Learning and Motivation 59 (2017) 11–18

Contents lists available at ScienceDirect

Learning and Motivation

journal homepage: www.elsevier.com/locate/l&m

Decaffeinated coffee induces a faster conditioned reaction time even when participants know that the drink does not contain caffeine

Mina Fukuda[a,b,*], Kenjiro Aoyama[c]

[a] Graduate school of Psychology, Doshisha University, Kyotanabe-shi, Kyoto 610-0394, Japan
[b] Japan Society for the Promotion of Science, Chiyoda-ku, Tokyo 102-0083, Japan
[c] Department of Psychology, Doshisha University, Kyotanabe-shi, Kyoto 610-0394, Japan

ARTICLE INFO

Keywords:
Decaffeinated coffee
Classical conditioning
Conditioned response
Extinction
Caffeine
Reaction time

ABSTRACT

We conducted two experiments based on the hypothesis that the taste, smell, and sight of (decaffeinated) coffee and internal senses of ingestion (caffeine-associated stimuli) would induce a conditioned response even when participants were informed that the drink was decaffeinated coffee. The caffeine-associated stimuli were supposed to be associated with caffeine because the participants drank coffee regularly. In experiment 1, forty-four coffee drinkers received decaffeinated coffee or water and completed a simple reaction time task. Reaction time was faster in the decaffeinated group than in the water group. In experiment 2, we examined whether the effect of decaffeinated coffee was extinguished by the repeated intake of decaffeinated coffee (conditioned stimulus). Forty-four coffee drinkers received decaffeinated coffee or water five times. Then, the participants drank decaffeinated coffee and completed a reaction time task. The effect of decaffeinated coffee was weakened in the test session by the extinction procedure: the repeated intake of decaffeinated coffee. In conclusion, both experiments supported the hypothesis that caffeine-associated stimuli induced a conditioned response in people who drank coffee regularly. Therefore, in everyday life, decaffeinated coffee may improve performance in coffee drinkers.

1. Introduction

Many studies have investigated whether a stimulus that is associated with a drug (e.g., alcohol, caffeine) induces a drug-like effect by classical conditioning in humans (Siegel, 2002). Alcohol and caffeine are the drugs we typically consume on a daily basis. Many studies have demonstrated that a neutral stimulus could become associated with alcohol (e.g., Birak, Higgs, & Terry, 2011; Shapiro & Nathan, 1986; Staiger & White, 1988). Some have even demonstrated that the taste, smell, and sight of alcoholic beverages and internal senses of ingestion can acquire the properties of a conditioned stimulus (Marczinski & Fillmore, 2005; Remington, Roberts, & Steven, 1997). Among caffeine-related studies, Attwood, Terry, and Higgs (2010) demonstrated that a neutral stimulus could become associated with caffeine. This study consisted of four conditioning sessions and a test session. First, in the conditioning sessions, participants in the paired group drank juice that contained caffeine in the experimental room. Conversely, participants in the unpaired group drank juice that did not contain caffeine in the experimental room. In a test session at a later date, participants in both groups drank juice that did not contain caffeine in the experimental room. Then they completed a simple reaction time task.

* Corresponding author at: Graduate school of Psychology, Doshisha University, 1–3 Tatara-Miyakodani, Kyotanabe, Kyoto 610-0394, Japan.
E-mail addresses: mina.f.psych@gmail.com (M. Fukuda), kaoyama@mail.doshisha.ac.jp (K. Aoyama).

http://dx.doi.org/10.1016/j.lmot.2017.07.002
Received 3 July 2017; Received in revised form 7 July 2017; Accepted 7 July 2017
Available online 26 July 2017
0023-9690/

Reaction time was faster in the paired group than in the unpaired group. The effect that appeared in the paired group was not due to caffeine itself because the juice did not contain caffeine in the test session. In conclusion, these results suggest that a conditioned response appeared in the paired group.

It is possible that this type of classical conditioning occurs frequently in everyday life. For example, the taste, smell, and sight of coffee and internal senses of ingestion (caffeine-associated stimuli) are expected to be associated with caffeine if a person usually drinks coffee. Therefore, the caffeine-associated stimuli may induce a conditioned response. Considering that we drink decaffeinated coffee in our daily lives, we almost always know that a drink does not contain caffeine, contrary to the assumption in an experimental situation using a blind design. Decaffeinated coffee may induce a conditioned response in such a situation (i.e., when they are informed that the drink is decaffeinated).

As far as we know, no studies have investigated the effect of decaffeinated coffee, wherein the participants were informed that their drink was decaffeinated. Previous studies using decaffeinated coffee are of three kinds. In the first kind, one study examined the effect of decaffeinated coffee, but participants were informed that their coffee was caffeinated (Anderson & Horne, 2008). The second employed a blind design to examine the effect of decaffeinated coffee. That is, participants were not told that their drink was decaffeinated (Adan, Prat, Fabbri, & Sànchez-Turet, 2008; Andrews, Blumenthal, & Flaten, 1998; Flaten & Blumenthal, 1999; Flaten, Aasli, & Blumenthal, 2003; Zwyghuizen-Doorenbos, Roehrs, Lipschutz, Timms, & Roth, 1990). These two types of studies did not inform participants that their drink was decaffeinated. Therefore, a caffeine-expectancy effect might have occurred in those studies.

In the third kind, several studies used a balanced-placebo design to provide the participants with either caffeinated or decaffeinated coffee and they were told that their drink would either contain or not contain caffeine (Dawkins, Shahzad, Ahmed, & Edmonds, 2011; Elliman, Ash, & Green, 2010). These studies contained a group that drank decaffeinated coffee and were told that their drink was decaffeinated. However, that group worked as the control group to be compared with the group given decaffeinated but told they were given caffeinated coffee, because those studies aimed to examine the expectancy effect of caffeine (Dawkins et al., 2011; Elliman et al., 2010). Therefore, these three types of studies were not designed to investigate the effect of decaffeinated coffee when the participants were informed that their drink was decaffeinated.

When participants are informed that their drink is decaffeinated, the decaffeinated coffee does not induce the caffeine effect or an expectancy effect but may induce a conditioned response. Hence, a control group such as a water group is needed that does not induce any of the effects mentioned above. Some studies used a control group (decaffeinated juice) that did not induce the caffeine effect or conditioned response (Flaten & Blumenthal, 1999). However, it is unclear whether the participants had an expectancy effect. In this research, participants received caffeinated coffee, caffeinated juice, decaffeinated coffee, or decaffeinated juice. Decaffeinated coffee increased subjective and physiological arousal (caffeine-like effect). Decaffeinated juice was used for the control group. However, in the decaffeinated coffee group, the expectancy effect might have occurred because they did not inform participants whether the drink contained caffeine. Therefore, in our study, we compared decaffeinated coffee with water when the participants were told that the drink did not contain caffeine, to completely remove the expectancy effect.

In the present study, we conducted two experiments based on the hypothesis that caffeine-associated stimuli (decaffeinated coffee) induce a conditioned response even when participants are informed that their drink is decaffeinated. The caffeine-associated stimuli are expected to be associated with caffeine because the participants usually drink coffee. In experiment 1, the participants drank decaffeinated coffee or water and completed a reaction time task. It has been repeatedly demonstrated that caffeine decreases reaction time (i.e., unconditioned response; reviewed in Nehlig, 2010). If the conditioned response occurred, we predicted that reaction time would be faster in the decaffeinated group than in the water group. In experiment 2, we examined whether the shortened reaction time effect would be extinguished by the repeated intake of decaffeinated coffee (conditioned stimulus). The participants drank decaffeinated coffee or water five times. Then, all participants drank decaffeinated coffee and completed the reaction time task. If extinction occurred, we predicted that the shortened reaction time effect would be weakened in the group that drank decaffeinated coffee five times.

2. Experiment 1

2.1. Method

2.1.1. Participants

Forty-four participants (19 male, 25 female) were undergraduate students and coffee drinkers who consumed black coffee at least once a month (mean frequency: 11.43 times per month). They were asked to abstain from caffeinated drinks (e.g., coffee, energy drinks) for two hours before the testing (mean abstinence time: 67.0 h). The participants were randomly allocated to either decaffeinated coffee (n = 22) or water (n = 22) group. The Institutional Review Board of Doshisha University approved the study.

2.1.2. Materials

The participants in the decaffeinated coffee group (DC group) drank decaffeinated coffee (120 ml; caffeine content about 1.5 mg; 97% caffeine-free). At present, one study has shown that the minimum amount of caffeine for there to be an effect is 12.5 mg (Smit & Rogers, 2000). Therefore, this decaffeinated coffee has no such caffeine effect. We brewed the decaffeinated coffee in a “Nescafe Dolce Gusto” (Nestle Japan Limited) coffee maker. The capsule was labeled “Decaffeinato.” The participants in the water group (W group) drank water (120 ml; Suntory Beverage & Food Limited).