between social and smoking risk-factors (Chapter 1), cue-reactivity and automatic associations between smokers' romantic partners and smoking-stimuli (Chapter 2), and the mutual influence of relationship quality on smoking cessation outcomes (Chapter 3). Results from five studies revealed specific challenges that smokers face, such as living with other smokers and cue-reactivity to a romantic partner, but it also illuminated potential pathways to quitting, like partner support, which significantly improves outcomes. Findings highlight the need for deeper examination of the mechanisms by which social factors influence smoking behavior and cessation efforts. The insights gained from this research can guide future research efforts, inform the development of more effective interventions, improve quit rates and lead to better health outcomes for smokers.

References

Christakis, N. A., & Fowler, J. H. (2008). The collective dynamics of smoking in a large social network. *New England Journal of Medicine*, *358*(21), 2249–2258. https://doi.org/10.1056/NEJMsa0706154

Cobb, L. K., McAdams-DeMarco, M. A., Huxley, R. R., Woodward, M., Koton, S., Coresh, J., & Anderson, C. A. M. (2014). The association of spousal smoking status with the ability to quit smoking: The atherosclerosis risk in communities study. *American Journal of Epidemiology*, *179*(10), 1182–1187. https://doi.org/10.1093/aje/kwu041

Cornelius, M.E., Loretan, C.G., Jamal, A., et al. (2023). Tobacco product use among adults – United States. *Morbidity & Mortality Weekly Report,72*(18), 475–483. http://dx.doi.org/10.15585/mmwr.mm7218a1.

Denney, J. T., Sharp, G., & Kimbro, R. T. (2022). Community social environments and cigarette smoking. *SSM - Population Health*, *19*, 101167. https://doi.org/10.1016/j.ssmph.2022.101167

Derrick, J. L., Leonard, K. E., & Homish, G. G. (2013). Perceived partner responsiveness predicts decreases in smoking during the first nine years of marriage. *Nicotine & Tobacco Research, 15*(9), 1528–1536. https://doi.org/10.1093/ntr/ntt011

Doubeni, C. A., Li, W., Fouayzi, H., & Difranza, J. R. (2008). Perceived accessibility as a predictor of youth smoking. *Annals of family medicine*, *6*(4), 323–330. https://doi.org/10.1370/afm.841

Etcheverry, P. E., & Agnew, C. R. (2008). Romantic partner and friend influences on young adult cigarette smoking: Comparing close others' smoking and injunctive norms over time. *Psychology of Addictive Behaviors, 22*(3), 313–325. https://doi.org/10.1037/0893-164X.22.3.313

Etcheverry, P. E., Hoffman, N. G., & Agnew, C. R. (2010). Romantic partner influence on young adult cigarette smoking: Testing a behavioral mechanism. *Social Influence, 5*(4), 289–305. https://doi.org/10.1080/15534510.2010.502044

Ferguson, J., Bauld, L., Chesterman, J., & Judge, K. (2005). The English smoking treatment services: One-year outcomes. *Addiction*, *100*(s2), 59–69. https://doi.org/10.1111/j.1360-0443.2005.01028.x

Homish, G. G., & Leonard, K. E. (2005). Spousal influence on smoking behaviors in a US community sample of newly married couples. *Social Science & Medicine*, *61*(12), 2557–2567. https://doi.org/10.1016/j.socscimed.2005.05.005

Kraemer, H. C., Mintz, J., Noda, A., Tinklenberg, J., & Yesavage, J. A. (2006). Caution regarding the use of pilot studies to guide power calculations for study proposals. *Archives of general psychiatry*, *63*(5), 484–489. https://doi.org/10.1001/archpsyc.63.5.484

Leon, A. C., Davis, L. L., & Kraemer, H. C. (2011). The role and interpretation of pilot studies in clinical research. *Journal of psychiatric research*, *45*(5), 626–629. https://doi.org/10.1016/j.jpsychires.2010.10.008

Margolis, R., & Wright, L. (2016). Better off alone than with a smoker: The influence of partner's smoking behavior in later life. *The Journals of Gerontology: Series B*, *71*(4), 687–697. https://doi.org/10.1093/geronb/gbu220

Park, E. W., Tudiver, F., Schultz, J. K., & Campbell, T. (2004). Does enhancing partner support and interaction improve smoking cessation? A meta-analysis. *Annals of family medicine*, *2*(2), 170–174. https://doi.org/10.1370/afm.64

Ranby, K. W., Lewis, M. A., Toll, B. A., Rohrbaugh, M. J., & Lipkus, I. M. (2013). Perceptions of smoking-related risk and worry among dual-smoker couples. *Nicotine & Tobacco Research, 15*(3), 734–738. https://doi.org/10.1093/ntr/nts210

Roberts, M. E., Nargiso, J. E., Gaitonde, L. B., Stanton, C. A., & Colby, S. M. (2015). Adolescent social networks: General and smoking-specific characteristics associated with smoking. *Journal of Studies on Alcohol and Drugs, 76*(2), 247–255. https://doi.org/10.15288/jsad.2015.76.247

Schaefer, D. R., Adams, J., & Haas, S. A. (2013). Social networks and smoking: Exploring the effects of influence and smoker popularity through simulations. *Health Education & Behavior : The Official Publication of the Society for Public Health Education*, *40*(1 0), 24S-32S. https://doi.org/10.1177/1090198113493091

Westmaas, J. L., Bontemps-Jones, J., & Bauer, J. E. (2010). Social support in smoking cessation: Reconciling theory and evidence. *Nicotine & Tobacco Research*, *12*(7), 695–707. https://doi.org/10.1093/ntr/ntq077