Beneficial Effects of Nicotine – Fact or Fiction?

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Nicotine receptor binding

• Nicotine binds to and activates *nicotinic acetylcholine receptors (nAChRs)* throughout the Autonomic and Central Nervous Systems

• In the ANS – stimulatory effects – e.g. increased heart rate, blood pressure, release of adrenaline

• In the CNS – nAChR are found throughout the cerebral cortex, thalamus, hypothalamus, midbrain & brainstem

• And also on the cells of dopamine (DA), noradrenalin (NA), serotonin (5-HT) and glutamine neurons...

• Producing effects on arousal, anxiety, reward, learning, memory, conditioning, respiration, nausea...
Positive reinforcement models

• Smokers use nicotine because it offers positive effects.

• ‘Nicotine provides a number of benefits, including anxiety relief, increased alertness, and improved cognitive functioning’ Dudas & George (2005)

• Nicotine helps smokers to cope with daily tasks by manipulating levels of arousal Balfour (1982)

• Self-medication model: smokers use nicotine to relieve neurocognitive deficits (Dinn et al. 2004)
Negative reinforcement models

• Escape & avoidance of negative affect is the primary motive for using nicotine (Baker et al., 2004)

• Smokers feel tired & stressed without nicotine and smoking normalises cortical arousal and emotional tension (Parrott, 2006)

• Smoking directly causes stress & negative mood states which is why quitting is associated with reduced stress (Cohen & Lichtenstein, 1990)
Common reasons given for smoking:

- Pleasure
- Enjoyment
- Stress relief
- Relaxation
- Improves depression/anxiety
- To socialise
- Concentration aid
- Stimulation
- Addiction
- Habit
- To cope with problems
- Alleviate boredom

But is smoking genuinely beneficial or is it tied to relief of withdrawal?
Acute effects on nicotine on cognitive performance

• Numerous studies show smokers perform better after smoking/receiving nicotine than during abstinence

• Wesnes & Warburton (1983) performance on a rapid visual information processing (RVIP) task better after nicotine vs. abstinence

• Authors concluded that nicotine was acting as a cognitive enhancer

• But unclear if this is a true enhancing effect due to lack of a non-smoking control group
Effects of nicotine on executive functioning

Effects on cognitive performance

• Review by Heishman, Kleykamp & Singleton (2010) included 41 double-blind placebo controlled trials which included non-smokers and smokers not experiencing withdrawal

• Significant positive effects of nicotine found on six of the nine domains meta-analysed: fine motor abilities, accuracy and response times (RT) for alerting attention, orienting attention RT, working memory RT and accuracy of episodic memory performance

• These ‘likely represent true performance enhancement because they are not confounded by withdrawal relief’ (Heishman et al. 2010)
However...

- Whilst there may be enhancing effects of acute nicotine, chronic cigarette smoking has been associated with:
  - Decreased cognitive performance in middle age \( (\text{Kalmihn et al., 2002; Richards et al., 2003}) \)
  - Increased risk of cognitive decline in later life \( (\text{Anstey et al., 2007; Peters et al., 2008}) \)
  - And two reviews of cross-sectional studies have reported that, compared with non-smokers, smokers perform worse on a range of cognitive functions (attention, memory & executive functioning) \( (\text{Durazzo et al., 2010; Conti et al. 2019}) \)
  - Limitations – causality cannot be ascertained and nicotine cannot be isolated from smoking
Effects on Stress & Mood

• Smokers commonly report that smoking helps them to cope with stress.

• Studies comparing smokers & non-smokers consistently find smokers report *higher* levels of stress.
Smokers similar to non-smokers, deprived smokers significantly worse.

“dependent smokers need regular hits of nicotine just to remain feeling normal”

Due to nicotine dependency? OR… to pre-existing differences that predispose some to smoke?

Also see Wan et al. (2008) Pers Individ Dif 44: 425-35
Depression

• For clinically depressed individuals, smoking rates are double that in the general population (Cook et al., 2014) and depressed smokers are less likely to quit (Stepankova et al., 2017)

• Smokers twice as likely than non-smokers to have suffered depression at some point in their lives (Ferguson et al., 1996)

• Self-medication? or does smoking cause depression?

• In 8704 teenagers, smokers who were not depressed at baseline, were 4x more likely to develop depression after one year (Goodman & Capitman 2000)

• Numerous longitudinal studies demonstrating that depressive symptoms improve after quitting (see reviews/meta-analyses by: Ragg et al. 2013; Taylor et al., 2014; Hitsman et al. 2013)
Can nicotine enhance the reward value of other reinforcers?
Rats increase responding for a visual stimulus (VS) when it is paired with nicotine compared to VS +saline or VS alone.

Donny et al. (2003)
Psychopharmacology 169: 68-76
Human Smokers: Responsiveness to a financial incentive on a card-sorting task

52 smokers completed Applepicker task under 4 conditions after smoking nic and denic cigarettes.

Documented nicotine's reinforcement enhancing (RE) effects as a function of type of reinforcer:

Displayed are mean (SEM) responses on PR30% for each reinforcer due to acute administration of nicotine from tobacco smoking, after controlling for responding due to denicotinized smoking.

Conclusions

- Acute nicotine administration can yield performance enhancements in particular areas of attention and memory.
- Chronic smoking is associated with poorer cognitive performance (causal?).
- Smoking does not seem to improve stress & negative mood and may exacerbate them (effect of nicotine or smoking?).
- Some evidence that nicotine can enhance the reward value of other rewards.