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Encouraging COVID-19 vaccination via an evolutionary theoretical approach: A randomized controlled study in Japan

Tsuyoshi Okuhara *, Hiroko Okada, Eiko Goto, Aiko Tsunezumi, Yumi Kagawa, Takahiro Kiuchi

Department of Health Communication, School of Public Health, The University of Tokyo, Tokyo, Japan

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ABSTRACT

Objective: We aimed to examine the effect of a message that targets the fundamental human motive of kin care on COVID-19 vaccination recommendations among participants with young children, based on an evolutionary theoretical approach.

Methods: Participants with young children (n = 969) were randomly assigned either to a group that received an intervention message that targeted the fundamental motive of kin care, or that targeted the fundamental motive of disease avoidance, or a control message. Intention to receive COVID-19 vaccination was assessed both before and after reading the messages. A one-way ANOVA with Tukey’s or Games–Howell test was conducted.

Results: An intervention message targeting the fundamental motive of kin care and disease avoidance significantly increased intention of vaccination versus a control message (p < 0.001, respectively).

Conclusion: The evolutionary theoretical approach that focuses on fundamental human motives has the potential to extend the communication strategy for COVID-19 vaccination recommendations.

Practice implications: Health professionals should deliver messages that target the fundamental motive of kin care as well as messages about the susceptibility and severity of COVID-19 and vaccine efficacy (e.g., “Get vaccinated against COVID-19 for your child’s sake, because if you are infected, you will be unable to care for your child.”)

1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic has caused millions of infections and hundreds of thousands of deaths worldwide [1]. The development of vaccines against COVID-19 has proceeded at an unprecedented pace, and high efficacy in preventing the onset of disease has been reported [2]. Israel, the United States, and the United Kingdom launched COVID-19 vaccination program on December 2020[3-5]. In Japan, priority vaccination for healthcare workers was launched in February 2021 [6]. As of October 7, 2021, share of people fully vaccinated against COVID-19 was less than 70% in most countries, including the U.S., U.K., France, Germany, Italy, Japan, and 35% in the world [7]. Vaccine hesitancy—the reluctance or refusal to vaccinate despite the availability of vaccines—has been listed by the WHO as one of the top 10 global health threats and is now a central issue to address with the COVID-19 pandemic [8,9]. Because repeated COVID-19 vaccinations are currently required, further efforts are needed to develop communication strategies to encourage COVID-19 vaccination to help tackle the prolonged pandemic [10].

Various models and theories have been used in studies of methods to encourage vaccination (including COVID-19 vaccination), such as the health belief model, protection motivation theory, and theory of planned behavior [11–13]. These models and theories emphasize cognitive beliefs such as perceived vaccine efficacy, susceptibility, and severity of infection. Previous intervention studies examined the impact of perceived COVID-19 vaccine efficacy and safety, perceived susceptibility of infection and perceived seriousness of the pandemic on COVID-19 vaccine acceptance [14–16]. Intervention messages used in these studies provided probability numbers of vaccine efficacy and safety [14,15] and explanatory notes of vaccination benefits, vaccine safety and seriousness of the pandemic[16]. However, the effects of behavioral change resulting from interventions using such cognitive appeals are not as large as has been expected [17]. Existing cognitive behavioral models have been criticized for focusing on proximate causes of cognitive
In the present study, we adopt another approach grounded in an evolutionary theoretical framework by focusing on fundamental human motives. Studies of public health communication and practices including vaccination have been hampered by a serious limitation: they have not paid attention to the fact that humans have evolved as part of the animal kingdom [19]. In recent years, researchers have discussed the introduction of an evolutionary perspective into health behavior research [20,21], and The Lancet published an evolutionary public health series in 2017 [22–24]. Those studies suggest that, in order to understand health behavior, we must connect the various choices we make in our day-to-day lives with their evolutionary meaning. Evolutionary biologists have presumed that all living organisms have been selected to maximize their relative success at passing genes into future generations via either direct reproduction or helping kin reproduce, which they call inclusive fitness [25].

Because humans are a highly social species, they have faced and solved crucial social challenges to enhance their inclusive fitness. Evolutionary psychologists have assumed that these evolutionary challenges include self-protection (protecting oneself from enemies and predators), disease avoidance (avoiding infection and disease), affiliation (forming and maintaining cooperative alliances), status (gaining and maintaining respect and prestige of one’s fellow members), mate acquisition (successfully attracting and acquiring a romantic partner), mate retention (fostering long-term mating bond with that person), and kin care (investing in and cared for family and kin) [18,26,27]. These seven are the fundamental human motives to enhance inclusive fitness [18,26,27]. The humans who succeeded in solving these critical challenges successfully enhanced their inclusive fitness and became our ancestors.

According to the concept of domain specificity, which is one of the key features of modern evolutionary approaches [28,29], a different psychological system guides each decision, depending on which fundamental motive is currently paramount on an individual’s mind [18,26,27]. A fundamental motive can be activated and become paramount by external or internal cues that indicate threats or opportunities related to a specific evolutionally challenge [18,26,30]. Each of the seven fundamental motives is assumed to develop in stages as an individual grows through childhood and adolescence to old age, based on the life history theory [31]; even as later-developing motives become paramount, earlier-developed motives are ready to be active whenever pertinent threats or opportunities are perceived to arise [18,26,27]. For example, in the mature life stage, the fundamental motives of mate retention and kin care are paramount and guide decisions (e.g., when one becomes a parent, the care of one’s child becomes a top priority). Therefore, it is important to presume an audience’s paramount fundamental motive and target it when encouraging health behaviors, including vaccination.

Previous studies have shown that vaccination recommendation messages have primarily communicated the causes of infectious diseases and the benefits of vaccines [32–34]. Namely, communication to encourage vaccination to date has often targeted the fundamental motive of disease avoidance (e.g., “Vaccination can prevent the onset of infectious diseases”). However, in a safe and hygienic environment such as that of a modern industrialized country and in a situation where people are becoming accustomed to the COVID-19 lifestyle, the fundamental motive of disease avoidance may not be paramount. Additionally, prolonged exposure to similarly-themed messages generates psychological reactance and disengagement toward incoming messages, leading to ineffective persuasive outcomes [35,36]; therefore, some people may enter crowded social situations and hesitate to receive vaccination even during the COVID-19 pandemic.

Contrarily, the fundamental motive of kin care is paramount in the minds of people with young children, although messages targeting this fundamental motive (e.g., “If you are infected with the novel coronavirus, there will be no one to care for your young child. Let’s get vaccinated to take care of your child.”) have rarely been used in communication to encourage vaccination to date [32–34]. Therefore, we hypothesize that a COVID-19 vaccination recommendation message that targets the fundamental motive of kin care will be equally effective or more effective in encouraging COVID-19 vaccination among people with young children than a message that targets the fundamental motive of disease avoidance.

However, to our knowledge, no study has focused on the fundamental human motives based on the evolutionary theoretical approach and examined their influence on health decision-making including COVID-19 vaccination using a message that targets the fundamental motive of kin care. The aim of this study is to examine the persuasive effects of messages that target the fundamental motive of kin care on COVID-19 vaccination recommendations among participants with young children, and to investigate the usefulness of developing messages to encourage COVID-19 vaccination based on an evolutionary theoretical approach.

2. Methods

2.1. Participants and design

A web-based survey was conducted from October 7–8, 2021. Participants were recruited from people registered in a survey company database in Japan (Rakuten Insight, Inc.). E-mails were sent to registered users who responded to screening questions. The inclusion criteria were men and women with children under the age of 11 (equivalent to elementary school age or younger in Japan). People who work in medical institutions or elderly welfare facilities, have a body mass index of 30 or higher, or have chronic diseases such as respiratory, cardiac, or renal diseases were excluded because they are eligible for priority COVID-19 vaccination by the Japanese government. Pregnant or lactating women were excluded because they may be hesitant to be vaccinated due to concerns about adverse effects on the fetus or infant. People who had themselves or someone close to them infected with COVID-19 were excluded, as were those who had already received the COVID-19 vaccine. Because vaccine promotion should target people who are vaccine hesitant rather than the outright vaccine refusers [37], those who answered “absolutely not to do” to the question “If you could receive a COVID-19 vaccination right now, would you receive it?” were excluded; those who answered “may do” and “probably do” were included. Those who answered “absolutely do” to the same question were also excluded because there was no need to recommend it to people who were actively going to receive vaccination. Fig. 1 shows the participant flow diagram.

Recipients who were eligible and consented to participate were invited to complete a web-based survey. When participants consented to participate in the study via the website, they were randomly assigned to a group that received either an intervention message that targeted the fundamental motive of kin care, an intervention message that targeted the fundamental motive of disease avoidance, or a control message, using an algorithm included in the survey program. A total of 1005 participants were randomized and 969 participants completed the survey. Tens of yen worth of points that can be used as gift certificates or donations were given to all participants upon completion of the study by the survey company. The study was registered as a University Hospital Medical Information Network Clinical Trials Registry Clinical Trial (Unique Trial Number: UMIN000045387) on September 5, 2021. The methods of the present study adhered to CONSORT guidelines [38]. The protocol was approved by the ethical review committee at the Graduate School of Medicine, University of Tokyo (number 2021155N). All participants gave written informed consent in accordance with the Declaration of Helsinki.
2.2. Sample size

Based on the effect size in previous randomized controlled studies [39,40], we estimated a small effect size ($f = 0.10$) in the present study. We conducted a power analysis at an alpha error rate of 0.05 (two-tailed) and a beta error rate of 0.20. The power analysis indicated that 323 participants were required in each of the intervention and control groups.

2.3. Intervention and control messages

We searched news articles about COVID-19 using Yahoo! Japan News (https://news.yahoo.co.jp), the largest Japanese news portal site. By referring to these articles, we created an intervention message using a patient’s narrative that targeted the fundamental motive of kin care and that targeted the fundamental motive of disease avoidance. Appendix A shows the intervention and control messages used in this study, translated into English for this report. For a control message, we obtained textual information about bruxism from the website of the Ministry of Health, Labour and Welfare (https://www.e-healthnet.mhlw.go.jp/). The total number of Japanese characters in each of the intervention messages and the control message ranged from 469 to 544. Before reading the intervention or control message, participants were presented with the following instruction. “Please read the following pages carefully. Otherwise, you will not be able to answer the questions that follow. The next page will be fixed for 10 s (you will not be able to move on until 10 s have passed).”

2.4. Measures

The primary outcome was intention to receive COVID-19 vaccination. Participants responded to the following three questions on a scale of 1–6, ranging from “extremely unlikely” to “unlikely,” “a little unlikely,” “a little likely,” “likely,” and “extremely likely”:

1. If I could make an appointment to receive COVID-19 vaccination right now, I would do it right now.
2. Even if I am busy, I am going to make time to receive COVID-19 vaccination.
3. Even if I am worried about the side effects of COVID-19 vaccination, I will receive it.

We adapted this measure from previous studies [41–43] and included the items of concern about side effects and time burden, which have been identified as barriers to COVID-19 vaccination in Japan [44].

The secondary outcome was attitude toward COVID-19 vaccination. Participants rated “receiving COVID-19 vaccination” on a scale consisting of six 1–6 semantic differential items (bad/not bad, beneficial/not beneficial, harmful/not harmful, good/not good, valuable/not valuable, and important/not important). This measure was adapted from previous studies [45,46].

Participants also responded to the following questions on a scale of 1–6 as mentioned above:

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Fig. 1. Participant flow diagram.
(1) The care of my own child is my greatest motive among my various motives.

(2) Not getting sick is my greatest motive among my various motives.

Each of these two questions served as a manipulation check to examine if each intervention message activated the fundamental motive of kin care and disease avoidance, respectively.

All these questions were measured before and after the participants read intervention or control messages. Mean scores (ranged from 1 to 6) were used for the analysis. Higher scores indicate greater intentions, more favorable attitudes, and greater motives. Additionally, all participants were asked for their sociodemographic information before they read intervention or control messages.

2.5. Statistical analysis

Descriptive statistics were used to summarize participants’ sociodemographic information as percentages for categorical variables and as mean ± standard deviation for continuous variables. Cronbach’s α values were used to determine the internal reliability of the outcome measures. A one-way analysis of variance (ANOVA) was conducted with the absolute change in mean values before and after intervention and the mean values after intervention for each measure as the dependent variable and the group assignment as the independent variable. For multiple comparisons, Tukey’s test was conducted on significant main effects where appropriate. The Games–Howell test was performed when the assumption of homogeneity of variances was not satisfied. A p value of < 0.05 was considered significant in all statistical tests. All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 21.0 (IBM, Armonk, NY, USA).

3. Results

3.1. Participant characteristics

Table 1 shows the participants’ characteristics. Most participants (77%) were female; participant age ranged from 22 to 61 years (mean = 36 years, standard deviation (SD) = 5.6). The age of the participants’ youngest child ranged from 0 to 11 years (mean = 3 years, SD = 2.9). Overall, 45% of participants had an educational attainment level beyond university graduation. Participants were distributed throughout Japan.

3.2. Comparison of outcomes between groups

Cronbach’s α for internal consistencies of questions were 0.911 in intention to receive vaccination and 0.908 in attitude toward vaccination.

Table 2 shows the intention of receiving and attitude toward COVID-19 vaccination across groups. Regarding the absolute change in mean values for intention of vaccination before and after the intervention, ANOVA revealed a significant main effect of the group assignment [F(2, 966) = 11.274, p = 0.006]. Motive of kin care increased the most in the intervention group that targeted the fundamental motive of kin care; Tukey’s test revealed a marginally significant difference between the kin care and the control groups (M = 0.35 vs. M = 0.21, p = 0.057). The absolute change for motive of kin care in the intervention group that targeted the fundamental motive of kin care was higher than in the intervention group that targeted the fundamental motive of disease avoidance (M = 0.35 vs. M = 0.25), although the difference was not significant.

Regarding the absolute change in mean values for attitude toward vaccination before and after the intervention, ANOVA and multiple comparisons revealed the same trend as the absolute change.

3.3. Manipulation check

As Table 2 shows, for absolute change in mean values for the motive of kin care before and after the intervention, ANOVA revealed a marginally significant main effect of the group assignment [F(2, 966) = 6.958, p = 0.001]. The absolute change for motive of kin care in the intervention group that targeted the fundamental motive of disease avoidance (M = 0.35 vs. M = 0.25), although the difference was not significant. Regarding the mean values for motive of kin care after the intervention, ANOVA and multiple comparisons revealed the same trend as the absolute change.

In terms of absolute change in mean values for the motive of disease avoidance before and after the intervention, ANOVA revealed a significant main effect of the group assignment [F(2, 966) = 6.958, p = 0.001]. The absolute change for motive of disease avoidance after the intervention, ANOVA and multiple comparisons revealed the same trend as the absolute change.
We conducted interventions to examine the effectiveness of a COVID-19 vaccine recommendation message that targeted the fundamental human motive of kin care of people with young children, based on the evolutionary theoretical approach. Our hypothesis was supported by the study results: a COVID-19 vaccination recommendation message that targeted the fundamental motive of kin care was as effective in encouraging COVID-19 vaccination as a message that targeted the fundamental motive of disease avoidance. Our results indicate that previous strategies for communicating vaccination recommendations, which primarily used messages that targeted the fundamental motive of disease avoidance, was not the only optimal choice. It is recommended that health professionals add messages that target the fundamental motive of kin care to their repertoire of COVID-19 vaccination recommendations.

A message targeting the fundamental motive of kin care significantly improved attitudes toward COVID-19 vaccination and significantly increased intention to receive COVID-19 vaccination compared to a control message. It should be noted that participants in this study were the vaccine hesitant groups. The results in this study were in line with one previous study showing that personal benefit information was the most effective to reduce COVID-19 vaccine hesitancy among the other messages that addressed collective benefit, seriousness of the pandemic, and vaccine safety concerns: the personal benefit information included sentences, “Catching coronavirus can seriously disrupt your life. It can take you away from work, education, family, and friends” [16]. However, because this personal benefit information in that study also includes other sentences corresponding to disease avoidance [16], it is unclear which element of the message was effective. Additionally, because that study did not provide a theoretical framework for the intervention [16], it is unclear why that personal benefit information worked and which of the “work, education, family, and friends” benefits worked. Due to these limitations, it is not possible to create the tailored communication according to the attributes of the target audience based on the theoretical framework of fundamental human needs: this is a novelty and strength of the evolutionary theoretical approach of the present study.

Previous research and practice on behavior change, including vaccination recommendations, have been based mainly on cognitive behavioral models and focused on cognitive beliefs such as perceived susceptibility and severity of infection [12,13]. Previous studies have shown that many vaccine recommendation messages target the fundamental motive of disease avoidance and communicate the causes of infectious diseases and the benefits of vaccines (e.g., “let’s get vaccinated because vaccines prevent infection”) [32–34]. However, repeated exposure to messages with similar themes generates a psychological reactance and disengagement toward incoming messages, leading to ineffective persuasive outcomes [35,36]. Therefore, the results of this study imply that health professionals should deliver messages that target not only the fundamental motive of disease avoidance, but also the fundamental motive of kin care, to encourage COVID-19 vaccination among people with young children.

This communication strategy that targets the fundamental motive of kin care will bring a new option to health professionals who experience complexity and difficulty in communicating about the COVID-19 vaccine. First, low health literacy levels are associated with low acceptance of the COVID-19 vaccine [49,50]. However, messages that target the fundamental motive of kin care are simple and straightforward and may influence people of all health literacy levels. Second, messages that target the fundamental motive of kin care can be used to deliver tailored, personally relevant messages, which is recommended to amplify vaccine affirmation [47,48]. Third, messages that target the fundamental motive of kin care can be used in multiple channels—which are also recommended for effective vaccine communication—such as online, offline and face-to-face communication [51–53].

Future studies should examine whether a combination message (i.e., kin care plus disease avoidance) is more effective than a kin care only message or a disease avoidance only message. Future studies should also examine the effect of messages that target the fundamental motive of kin care on encouraging health behavior change, including encouraging vaccination other than COVID-19 vaccination. For example, messages that target the fundamental motive of kin care may encourage adolescent girls to receive HPV vaccination (e.g., “Cervical cancer may prevent your future childbirth and parenting. So let’s receive HPV vaccination for your future child”). Additionally, future studies should examine the effectiveness of public health messages including vaccination recommendations that target the fundamental motives such as affiliation, status, mate acquisition, and mate retention.

The present study has several limitations. First, although participants were instructed to read messages carefully before reading the intervention or control message, it is unclear to what extent the participants perused the messages. Second, although the narrator of the kin care
message was a male, about 70% of the participants were female. Because recipients’ identification with characters is a relevant factor in the effects of narrative persuasion[54], the effects of kin care message may have been reduced for female participants. Third, because the content of the control message was not associated with COVID-19, it cannot be determined that the intervention messages targeting the fundamental motives encouraged vaccination. For example, the results of this study may have detected an effect of patient narratives on COVID-19. Future studies should compare the effects between messages targeting the fundamental motives and other message types (e.g., COVID-19 vaccine efficacy and safety). Fourth, this study assessed vaccination intentions directly after message exposure; future studies should examine the long-term effects of messages because currently, the COVID-19 vaccination needs to be given routinely. Fifth, this study assessed vaccination intentions rather than actual vaccination behaviors. Sixth, regarding the manipulation check, the motive of disease avoidance increased in the kin care group to the same extent as in the disease avoidance group. The mere reading of the term “novel coronavirus” may have activated the participants’ fundamental motive of disease avoidance. Additionally, the motive of kin care may have increased the motive of disease avoidance (e.g., “To be able to take care of my young child, I cannot get sick”). Finally, 77% of participants were female and 45% of participants had an educational attainment level beyond university graduation. The interpretation of the study results needs to take into account the bias of the participants’ demographics. It is unclear as to what extent the present findings are generalizable to populations other than the participants in this web-based survey.

4.2. Conclusions

This is the first study to examine the effectiveness of COVID-19 vaccination recommendation messages by focusing on the fundamental human motives based on the evolutionary theoretical approach. We found that a message that targeted the fundamental human motive of kin care—which has been rarely used—was as effective in encouraging COVID-19 vaccination among parents with young children as a message that targeted the fundamental human motive of disease avoidance, which has been frequently used in cognitive behavioral models. This result indicates that the evolutionary theoretical approach that focuses on fundamental human motives has the potential to extend the communication strategy for COVID-19 vaccination recommendations.

4.3. Practice implications

From an evolutionary perspective, the fundamental motive of kin care is paramount in the mind of people with young children; their first priority is care for their children. Therefore, health professionals should deliver messages that target the fundamental motive of kin care, in addition to messages about susceptibility and severity of COVID-19 and vaccine efficacy, to encourage COVID-19 vaccination among people with young children. Messages that target the fundamental motive of kin care are those such as, “Get vaccinated against COVID-19 to protect your beloved child, because if you are infected, you may infect your child, and you will be unable to care for your child.”

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CRediT authorship contribution statement

Tsuyoshi Okuhara: Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Funding acquisition. Hiroko Okada: Writing – review & editing. Eiko Goto: Writing – review & editing. Aiko Tsunezumi: Writing – review & editing. Yumi Kagawa: Writing – review & editing. Takahiro Kiuchi: Writing – review & editing, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

An intervention message that targeted the fundamental motive of kin care

In Japan, about 1.7 million people have become infected with the novel coronavirus and about 17,000 people have died from the novel coronavirus infection.

The following is a message from a patient who was infected with the novel coronavirus.

“I had a cough and a fever. I took a PCR test and was positive. My wife also tested positive. My son in elementary school and daughter in kindergarten tested negative.

My wife was immediately hospitalized because of her chronic illness. I also began to suffer as if I was inhaling shards of glass. I called my family doctor and was told that I needed to be hospitalized immediately. My children were to be taken care of by a welfare agency. It was such a sudden turn of events that I was transported by ambulance, leaving my children behind. I can’t stop thinking about the crying faces of my children.

I am now in the hospital, unable to breathe without a breathing tube. I talked to my wife on the video phone, but she immediately said she had to hang up because of the pain. I wondered how my children were doing now, after not seeing their mom and dad for so many days. I want to hug them and tell them that everything will be okay. If something were to happen to my wife and I, what would we do with the children?”

The novel coronavirus vaccine has been shown to be highly effective in preventing the onset of the disease.

As the benefits of vaccination are greater than the risks of adverse reactions, vaccination is recommended.

An intervention message that targeted the fundamental motive of disease avoidance

In Japan, about 1.7 million people have become infected with the novel coronavirus and about 17,000 people have died from the novel coronavirus infection.

The following is a message from a patient who was infected with the novel coronavirus.

“I had a 40-degree fever and a headache that felt like someone was stomping on my head. I could not stop coughing, and the pain felt as though I was inhaling broken glass. I really thought that I was going to die.

I have no pre-existing conditions, do not smoke, and was perfectly healthy, but now I cannot breathe without a breathing tube. I have a drip and a catheter stuck into both of my hands. Right now, I feel ten times better than I did when I was at my worst, and I am able to talk about my condition. But my fever refused to go down even after I had taken medication, and I do not know how many days have passed since I was...
hospitalized.

I do not know where I was infected. I do not know the route of infection, whether it was my workplace, somewhere I had visited for work, or when I was out shopping. You do not know where you can be infected. Do not assume that you will be okay because you are young or healthy. The virus does not pick and choose.”

The novel coronavirus vaccine has been shown to be highly effective in preventing the onset of the disease.

As the benefits of vaccination are greater than the risks of adverse reactions, vaccination is recommended.

A control measure

According to the traditional definition, grinding one’s teeth is when somebody makes a sound by strongly grinding the teeth together, usually unconsciously or while asleep. Nowadays, it is often referred to as ‘teeth grinding,’ a term which also covers various actions that we do whilst awake.

Whether you are sleeping or awake, the non-functional biting habit of grinding one’s teeth dynamically or statically, or clenching one’s teeth, can also be referred to as bruxism (sleep bruxism if it occurs at night). Bruxism can be categorized into the movements of: sliding the upper and lower teeth together like mortar and pestle (grinding); firmly and statically engaging the upper and lower teeth (clenching); and dynamically bringing the upper and lower teeth together with a tap (tapping).

Bruxism is difficult to diagnose, as it often has no noticeable symptoms. Stress and dentition are thought to be causes of bruxism, but it is currently unclear and future research is anticipated.

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