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Short communication

Chewing gum moderates multi-task induced shifts in stress, mood, and alertness. A re-examination☆

Andrew J. Johnson[a,*], Rebecca Jenks[a], Christopher Miles[b], Michael Albert[a], Martin Cox[a]

[a] Department of Psychology, Coventry University, James Starley Building, Priory Street, Coventry CV1 5FB, UK
[b] School of Psychology, Cardiff University, Cardiff, UK

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ABSTRACT

The finding that chewing gum can moderate stress and mood changes following a multi-task cognitive stressor (Scholey et al., 2009) was re-examined. In a repeated measures cross-over design, thirty participants completed a 20-min multi-tasking stressor on consecutive days, both with and without chewing gum. Both prior to and post stressor, participants provided salivary cortisol samples and self-rated measures of stress, state anxiety, calmness, contentedness, and alertness. Contrary to Scholey et al. (2009), chewing gum failed to attenuate both salivary cortisol levels and the increase in self-rated stress. Self-rated anxiety, calmness, and contentedness were not impacted by chewing gum. This suggests that the stress effects reported by Scholey et al. may be constrained by particular features of that study (e.g. morning testing). However, consistent with Scholey et al. (2009), chewing gum was shown to increase alertness following the stressor. The mechanisms underpinning heightened alertness are unclear; however, such increases may be linked to greater cerebral activity following the chewing of gum (Fang Li, Lu, Gong, & Yew, 2005).

Introduction

The effects of chewing gum on cognition and mood are variable. For instance, initial reports of facilitated memory performance following the chewing of gum (Baker, Bezance, Zellaby, & Aggleton, 2004; Stephens & Tunney, 2004; Wilkinson, Scholey, & Wesnes, 2002) have proved difficult to replicate (e.g. Johnson & Miles, 2007, 2008; Smith, 2009a, 2010; Tucha, Mecklinger, Maier, Hammerl, & Lange, 2004). Such variability is surprising given the compelling neurological evidence linking the chewing of gum to increased delivery of both glucose and oxygenated blood to the brain (Onozuka et al., 2002; see also Stephens & Tunney, 2004), in addition to more general increases in cerebral activity (Fang, Li, Lu, Gong, & Yew, 2005).

Recently, Scholey et al. (2009) examined the effects of chewing gum on mood and stress, via both salivary cortisol and self-rated measures. Participants completed a 20-min 4-component multi-task stressor both with and without chewing gum and results showed that salivary cortisol was reduced in the chewing gum condition compared to the no gum condition (in contrast, see Smith, 2010, where chewing gum increased cortisol concentrations). This physiological effect was mirrored by significant reductions in both self-rated stress and state anxiety in the chewing gum condition coupled with significantly higher levels of self-rated alertness (see also Smith, 2009a, 2009b, 2010 for effects on alertness). Furthermore, Smith's (2009c) survey data corroborate the self-rated data of Scholey et al., such that gum chewers (compared to non-chewers) reported significantly lower levels of extreme work stress, life stress, lifetime instances of high blood pressure, and lifetime incidences of high cholesterol.

Although the precise mechanism(s) underpinning these effects is unclear, Scholey et al. (2009) suggest that the act of chewing flavourless material (Tahara et al., 2007) and flavoured gum (Morinushi, Masumoto, Kawasaki, & Takigawa, 2000) each have distinct effects on stress and mood. Specifically, chewing per se acts to reduce stress, but flavour induces a state of relaxation. Indeed, it is possible, therefore, that the mint flavour enhanced alertness (see Norrish & Dwyer, 2005). With respect to stress, Scholey et al. highlight that brief stress exposure can cause short-term reductions in vasodilatation. They argue that since chewing gum has been shown to increase cerebral blood flow (e.g. Onozuka et al., 2002) it may serve to minimize reductions in blood flow (and secondary decreases in oxygen and glucose delivery) resulting from blood vessel constriction.

An alternative explanation for the stress reduction associated with chewing gum suggests it is epiphenomenal to task facilitation, i.e. that improvements in mood and stress are secondary to a gum-induced benefit to task performance (as suggested also by Scholey et al., 2009). In this regard, Scholey et al. (2009) reported significantly higher task performance for the chewing gum condition compared to the no gum condition. It is possible then, that the observations on mood and stress were a consequence of the chewing gum-facilitated reduction in task difficulty. This proposi-

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* Corresponding author.
E-mail address: Andrew.Johnson@Coventry.ac.uk (A.J. Johnson).

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tion was examined directly by Torney, Johnson, and Miles (2009) who induced participant stress via an impossible task and then compared the extent of stress elevation in the chewing gum and no gum groups. Importantly, when changes in task performance were eliminated, Torney et al. (2009) showed that the increase in self-rated stress and mood were not moderated by chewing gum.

The Torney et al. (2009) data suggests that the effects of chewing gum on stress and mood may be analogous to the intermittent effects observed with memory (e.g. see Tucha et al., 2004; Wilkinson et al., 2002). Indeed, one proposition is that the attenuation of stress following gum chewing is limited to the stress induced when cognitive resources are inadequate to meet demands (i.e. Scholey et al. 2009) and is absent for social evaluative impasse stress (i.e. Torney et al., 2009). The current study examines this proposition via a partial replication of Scholey et al. To simplify the design of Scholey et al., and to limit effects of fatigue, participants (1) completed the stressor once on each day of testing, (2) were tested within a single time period (i.e. 11:00–13:00), and (3) only completed the medium intensity stressor (Scholey et al., 2009, reported similar effects of the stressor at low and medium intensities). If chewing gum does reliably reduce stress under conditions of multi-task cognitive stress, the present study should replicate the effects of Scholey et al. That is, we should observe an interaction between experimental stage and chewing gum, such that mood increases and stress decreases are apparent uniquely for the chewing gum condition but only following the stressor.

Method

Participants

Thirty (9 males, 21 females, mean age = 21.24 years) non-smoking Coventry University Psychology undergraduates participated in exchange for course credit. All participants were regular chewing gum users but did not chew more than ten times per week. All participants reported they were free from both concurrent medication and illicit drug use. Participants were instructed to refrain from caffeine, alcohol, and chewing gum on the morning of testing and asked to not consume food up to 1 h prior to testing. Ethical approval was obtained from the Coventry University Ethics Committee

Materials

Defined intensity stressor simulation (DISS)

The defined intensity stressor simulation (DISS) is a multi-tasking framework allowing both the number and intensity of tasks to be manipulated. The DISS involves the division of the computer screen into quarters, with separate tasks presented in each segment. The four tasks selected for this study were those employed by Wetherell and Sidgreaves (2005), Wetherell, Hyland, and Harris (2004), and Kennedy, Little, and Scholey (2004): i.e. auditory monitoring, visual tracking, memory search, and mental arithmetic. This configuration of tasks has been shown to increase S-IgA reactivity (Wetherell & Sidgreaves, 2005; Wetherell et al., 2004), increase perceived stress relative to workload (Wetherell & Sidgreaves, 2005) and reduce calmness (Kennedy et al., 2004). Each task is described below.

Auditory monitoring task: the participant is presented with individual tones separated by an inter-stimulus interval of approximately 5-s. Two tones are used which, relative to each other, are high or low. The participant is instructed to click on the '@' symbol when the higher of the two tones is presented. Ten points are awarded for the correct response and ten points are deducted for the incorrect response.

Visual tracking task: the participant is presented with six overlapping circles wherein the diameter of each circle is greater than that of the preceding circle. A small red dot drifts gradually out of the set of six circles, beginning in the centre of the smallest circle. The participant is instructed to click on the 'reset' icon before the dot leaves the final circle. If 'reset' is clicked whilst the dot has passed the inner circle, 2 points are awarded. Two additional points are awarded for every subsequent circle that the dot passes through. If 'reset' is clicked whilst the dot is within the final circle, ten points are awarded. However, if the dot touches the outer rim, ten points are deducted for every 0.5 s until 'reset' is clicked.

Memory search task: the participant is presented with a series of four letters simultaneously for approximately 10-s, followed by a series of single test letters to which a 'new/old' judgement is required for each. Ten points are awarded for each correct response and ten points deducted for each incorrect response. Review of the original letter sequence results in a five point deduction.

Mental arithmetic task: the participant is presented with an addition sum comprising two 3-integer numbers and required to type their sum. Ten points are awarded for a correct response and ten points are deducted for an incorrect response.

Both the four concurrent tasks and the positional configuration of these tasks were identical across participants. The task was used at medium intensity.

Self-rated mood scales

The bond lader visual analogue mood scales (VAMS) (Bond & Lader, 1974) was employed. It comprises 16 mood questions, with mood antonyms anchoring either end of a 100 mm line. These produce overall scores of alertness, calmness, and contentedness. As described in Torney et al. (2009) the VAMS had an additional seventeenth imbedded stress question of: no stress at all-worst stress imaginable. The stress antonym is not presented separately in order to limit effects of social desirability. Participants are instructed to rate, via a mark on the line, with respect to each antonym pairing, how they are feeling at that precise moment.

The State-Trait Anxiety Inventory (STAI: Speilberger, Gorsuch, & Lushene, 1969) comprises separate measures for changing levels of anxiety (state) and fixed levels of anxiety (trait). The questionnaire comprises 20 questions each assessing state and trait anxiety. Each question contains a single statement to which the participants state the extent to which they agree on a 4-point likert scale. A high score indicates greater anxiety levels. For the current study state anxiety was assessed.

Cortisol measurement

All participants provided salivary samples through placing an Oral Swab (Salimetrics LLC) in their mouth until saturated. Samples were then placed in a conical polypropylene tube and immediately frozen at $-20\,^{\circ}$C. Salivary samples were thawed to room temperature on the day of analysis and centrifuged. Analysis of the samples followed the instructions of the manufacturers (Salimetrics LLC).

Design. A 2×2 within-participants design was employed. The first factor refers to experimental stage (pre- or post-stressor) and the second factor refers to the chewing gum condition (chewing gum versus no chewing gum). The dependent measures were salivary cortisol concentration (μg/dL), self-rated measures of stress, state anxiety, alertness, contentedness, and calmness. The presentation order of these measures was counterbalanced.

Procedure. Participants were tested individually in a Psychology laboratory. Participants were tested on two consecutive days between the hours of 11:00 and 13:00 (in order to minimise diurnal variation effects reported by Scholey et al., 2009). Prior to entering the laboratory, participants were instructed to rinse their mouth thoroughly with water. Participants provided informed consent and completed a lifestyle questionnaire for screening purposes and then completed the STAI, Bond-Lader VAS, and