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Negative correlation between salivary testosterone concentration and preference for sophisticated music in males

Hirokazu Doi[a], Ilaria Basadonne[b], Paola Venuti[b], Kazuyuki Shinohara[a,*]

[a] Graduate School of Biomedical Sciences, Nagasaki University, Japan
[b] Department of Cognitive Science and Education, University of Trento, Italy

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ABSTRACT

Music constitutes an integral part of everyday life. There is great variation in preference patterns for music. However, the cause of such individual differences has not been fully elucidated to date. Many behavioral traits, including personality, are known to be influenced by steroid-hormone testosterone. On this basis, we conjectured that testosterone partly determines individual differences in music preference. To examine this hypothesis, in the present study, we investigated the association between salivary testosterone concentration and strength of preference for five different music types in young males and females. The results revealed a significant negative correlation between salivary testosterone concentration and preference for sophisticated music, such as classical and jazz in males. This relationship was not mediated by the big-five personality traits. These findings indicate the possibility that neuroendocrinological function can exert influences on music preference patterns.

1. Introduction

People listen to music for various purposes, such as emotional regulation (Boer, Fischer, Tekman, et al., 2012; Garrido & Schubert, 2011; Schäfer, 2016) and as an expression or "badge" of their own identity (Mulder, Ter Bogt, Raaijmakers, et al., 2010; North, Hargreaves, & O'Neill, 2000). Music appeals to people strongly due to its potency to induce hedonic states in listeners, and has constituted an integral part of human life throughout evolutionary history (Cross, 2001; Masataka, 2009; Perlovsky, 2012).

Many people like to listen to music, but great variation in music preference patterns exist, *i.e.*, the type of music they prefer. Although a pioneering study on this topic by Cattell and Anderson (1953) measured music preference as a proxy for unconscious personality traits, later studies focused on individual differences in music preference itself and determined that preference has many underlying factors. For example, people with a bias towards empathizing cognitive style prefer mellow music such as soft rock, while those with a bias towards systemizing cognitive style prefer intense music such as heavy metal (Greenberg, Baron-Cohen, Stillwell, Kosinski, & Rentfrow, 2015). Likewise, people with high intelligence have reportedly been shown to have a strong preference for classical music (Kanazawa & Perina, 2012). Many studies have found an association between the big-five personality traits and music preference patterns (Brown, 2012; Fricke & Herzberg, 2017; Langmeyer, Guglhör-Rudan, & Tarnai, 2012; Rentfrow & Gosling, 2003; Zweigenhaft, 2008; but see, Schäfer & Mehlhorn, 2017). For example, people with high extraversion have been shown to have a preference for pop music (Brown, 2012; Rawlings & Ciancarelli, 1997), while those with high openness to experiences have been found to like wide genres of music including jazz, classical and folk music (Brown, 2012; Dollinger, 1993; Dunn, de Ruyter, & Bouwhuis, 2011; Langmeyer et al., 2012).

Another line of studies has shown that steroid hormone testosterone modulates neural function, thereby influencing many aspects of human behaviors including personality (Alvergne, Jokela, Faurie, & Lummaa, 2010; Smeets-Janssen, Roelofs, Van Pelt, et al., 2015). On the basis of these studies, it seems plausible to regard the secretion level of testosterone as partly determining individual differences in music preference patterns either directly or indirectly through its influences on personality traits (Alvergne et al., 2010; Smeets-Janssen et al., 2015).

The primary goal of the present study is to clarify the biological basis of individual differences in music preference. To achieve this goal, we investigated the relationship between music preference and testosterone. Many previous studies have indicated that testosterone functions to drive people to seek dominance (Mazur & Booth, 1998, 2014). A high dominance motive associated with high testosterone level is shown to induce rebellion (Mazur & Booth, 1998) and challenge to authority, *e.g.*, rule violation (Dabbs, Carr, Frady, & Riad, 1995; Dabbs, Jurkovic, & Frady, 1991). Several studies have revealed that people exhibiting rebellious personality traits (Carpentier, Knobloch, &

* Corresponding author at: Graduate School of Biomedical Sciences, Nagasaki University, 1-12-4 Sakamoto-cho, Nagasaki City, Nagasaki 852-8523, Japan.
E-mail address: kazuyuki@nagasaki-u.ac.jp (K. Shinohara).

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Zillmann, 2003) and problem behaviors (Mulder, Bogt, Raaijmakers, & Vollebergh, 2007; Selfhout, Delsing, ter Bogt, & Meeus, 2008) show strong preference for rebellious music such as hard rock and an aversion to music genres such as jazz and classical (Mulder et al., 2010). Furthermore, North et al. (2000) revealed that classical music is often viewed negatively among the young generation as a sign of obedience to authorities such as parents and teachers. These studies raised the possibility that people with a high level of testosterone show increased preference for intense music such as hard rock and heavy metal, *versus* decreased preference for sophisticated music such as jazz and classical music. However, to date, no empirical studies have tested the association between testosterone level and preference patterns for music. Thus, the present study fulfils this important knowledge gap by linking endocrinological predispositions and patterns of music preference, which leads to understanding of individual differences in musical preference from a biological perspective.

We investigated the relationship separately in males and females. One reason for this approach is that several previous studies have found a sex difference in patterns of music preference (Colley, 2008; Dunn et al., 2011; Zweigenhaft, 2008). The trait level of testosterone was quantified by measuring salivary concentration of testosterone, thus reflecting the level of bio-available testosterone, *i.e.*, free testosterone or testosterone weakly binding to sex hormone-binding globulin (Papacosta & Nassis, 2011).

Rentfrow, Goldberg, and Levitin (2011) measured preference for music excerpts selected from varying music genres in contrast to other existing studies that measured music preference by having participants rate preference for music genre labels (for example, Brown, 2012; Oshio, 2012). They extracted five orthogonal dimensions defining variations in music preference pattern, *i.e.*, Mellow, Contemporary (Urban), Sophisticated, Intense and Unpretentious (Campestral) (MUSIC; Rentfrow et al., 2011; Rentfrow, Goldberg, Stillwell, et al., 2012). Importantly, each dimension of MUSIC spans multiple music genres. For example, the sophisticated dimension includes music genres such as classic, jazz and world music. The MUSIC structure in music preference has been replicated in different sets of music excerpts and different samples (Rentfrow et al., 2011, 2012). Later studies found that preference for each dimension of MUSIC is associated with cognitive style and the big-five personality traits (Greenberg et al., 2015). The five-dimensional structure of MUSIC is relatively stable across one's lifespan, although developmental change exists in regard to preference strength for each dimension (Bonneville-Roussy, Rentfrow, Xu, & Potter, 2013). In addition, each dimension of MUSIC is associated with a different set of sound-related and psychological attributes (Greenberg et al., 2015; Rentfrow et al., 2011, 2012).

In the present study, music preference was measured by having participants rate their preference for music excerpts representing each of the MUSIC dimensions. Use of actual musical excerpts rather than genre labels avoids the problem of confounds of individual differences in stereotypical associations with musical genre labels (Langmeyer et al., 2012; Rentfrow et al., 2011).

2. Method

2.1. Participants

In total, 37 males and 39 females with normal or corrected-to-normal visual acuity participated in the present study after giving written informed consent. None reported a history of psychiatric condition or was taking mediation at the time of participation. Demographic information and musical experience together with participants' salivary testosterone concentration are summarized in Table 1. Females were significantly older than males, $t\,(74) = 2.16$, $p = 0.03$. As expected, testosterone level was significantly higher in males than in females, $t\,(74) = 11.42$, $p < 0.001$. Musical experience was coded as a binary Figure (0–1). The instruments they learned included piano ($n = 32$), other key instruments (n = 3), wind instruments ($n = 7$), and stringed instruments (n = 3). Some participants had experience with more than one kind of instrument. The distribution of musical experience was compared between males and females by chi-squared test, but no significant difference was revealed, $\chi^2_{(1)} = 0.46$.

Table 1
Age, salivary testosterone concentration and musical experience of participants. In the parenthesis are the standard deviations. The numbers in musical experience row shows the percentage of participants who had experience of learning at least one musical instruments.

	Female	Male
Age (yrs)	23.2 (5.9)	20.9 (2.4)
Testosterone (pg/ml)	54.5 (15.7)	162.5 (56.8)
Musical experience (%)	56.4	48.6

2.2. Procedure

2.2.1. Music preference measurement

Music preference was measured by using customized software running on a laptop computer. In each trial, a square picture window subtending approximately 4.2 cm in height and 4.2 cm in width was presented on the left side of the display with a vertical trackbar on the right side. At the start of each trial, a countdown started by presenting "3", "2", "1" in the picture window. After that, a musical note mark appeared in the picture window and a musical excerpt was played from a set of headphones. The musical excerpt continued for approximately 15 s. After the music stopped, a prompt stating "Please evaluate" was presented in the picture window, and the trackbar was enabled. The uppermost edge of the trackbar was labelled "Like Very Much", while the lowermost was labelled "Don't Like At All". The participant's task was to move the trackbar to the location where their feeling towards the music excerpt was most appropriately reflected. The degree of preference was measured according to 19 levels. After the evaluation was completed, participants clicked a button below the trackbar to register their evaluation and the experiment proceeded to the next trial. A participant made evaluations for a total of 25 musical excerpts. These excerpts were taken from those used in Study 3 of Rentfrow et al. (2011; available online from http://daniellevitin.com/levitinlab/LabWebsite/expsupport/MUSIC/Rentfrow_JPSP_Index.html).

2.2.2. Salivary testosterone concentration measurement

Saliva samples were collected between 12:00 and 14:00 h to mitigate the influences of circadian fluctuation (Dabbs, 1990) before behavioral measurement. Each saliva sample was collected into a polystyrene tube by passive drool and stored at − 80 °C until assay. The participants refrained from eating, drinking, smoking, tooth-brushing and exercise for 1 h prior to the experiment. They also rinsed their mouths with water approximately 15 min before sample collection.

After all participants had completed the experimental tasks, the concentration of salivary testosterone in each sample was assayed by enzyme immunoassay (EIA) using a commercially available kit (Salimetrics Europe Ltd., Suffolk, UK). The sample was first centrifuged and the aqueous layer was aliquoted for assay. The cumulative intra-assay coefficient of variation, an index of stability of concentration measurement, was < 5% in measurements in our laboratory. Information about recovery and specificity of the kit can be found online in the EIA kit manual.

2.2.3. Self-administered questionnaire

After completion of music preference measurement, participants answered self-administered questionnaires. The questionnaires included items about demographic information and musical experience. We also asked the participants to answer an abbreviated version of the Japanese big-five questionnaire (Namikawa et al., 2012) in 7 points.