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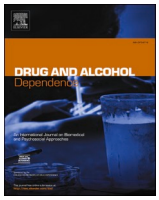

Review

Associations of outcome expectancies with smoking: A meta-analysis

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ABSTRACT

Objective: Expected positive and negative outcomes of smoking have been suggested to predict nicotine involvement. The present meta-analysis integrated research on the associations between smoking outcome expectancies and smoking.

Method: A systematic search in the electronic databases PsycInfo, Medline, Psyndex, Google Scholar, and Web of Science identified 215 studies, which were included in a multi-level meta-analysis.

Results: Positive smoking outcome expectancies were associated with higher smoking levels, with expectancies that smoking reduces negative affect showing the strongest correlation ($r = .29$) and expectancies that smoking helps with appetite/weight reduction showing the weakest correlation with smoking ($r = .14$). Associations of expected negative outcomes of smoking tended to be weaker than associations with positive outcome expectancies and were, in part, inconsistent. There were moderating effects of child age, percentage of individuals who smoke, sampling (clinical versus nonclinical), outcome measure (quantity of smoking versus nicotine dependence; use of conventional cigarettes versus e-cigarettes), publication status, and validity of the outcome expectancy measure.

Conclusions: Expectancies about the reduction of negative affect via smoking are a particularly relevant target for prevention and intervention. Our results indicate that decreasing positive expectancies may be more promising than increasing negative expectancies. Tobacco control advocates should draw attention to perceived consequences of smoking in designing measures aimed at preventing smoking initiation and reducing smoking involvement.

1. Introduction

Smoking cigarettes is a leading cause of morbidity and mortality (Lariscy et al., 2018). Knowledge of risk factors and protective factors related to smoking is relevant for prevention and intervention. In line with Social Cognitive Theory (Bandura, 1986) and the Theory of Planned Behavior (Ajzen, 1991), smoking is influenced by social factors (such as substance use by parents and peers) and individual factors (such as expectancies, motives, and substance use resistance self-efficacy) (Stewart et al., 2023). As an individual factor, smoking outcome expectancies (SOE) refer to the anticipated positive and negative consequences of smoking (Cooper et al., 2016). SOE include, among other domains, beliefs about sensory experiences, social facilitation, negative affect reduction, appetite/weight control, risk for addiction, other negative health effects, and negative social impressions (Brandon and Baker, 1991; Copeland et al., 1995; see Electronic Supplement Material ESM1 for a description of commonly assessed expectancy domains). The acquisition and development of SOE have been linked to learning (e.g., from parents, peers, advertisement, prevention programs, and experienced consequences of past smoking) and dispositional factors (such as sensation seeking which promotes learning of expectancies for positive reinforcement) (Doran et al., 2013). SOE, in turn, affect future consumption (Brandon and Baker, 1991; Copeland et al., 1995), thus indicating bidirectional effects. An experimental study by Kassel et al. (2007) found that expectancies also shape the experienced effects of smoking. Adolescents who were led to believe that they were smoking regular nicotine-contained cigarettes showed decrease in negative affect when they, in fact, were smoking nicotine-free cigarettes.

While several studies have found associations between SOE and smoking behavior, the magnitude of the associations between SOE and smoking behavior varied between individual studies and even between subsamples of the same study (e.g., Ahijevych and Wewers, 1993; Gillmore et al., 2002). This suggests that the results may vary depending on the expectancy assessed, the study design, and/or the characteristics of

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the sample. For example, associations of smoking with expected negative consequences seem to be weaker and less consistent than associations with expected positive consequences. This may be based on their different temporal perspectives, as some negative (health-related) consequences tend to occur in the distant future, while positive consequences are experienced immediately (van Harreveld et al., 1999). Meta-analysis is an ideal tool for systematically comparing results across expectancy domains and for analyzing the moderating effects of study and sample characteristics. Practitioners could benefit from knowing which expectancy contents are most strongly related to smoking and should, therefore, particularly be considered as targets of prevention and intervention. As no previous meta-analysis had examined the associations of SOE with smoking, we conducted such a study.

Moderating effects of age and gender have been identified in an individual study. However, the robustness of these effects has not yet been tested. With regard to age, Hopper (2013) found that the association of SOE with smoking declined with age. This may indicate that smoking in younger people is more expectancy-driven, while in older individuals (who may have been smoking for a longer time), smoking may become more affected by their habits.

Vidrine et al. (2006) found that expected effects of smoking on weight control and the change of negative mood were stronger in female than male adolescents. However, the reverse was true for SOE related to pleasure and the good taste/smell of cigarettes.

Studies vary in the distribution of nonsmokers, persons who smoke, and individuals with substance-use disorders. Associations of SOE with smoking may be smaller in the case of similar consumption patterns within samples due to variance restrictions. The same argument holds true when comparing results on nicotine dependence (e.g., Fagerström Test; Heatherton et al., 2001) with those on the quantity of consumption.

With regard to kind of cigarettes, electronic nicotine delivery systems are often perceived as a healthy alternative to conventional cigarettes because they emit smaller amounts of toxic substances in the aerosol (Zwoliński et al., 2024). This might indicate that individuals who use e-cigarettes show weaker associations of smoking with expected negative health effects than individuals who use traditional cigarettes, because these consequences would be less likely and/or less severe. However, individuals who use e-cigarette seem to be more aware of the negative health effects of smoking than individuals who use conventional cigarettes (Biener and Hargraves, 2015), which might even lead to stronger associations of smoking with expected negative health effects in the former group.

Since the mid-to-latter half of the 20th century, smoking prevalence has declined in many countries (Ritchie and Roser, 2023), which may be due, in part, to the success of prevention efforts. As prevention programs may weaken positive SOE and strengthen negative SOE, associations of these outcome expectations with smoking might have changed over time. It has not yet been tested whether this, in fact, is the case.

Correlations of SOE with nicotine use may be stronger in published studies than in unpublished studies because non-significant, small effect sizes would be less likely to be published (Rosenthal, 1979). The size of association of SOE with smoking might also depend on criteria of study quality, such as response rate or the use of validated measures. Such moderating effects have not yet been analyzed in SOE research.

2. Research questions

In sum, the present meta-analysis addressed three research questions: First, we asked for the size of concurrent and cross-lagged associations of SOE with smoking behavior. Second, we asked which expectancies show the strongest associations with smoking behavior. And third, we asked for moderating effects of age, gender, percentage of individuals who smoke, sampling (clinical versus community sample), outcome measure (quantity of smoking versus nicotine dependence; use of conventional cigarettes versus e-cigarettes), year of publication, publication status, and study quality.

3. Methods

3.1. Study selection

Studies were identified through a systematic search in the electronic databases PsycInfo, Medline, Psyndex, Google Scholar, and Web of Science. We used the search terms (smoking expectanc*) OR (smoking outcome expectanc*) OR (smoking consequence) OR (vaping consequence) OR (vaping expectanc*) OR (vaping outcome expectanc*). The reference sections of the identified studies were checked for additional papers. Studies were included if they:

a) reported bivariate and/or cross-lagged associations between SOE and smoking (frequency/quantity of consumption and/or nicotine dependence) or provided sufficient information for computing effect sizes, and
b) had been published or made available online before December 1st, 2024.

Studies were excluded if they:

a) reported only multivariate associations of SOE with smoking that cannot be combined with bivariate effect sizes,
b) used exclusively implicit measures of SOE (i.e., reaction times), as there are only moderate associations between explicit and implicit expectancy measures (McCarthy and Thompsen, 2006), and the number of studies was too small for a separate analysis of associations of implicit SOE with smoking,
c) included only expectancies that addressed a possible relative advantage of e-cigarettes over conventional cigarettes rather than effects of smoking compared to non-smoking,
d) provided only qualitative data,
e) duplicated results already included.

No language restrictions were applied, and electronic translation tools or help from native speakers were used in the case of papers not written in English or German. Identified unpublished studies (e.g., dissertations) were included in order to reduce the risk of publication bias. If we did not have access to the full text, we contacted the authors via email, if address information was available. This procedure gave us access to one full text.

The final literature search was completed on December 1st, 2024. In total, 215 papers met the inclusion criteria. The PRISMA flow chart is provided in Fig. 1. Information on the included studies is given in the electronic supplements ESM2 and ESM3. The meta-analysis had been preregistered at OSF (osf.io/5du2k).

The following data were coded: authors, year of publication, number of participants, mean age, percentage of female participants, percentage of individuals who currently smoke, sampling (nonclinical sample = 1, clinical sample = 2), assessment of nicotine dependence (1 = no, 2 = yes), type of smoking (1 = conventional cigarettes, 2 = e-cigarettes, 3 = hookah/water pipe), expectancy measure, publication status (1 = unpublished, 2 = published), bivariate as well as cross-lagged correlations of SOE with smoking, and study quality. The component of quantitative descriptive studies from the Mixed Methods Appraisal Tool (MMAT) was used for evaluating study quality (Hong et al., 2018).

If studies reported separate correlations for subgroups (e.g., younger and older participants), we coded them separately. If an expectancy scale addressed more than one expectancy domain, we coded it as a global SOE.

Both authors independently searched for studies. All studies were coded by the first author, and a random sample of about 25 % of the papers was also coded by the second author ($n = 55$). The number of double-coded studies exceeded the minimum number of studies needed

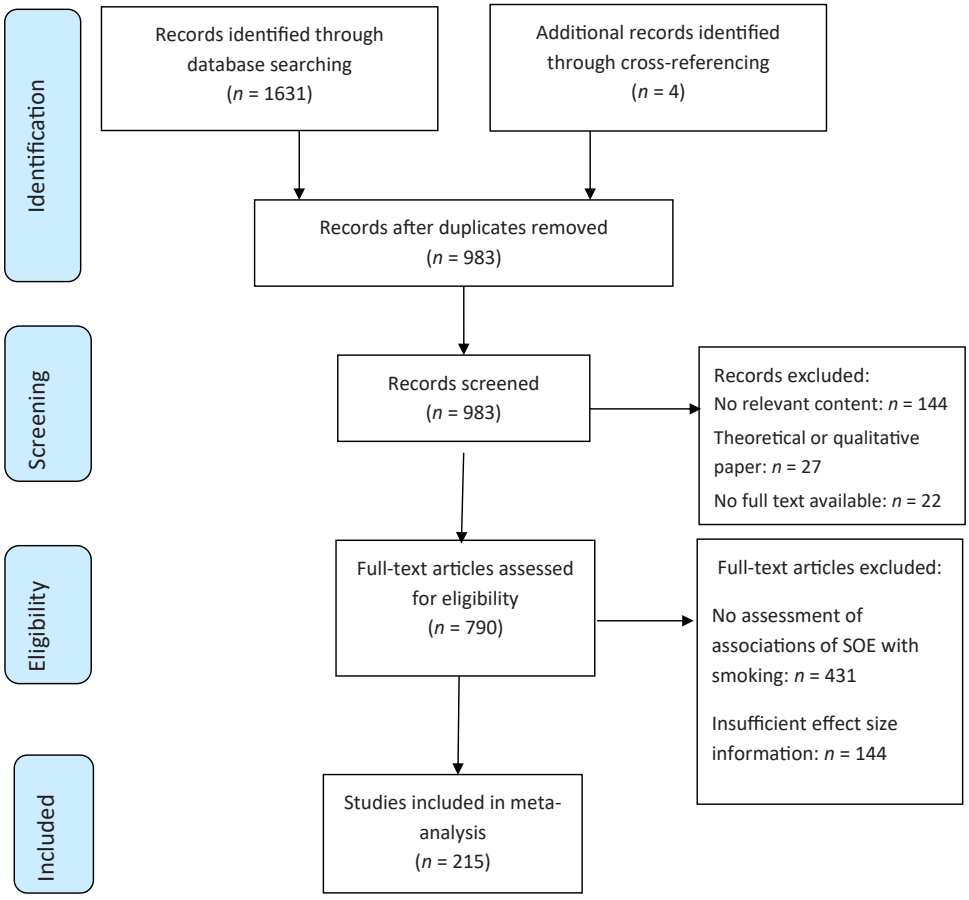

Fig. 1. PRISMA Flow Diagram.

for computing reliable inter-rater reliability ($n = 21$; Bonett, 2002). A mean intraclass correlation coefficient of.96 was achieved. Differences between the coders were resolved by double checking of the related references. As we did not collect new data from human subjects, there was no need for approval from an ethical board.

3.2. Statistical Analysis

We first transformed correlations using Fisher's *r*-to-*z* transformation. Outliers that were more than two standard deviations from the mean z-score were recoded to the value at two standard deviations (Lipsey and Wilson, 2001). After computing weighted mean effect sizes, we back-transformed the *z*-scores to the original metric of *r*.

As some studies provided more than one effect size, we used multilevel meta-analysis (Cheung, 2019) to address the dependency of effect sizes. This approach considers the hierarchical data structure, as individual correlations (at Level 1) are nested within samples (Level 2), which are nested within studies (e.g., when reporting separate effect sizes for subgroups; Level 3). We computed random-effects models.

Weighted mean associations between SOE and smoking were computed for bivariate and cross-lagged associations. Very few studies provided information on cross-lagged effect sizes. In preregistration, we intended to compute meta-analyses only if at least 10 effect-sizes were available for each. As this condition was met only for the association of global positive SOE with change in smoking, we decided to explore cross-lagged associations already if at least 5 effect sizes were available, despite limited test power.

To analyze moderator effects of sample or study characteristics, predictors were introduced at Level 2 or Level 3, respectively. The risk of publication bias was addressed by direct comparisons of results from published and unpublished studies and by computing trim-and-fill analyses (Duval and Tweedie, 2000). Computations were performed using the metafor package in R (Viechtbauer, 2024).

4. Results

The 215 included studies provided data from 204,717 individuals. The mean age was 21.81 years ($SD = 10.47$; range 9.20–49.60), and 52.6 % of participants self-identified as female. SOE were most often assessed using versions/derivatives of the Smoking Consequences Questionnaire (Brandon and Baker, 1991; Copeland et al., 1995; 101 studies). Most studies analyzed smoking of conventional cigarettes ($N = 178$), followed by e-cigarettes ($N = 41$), and hookah ($N = 2$). The majority of studies measured the quantity of smoking ($N = 169$), while 58 studies assessed nicotine dependence (e.g., Fagerström Test; Heatherton et al., 1991). Only a minority of studies collected data from a clinical sample, such as individuals in substance use disorder (SUD) treatment ($N = 42$). The papers have been published or made available between 1984 and 2024.

Regarding study quality (Hong et al., 2018), all studies used convenience samples. Only 63 studies confirmed a response rate ≥ 80 %. About 70 % of the studies applied validated SOE measures ($N = 151$), and 94.4 % of the studies provided complete effect size information.

With regard to our first research question, we found that positive SOE were correlated with higher levels of smoking, with small-to-moderate effect sizes (Cohen, 1992). The strongest correlation was found for the expectancy that smoking reduces negative affect ($r = .29$), followed by sum-measures of positive SOE ($r = .28$), boredom reduction expectancy ($r = .27$), expected positive sensory experiences ($r = .24$) and expected social facilitation ($r = .19$). Among positive SOE, expectancies about smoking effects on appetite/weight reduction showed the weakest association with tobacco smoking ($r = .14$; Table 1). The

Table 1
Weighted mean associations of smoking-related OE with smoking behavior.

Kind of SOE	*k*	*r*	r_{LL}	r_{UL}	*t*	*Q*	level-1 variance	level-2 variance	level-3 variance
Cross-sectional associations									
Global positive SOE	255	.28	.25	.30	18.97***	6754.89***	.0095*	.0044	.0195***
Positive sensory SOE	42	.24	.18	.30	7.83***	649.79***	.0004	.0000	.0225**
Social facilitation SOE	91	.19	.14	.24	7.19***	2236.91***	.0061**	.0000	.0263***
Negative affect reduction SOE	176	.29	.25	.32	15.70***	5868.85***	.0063***	.0004	.0310***
Appetite/weight reduction SOE	131	.14	.11	.17	9.12***	1650.05***	.0020**	.0026	.0142**
Boredom reduction SOE	47	.27	.20	.34	7.56***	535.04***	.0025**	.0000	.0280*
Global negative SOE	82	−.12	−.18	−.06	−4.02***	3802.72***	.0040***	.0000	.0434***
Negative health effects SOE	114	−.03	−.07	.01	−1.60	2067.30***	.0024***	.0021	.0204***
Addiction-related SOE	56	.11	.01	.21	2.29*	1664.25***	.0051	.0000	.0505***
Negative sensory SOE	38	−.18	−.27	−.08	−3.67***	487.33***	.0000	.0054	.0505
Negative social SOE	48	−.09	−.16	−.02	−2.49*	511.58***	.0067	.0100	.0100***
Cross-lagged associations of expectancies with change in smoking									
Global positive SOE	18	.10	.05	.15	3.91***	159.22***	.0000	.0066*	.0014
Negative affect reduction SOE	9	.16	.03	.29	2.84*	75.38***	.0000	.0118	.0118
Appetite/weight reduction SOE	7	.02	−.06	.11	.74	11.80	.0000	.0000	.0369
Cross-lagged associations of current smoking with change in expectancies									
Global positive SOE	5	.15	−.12	.41	1.52	81.79***	.0059	.0117	.0117

Notes. k = number of effect sizes, r = weighted mean correlation, r_{LL}/r_{UL}=lower/upper level of the 95 %-CI, t = test for the significance of r, Q=test for heterogeneity. Level-1 variance=within-sample variance, level-2 variance=within-study variance (between samples of the same study), level-3 variance=between-study variance. * $p < .05$, ** $p < .01$, *** $p < .001$.

non-overlap of the 95 % confidence intervals indicates that associations of appetite/weight reduction SOE with smoking were weaker than associations of most other positive SOE.

Associations of smoking with negative SOE were weaker than associations of most positive SOE, and, in part, inconsistent. While expected negative sensory effects of smoking (r = -.18), global negative SOE (r = -.12), and expected negative social consequences (r = -.09) were negatively correlated with smoking behavior, expected negative health effects did not significantly correlate with smoking (r = -.03), and stronger expectancies related to addiction were even associated with higher smoking levels (r = .11; Table 1). The non-overlap of the 95 % confidence intervals indicates that associations of smoking with expected negative sensory effects were stronger than associations with expected negative health effects. In addition, the size of associations of addiction-related SOE with smoking differed from the size of global negative SOE, expectancies about negative sensory experiences, and negative social effects of smoking.

Two significant cross-lagged effect sizes were identified (Table 1). Higher initial global positive SOE predicted an increase in smoking over time (r = .10), as did expectancies that smoking reduces negative affect (r = .16). We found no significant effects of initial smoking on change in SOE, but the minimum number of five effect sizes was only reached for global positive SOE.

The analysis of moderating effects of study characteristics is summarized in Table 2. There were four moderating effects of age, indicating that associations of smoking with global positive SOE, negative affect reduction SOE, boredom reduction SOE, and global negative SOE were weaker in older samples. We found no moderating effects of gender. In contrast, we identified eight moderating effects of the percentage of individuals who currently smoke. Associations of smoking with global positive SOE, social facilitation SOE, and negative affect reduction SOE were less positive in samples with a higher percentage of individuals who currently smoke. In addition, associations of smoking with global negative SOE, as well as expected negative health effects, negative sensory effects, and negative social effects, were less negative in samples with a higher percentage of individuals who currently smoke. While these moderating effects indicated weaker associations of SOE with smoking if a higher percentage of individuals who currently smoke participated, associations of smoking with addiction-related SOE became stronger in samples with a higher percentage of these individuals.

We found only one moderating effect of sampling, with weaker associations of global positive SOE with smoking in clinical compared to non-clinical samples. In addition, there were stronger associations of expectancies about appetite/weight reduction with nicotine dependence measures than with assessments of smoking quantity. The reverse was found for global negative outcome expectancies. The analysis of moderating effects of nicotine delivery devices compared conventional cigarettes and e-cigarettes, as only two studies were available on hookah/water pipes. Associations of global negative SOE, health risk SOE, and addiction-related SOE with smoking were more negative or less positive, respectively, in individuals who use e-cigarette than in individuals who consume conventional cigarettes.

Results did not vary by the year of publication. One moderating effect of publication status emerged, with stronger associations of smoking with social facilitation expectancies in published compared to unpublished studies. Studies with validated expectancy measures reported weaker associations of smoking with global positive and negative SOE as well as SOE about negative health effects, than studies with ad-hoc measures. Furthermore, results of studies that had confirmed a response rate of 80 % or higher did not differ from those of other studies. No moderating effects were computed for cross-lagged associations due to the small number of available effect sizes.

The trim-and-fill procedure imputed possibly missing effect sizes in 7 out of 17 analyses (see ESM 4). Concurrent associations of smoking with expectancies about global positive effects, negative affect reduction, global negative effects, and negative health effects became slightly stronger (by.01 to.03) after imputing possibly missing effect sizes. The concurrent correlation of expected negative health effects and smoking became statistically significant in the trim-and-fill analysis (r = -.06), although the size of the correlation was very small in statistical terms (Cohen, 1992). Only two effect sizes slightly declined after applying the trim-and-fill procedure–concurrent associations of appetite/weight reduction expectancies with smoking and associations of these expectancies with change in smoking.

5. Discussion

The present study reports the results of the first meta-analysis on associations of SOE with smoking behavior. It provides important knowledge on the average size of associations of SOE with smoking, on which expectancy domains showing the strongest associations, and on factors that explain heterogeneity between results of the individual studies. Positive SOE were concurrently related to higher smoking levels, with expectancies about negative affect reduction showing the strongest and expectancies about appetite/weight reduction showing

Table 2
Test for moderating effects of sample and study characteristics.

Moderator	*b*	*df*	*t*	*b*	*df*	*t*		Global positive SOE	Positive sensory SOE	Social facilitation SOE	Negative affect reduction SOE	Appetite/weight reduction SOE	Boredom reduction SOE	*df*	*t*	*b*	*df*	*t*
Age	−.007	214	−4.33[c]	−.002	38	−.74	−.004	68	−1.79	−.005	160	−2.80[b]	−.002	123	−1.15	−.008	43	−2.42[a]
% female	.001	245	1.32	.000	40	.20	−.000	88	−.19	.001	168	1.85	.000	125	.76	.001	45	.83
% individuals who smoke	−.002	224	−3.83[c]	.000	38	.05	−.002	74	−2.88[b]	−.002	165	−3.05[b]	.000	117	.59	−.001	37	−.71
Clinical sample[d]	−.129	254	−2.49[a]	−.144	40	−1.46	−.113	89	−1.20	−.081	174	−1.73	−.048	129	−1.08	−.130	45	−1.16
Assessm. of dependence[d]	.012	254	.41	.004	40	.12	.019	89	.43	.037	174	1.47	.048	129	2.11[a]	.061	45	1.60
Kind of cigarettes[e]	−.014	252	−.42	.003	40	.03	−.032	89	−.52	−.076	174	−1.50	−.011	129	−.29	−.091	45	−.54
Year	.002	254	1.18	.003	40	.84	.003	89	.97	.001	174	.30	.002	129	.77	.001	45	.30
Published[d]	−.038	254	−.67	.062	40	.53	.224	89	2.45[a]	.019	174	.31	.009	129	.18	.001	45	.01
Valid SOE measure[d]	−.073	254	−2.35[a]	−.106	40	−1.25	−.086	89	−1.61	−.036	174	−.80	.018	129	.48	−.167	45	−1.99
Response-rate ≥ 80 %[d]	.028	254	.81	.002	40	.04	.066	89	1.26	.054	174	1.31	.039	129	1.22	−.003	45	−.05

Table 2 (continued)

	Global negative SOE			Negative health effects SOE			Addiction-related SOE			Negative sensory SOE			Negative social SOE		
Moderator	*b*	*df*	*t*	*b*	*df*	*t*	*b*	*df*	*t*	*b*	*df*	*t*	*b*	*df*	*t*
Age	.009	76	4.29[c]	.004	90	1.77	.003	36	.62	.001	31	.14	.004	30	1.19
% female	−.000	76	−.44	−.001	108	−.79	.003	50	1.36	.003	35	1.01	.004	44	1.64
% individuals who smoke	.004	66	5.39[c]	.002	104	3.59[c]	.005	53	5.44[c]	.003	31	2.15[a]	.002	45	2.16[a]
Clinical sample[d]	.186	80	1.96	.052	112	.89	−.122	54	−.68	.035	36	.23	.138	46	1.37
Assessm. of dependence[d]	.099	80	2.00[a]	.040	112	1.37	.092	54	1.77	.013	36	.29	.107	46	1.70
Kind of cigarettes[e]	−.173	80	−2.53[a]	−.109	112	−2.34[c]	−.346	54	−2.84[b]	−.127	36	−.95	−.202	46	−1.56
Year	.001	80	.40	.000	112	.09	−.000	54	−.03	.006	36	1.03	.031	46	.24
Published[d]	.178	80	1.79	−.122	112	−1.91	.011	54	.06	.053	36	.39	.008	46	.06
Valid SOE measure[d]	.223	80	4.12[c]	.194	112	4.37[c]	.178	54	1.81	.122	36	1.14	.107	46	1.44
Resp.rate ≥ 80 %[d]	−.004	80	−.05	−.001	112	−.01	−.028	54	−.38	.098	36	1.35	.002	46	.03

Note. *b*=unstandardized regression coefficient, *df*=degrees of freedom, *Z* = test for significance of the moderator variable. [a] $p < .05$; [b] $p < .01$; [c] $p < .001$; [d] 1 =no, 2 =yes, [e] traditional cigarettes were coded as 1, e-cigarettes as 2.

the weakest correlation with smoking. Global negative SOE, expected negative sensory experiences, and expected negative social outcomes were associated with lower levels of smoking. Global positive SOE and the expectancy that smoking reduces negative affect were found to predict an increase in smoking over time. In addition, moderating effects of child age, percentage of individuals who smoke, sampling (clinical vs. community sample), outcome measure (quantity of smoking vs. nicotine dependence; use of conventional cigarettes vs. e-cigarettes), publication status, and validity of the expectancy measure were identified.

The observed size of the associations between SOE and smoking was similar to those in a recent meta-analysis on associations between alcohol outcome expectancies and alcohol use (Pinquart and Borgolte, 2024). However, fewer statistically significant cross-lagged associations were identified in the present study, probably because longitudinal associations between SOE and smoking have been less frequently assessed compared to research on alcohol use. Our results indicate that expectancies about the reduction of negative affect were most strongly related to smoking behavior. Regulation of negative affect also plays a central role in the underlying motivation for smoking (e.g., Mathew et al., 2014), and studies have shown that smoking cigarettes, in fact, reduces negative affect.

Among positive SOE, appetite/weight reduction expectancies showed the weakest association with smoking. This might, in part, be based on the fact that other expected positive effects of smoking are experienced immediately, while effects on weight control would only be observed over longer time intervals. In contrast to short-term effects, long-term weight (non-)changes cannot be exclusively attributed to cigarette consumption, as patterns of physical activity and caloric intake would also play a role. This could weaken the association of appetite/weight-reduction expectancies with nicotine consumption.

The observed weaker associations of negative SOE with smoking, as compared to positive SOE, may be explained by the Reinforcer Pathology Theory which suggests that individuals who use psychoactive substances tend to show an elevated preference for immediately available rewards and overvalue consequences that offer brief, intense reinforcement (Bickel et al., 2020). The identified positive association between addiction-related expectancies and smoking likely reflects the fact that persons with nicotine addiction tend to smoke more, and that anticipated effects of smoking on nicotine cravings motivate individuals with addiction to smoke (Ely et al., 2021). Unfortunately, we were not able to analyze cross-lagged associations between addiction-related expectancies and smoking.

While a publication bias would indicate that effect sizes decline after imputing possibly missing effect sizes (Duval and Tweedie, 2000; Rosenthal, 1979), we more often observed that effect sizes increased. The trim-and-fill procedure searches for an asymmetric distribution of effect sizes and corrects for asymmetry. However, asymmetrical distributions of effect sizes are not restricted to publication bias as they can also be found when effect sizes vary by sample characteristics (Afonso et al., 2024). For example, we found larger associations in samples with a lower percentage of individuals who currently smoke. At least 75 % of the participants smoked in about half of the included studies, while less than one-quarter of the studies reported rates of 25 % or lower. Conducting and including more studies with low rates of individuals who smoke would likely lead to an increase in the mean effect size. Nonetheless, trim-and-fill analysis led to very small adjustments in mean effect sizes, and only one out of 11 direct comparisons of results from published and unpublished studies suggested a possible publication bias. Thus, our main results were quite robust.

Many analyses found stronger associations between SOE and smoking in younger samples and in samples with lower percentages of individuals who currently smoke, which may indicate that smoking is more expectancy-driven in younger samples and in samples where many peers have not (yet) started smoking. In older samples, and in individuals who have smoked for a long time in particular, smoking becomes more affected by their habits, as shown by the stronger correlation between addiction-related expectancies and nicotine use. The observed weaker correlation between global positive SOE and smoking in clinical as compared to nonclinical samples can also be explained by the predominant role of smoking urges and cravings in consumption. Similarly, observed weaker association of global negative and negative social SOE with smoking dependence as compared to continuous measures of smoking quantity may indicate that negative consequences become less important when cigarette use gets influenced by smoking habits.

The identified stronger association of appetite/weight reduction SOE with smoking dependence measures, compared to smoking quantity, might reflect that some items on nicotine dependency scales address cigarette use shortly after awakening (Heatherton et al., 1991). This behavior is particularly relevant for reducing calorie intake at breakfast time. Future longitudinal research should test whether appetite/weight reduction SOE are a particular risk factor for SUD. The observed larger correlation between e-cigarette (rather than conventional cigarette) use and expected negative health effects and addiction can be interpreted as indicating higher sensitivity to negative health effects in individuals who use e-cigarettes compared to individuals who use conventional cigarettes (Biener and Hargraves, 2015). This finding indicates that individuals who use e-cigarettes can be more influenced by interventions that highlight negative health effects than individuals who smoke conventional cigarettes.

The three identified moderating effects related to the validity of expectancy measures suggest that researchers and practitioners should apply validated measures, as their use affects, in part, the size of the associations between SOE and smoking. Finally, the lack of moderating effects related to gender, year of publication or presentation, and response rate indicates that our results were robust with respect to these study characteristics.

5.1. Limitations

Some limitations of the present meta-analysis must be acknowledged. First, although we included more than 200 studies, the number of cross-lagged effect sizes was low. Therefore, more statistically significant cross-lagged associations may be identified as more longitudinal studies become available and test power increases. Second, the included studies primarily focused on adolescents and young-to-middle-aged adults. No data were available on samples of older adults. Third, due to missing values for some moderator variables, only univariate moderator analyses could be calculated. Adding multivariate analyses would have provided additional information on the robustness of the moderator effects. Fourth, we did not compare expectancies about dual use of conventional cigarettes plus e-cigarettes versus “regular use” as too few studies were available on this topic. Finally, we limited our analysis to 10 potential moderating variables. Other variables may also play a role, such as the length of smoking, but these variables were rarely and inconsistently reported in the available studies.

5.2. Conclusions

Despite these limitations, the following conclusions can be drawn. First, SOE—and expectancies about the positive effects of smoking in particular—are relevant predictors of nicotine consumption. Among SOE, the expectancy about the reduction of negative affect is the most relevant for predicting smoking behavior. Changing this expectancy is particularly useful for the prevention and reduction of smoking. Thus, individuals should learn that there are healthier ways of coping with negative emotions, and emotion regulation training has been found to promote smoking abstinence (Bradizza et al., 2017). Strengthening expectancies about the negative effects of smoking would be less promising, given their weaker, and in part, lacking associations with smoking.

Second, as associations between SOE and smoking became weaker with age and in samples with a larger proportion of individuals who

smoke, we conclude that measures to prevent and correct overly positive SOE should begin at an early age, when these expectancies are formed in late childhood and early adolescence, and when individuals have not yet begun using nicotine consistently.

Third, given the small number of longitudinal studies, more research is needed on the effects of SOE on changes in smoking over time, as well as on the effects of current smoking on changes in SOE. Future studies should also provide more information on additional potential moderators, such as comparing individuals who have been smoking for a shorter or longer period of time. Finally, as individuals who smoke also form expectancies about smoking abstinence (e.g., Hendricks et al., 2011), a future meta-analysis could integrate results on the associations between these expectancies and cigarette consumption.

CRediT authorship contribution statement

Martin Pinquart: Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Conceptualization. **Katharina Scheurle:** Writing – review & editing, Data curation.

Declaration of Competing Interest

All authors declare that they have no conflicts of interest with respect to the research, authorship, and/or publication of this article.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.drugalcdep.2025.112727.

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