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Brief Communication

Chewing gum differentially affects aspects of attention in healthy subjects

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Abstract

In a study published previously in this journal (Wilkinson et al., 2002), the effect of chewing gum on cognitive functioning was examined. The results of this study indicated that chewing a piece of gum results in an improvement of working memory and of both immediate and delayed recall of words but not of attention. In the present study, memory and a variety of attentional functions of healthy adult participants were examined under four different conditions: no chewing, mimicking chewing movements, chewing a piece of tasteless chewing gum and chewing a piece of spearmint flavoured chewing gum. The sequence of conditions was randomised across participants. The results showed that the chewing of gum did not improve participants' memory functions. Furthermore, chewing may differentially affect specific aspects of attention. While sustained attention was improved by the chewing of gum, alertness and flexibility were adversely affected by chewing. In conclusion, claims that the chewing a gum improves cognition should be viewed with caution.

Keywords: Chewing gum; Cognition; Attention; Memory

In a previous study published in this journal, Wilkinson, Scholey, & Wesnes (2002) investigated the effect of chewing gum on cognitive functioning and heart rate. They examined three groups of 25 healthy adult participants each of whom performed tasks measuring aspects of memory or attention while chewing a piece of sugar-free, spearmint flavoured chewing gum, mimicking chewing movements or not chewing. The findings indicate that chewing a piece of gum results in an improvement of working memory and of both immediate and delayed recall of words but not of attention. Furthermore, heart rate was significantly increased in the chewing gum condition when compared with the no chewing condition. The authors discussed the observed improvement of cognitive functioning in terms of a chewing-related increase of regional cerebral blood flow and an enhanced release of insulin.

In the present study, two experiments were performed. In the first experiment, memory and a variety of attentional functions of 58 healthy adult participants (29 female, 29 male; mean age = 22.9 years, SEM = 0.6 years) were assessed under four different conditions. Conditions were: no chewing (quiet condition), mimicking chewing movements (mimicking condition), chewing a piece of sugar-free, tasteless chewing gum (neutral condition) and chewing a piece of sugar-free, spearmint flavoured chewing gum containing sweetener (spearmint condition). The consistency of the chewing gum in the neutral and spearmint conditions was the same. The chewing gum used was produced by Dandy Sakiz Ve Sekerleme San. A.S. Company (Istanbul, Turkey).

Memory was assessed using a list of 15 nouns which were read once to the participant. Participants were asked to recall as many words as possible immediately and after approximately 40 min (delayed recall). Between the immediate and delayed recall of words, attentional functions comprising the computerised measurement of tonic and phasic alertness, divided attention, selective attention, visual scanning and flexibility were assessed. The order of attention tests was randomised. Descriptions of the tests used are provided elsewhere (Zimmermann & Fimm, 2001).

In the second experiment, 58 healthy adult participants (29 female, 29 male; mean age = 22.2 years, SEM = 0.3

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years) who did not participate in the first experiment were asked to perform the same memory and alertness tests as used in the first experiment under the four conditions described above. Furthermore, they were asked to perform a visual vigilance task for a period of 40 min, which was carried out between the immediate and delayed recall of the word list. Measurement of alertness was performed between the immediate word recall and the visual vigilance task.

Participants were tested individually in four sessions on alternate days. In both experiments, the sequence of conditions was randomised across participants. In the chewing conditions, the participants were instructed to chew naturally and constantly throughout the whole test session. During the attention tasks, reaction time and the number of omission errors and/or commission errors were recorded. According to Parasuraman (1984), the performance in a vigilance task can be subdivided into an overall performance, indicating the level of vigilance, and a vigilance decrement describing the deterioration of performance over time (sustained attention). In order to analyse the vigilance decrement over time (sustained attention), ipsative scores were calculated by subtracting the participants' performance during the last 5 min of the task from their performance during the first 5 min.

Furthermore, in both experiments, the pulse rate of participants (taken as a surrogate of heart rate) was measured as a total of three times for a period of 1 min.

Table 1
Cognitive performance of participants ($M \pm$ SEM)

	Condition				Friedman test ($df = 3$)
	Quiet	Neutral	Spearmint	Mimicking	
Experiment I					
Immediate word recall	9.3 ± 0.3	8.8 ± 0.3	8.9 ± 0.3	8.7 ± 0.3	$\chi^2 = 4.61$; $p = 0.203$
Delayed word recall	6.5 ± 0.3	5.8 ± 0.3	5.7 ± 0.3	6.0 ± 0.3	$\chi^2 = 7.13$; $p = 0.068$
Tonic alertness					
Reaction time (ms)	213.7 ± 3.4	226.2 ± 4.1**	225.5 ± 4.0**	234.8 ± 5.2**	$\chi^2 = 30.5$; $p < 0.001$
Phasic alertness					
Reaction time (ms)	205.4 ± 3.0	207.1 ± 3.3	206.5 ± 3.3	211.4 ± 4.0	$\chi^2 = 1.61$; $p = 0.658$
Divided attention					
Reaction time (ms)	599.1 ± 9.2	611.6 ± 10.4	603.7 ± 9.6	617.5 ± 9.8	$\chi^2 = 2.74$; $p = 0.433$
Number of commission errors	0.5 ± 0.1	0.6 ± 0.1	0.9 ± 0.5	0.7 ± 0.4	$\chi^2 = 4.44$; $p = 0.218$
Number of omission errors	0.7 ± 0.1	0.8 ± 0.1	0.6 ± 0.1	0.7 ± 0.1	$\chi^2 = 2.08$; $p = 0.557$
Selective attention					
Reaction time (ms)	387.6 ± 7.4	387.7 ± 8.5	378.3 ± 7.7	386.9 ± 9.0	$\chi^2 = 4.16$; $p = 0.245$
Number of commission errors	1.8 ± 0.3	1.6 ± 0.2	1.8 ± 0.3	1.9 ± 0.2	$\chi^2 = 3.75$; $p = 0.289$
Visual Scanning					
Reaction time (ms)	1660.0 ± 63.5	1707.8 ± 76.0	1735.0 ± 78.4	1626.5 ± 63.9	$\chi^2 = 2.01$; $p = 0.571$
Number of commission errors	0.2 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.2 ± 0.1	$\chi^2 = 1.12$; $p = 0.772$
Number of omission errors	1.9 ± 0.3	2.4 ± 0.4	2.3 ± 0.3	2.1 ± 0.3	$\chi^2 = 1.71$; $p = 0.634$
Flexibility					
Reaction time (ms)	512.3 ± 18.4	529.4 ± 13.5	523.1 ± 16.4	535.8 ± 18.6	$\chi^2 = 4.45$; $p = 0.217$
Number of commission errors	1.0 ± 0.2	1.7 ± 0.3*	1.9 ± 0.3*	2.0 ± 0.3**	$\chi^2 = 8.12$; $p = 0.044$
Pulse rate (beats per min)	76.1 ± 1.4	77.4 ± 1.6	77.9 ± 1.5	76.3 ± 1.4	$\chi^2 = 2.96$; $p = 0.398$
Experiment II					
Immediate word recall	9.8 ± 0.3	9.5 ± 0.3	9.4 ± 0.3	9.3 ± 0.3	$\chi^2 = 6.13$; $p = 0.105$
Delayed word recall	6.7 ± 0.4	6.8 ± 0.4	6.6 ± 0.4	6.6 ± 0.4	$\chi^2 = 2.22$; $p = 0.529$
Tonic alertness					
Reaction time (ms)	209.8 ± 3.5	224.6 ± 4.7**	222.4 ± 3.8**	230.3 ± 5.1**	$\chi^2 = 33.14$; $p < 0.001$
Phasic alertness					
Reaction time (ms)	199.9 ± 3.3	205.7 ± 3.3**	202.0 ± 3.1	206.9 ± 3.5*	$\chi^2 = 11.80$; $p = 0.008$
Vigilance					
Reaction time (ms)	610.9 ± 14.4	608.4 ± 14.1	603.7 ± 12.2	618.0 ± 14.0	$\chi^2 = 3.74$; $p = 0.290$
Number of commission errors	3.0 ± 0.5	3.5 ± 0.6	4.5 ± 1.3	4.6 ± 0.9	$\chi^2 = 4.03$; $p = 0.258$
Number of omission errors	7.7 ± 1.2	8.1 ± 1.1	6.9 ± 1.0	9.1 ± 1.2	$\chi^2 = 6.71$; $p = 0.082$
Sustained attention					
Reaction time (ms)[a]	− 107.6 ± 15.7	− 112.9 ± 14.9	− 51.4 ± 14.0**	− 93.0 ± 15.1	$\chi^2 = 10.25$; $p = 0.017$
Number of commission errors[a]	0.0 ± 0.1	0.5 ± 0.2	0.3 ± 0.2	0.0 ± 0.2	$\chi^2 = 5.63$; $p = 0.131$
Number of omission errors[a]	− 0.7 ± 0.2	− 0.8 ± 0.2	− 0.8 ± 0.2	− 0.5 ± 0.2	$\chi^2 = 1.55$; $p = 0.670$
Pulse rate (beats per min)	72.2 ± 1.3	71.9 ± 1.2	74.0 ± 1.4	72.5 ± 1.0	$\chi^2 = 4.76$; $p = 0.190$

* $p < 0.05$, ** $p < 0.01$ compared with the quiet condition (Wilcoxon test).
[a] Ipsative scores.

For further analysis, individual mean scores of pulse rate were calculated for each condition.

Statistical analysis was performed using the Friedman test. In order to reduce the number of statistical comparisons, post hoc analysis using the Wilcoxon test was restricted to comparisons between the participants' performance in the quiet condition and their performance in the neutral, spearmint and mimicking conditions. Nonparametric tests were chosen since parametric tests require normally distributed data. This requirement is often not fulfilled regarding reaction time and rare events such as errors in healthy individuals.

In both experiments, comparison between conditions using the Friedman test revealed no significant differences with regard to the immediate and delayed word recall (Table 1). Furthermore, no differences were observed in measures of divided attention, selective attention, visual scanning or vigilance. In addition, pulse rate did not differ across conditions. However, significant differences were found concerning sustained attention, flexibility and both tonic and phasic alertness. Subsequent post hoc analysis using the Wilcoxon test showed that, in both experiments, participants displayed longer reaction times in the tonic alertness task during the mimicking, neutral and spearmint conditions when compared to the quiet condition. In the second experiment, there was also a significant difference in reaction time in the phasic alertness task between the participants' performance during the quiet condition and both the neutral and mimicking conditions. Furthermore, the number of commission errors in the flexibility task (Experiment 1) was significantly increased when participants were asked to chew a piece of chewing gum (neutral and spearmint conditions) or to mimic chewing movements. However, in comparison to the quiet condition, there was a marked improvement of sustained attention in the spearmint condition as indicated by a smaller increase in reaction time over time during the vigilance task (Experiment 2).

In conclusion, the experiments of the present study failed to replicate the findings of a previous study in which the effects of chewing gum on cognitive functioning were empirically assessed for the first time (Wilkinson et al., 2002). In the present study, the chewing of gum did not improve participants' memory functions. Furthermore, while the previous study found no effects of chewing gum on attentional functioning, the present results indicate that chewing may differentially affect specific aspects of attention. While sustained attention was improved by the chewing of spearmint gum, alertness and flexibility were adversely affected by chewing. Possible reasons for finding different results from Wilkinson et al. (2002) include the fact that four repeated measures on the same subjects were used in the present study while the previous study used separate groups for each condition. Since Wilkinson et al. (2002) did not perform a baseline assessment, it cannot be excluded that the groups differed from one another prior to the experimental treatment. In conclusion, claims that the chewing of gum improves cognition should be viewed with caution. Since in both the previous and the present study, laboratory measures with limited ecological validity were used, the aim of future studies could be to examine the effect of chewing gum on measures of cognition in normal everyday settings such as the classroom or the workplace.

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