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Habitual formation in teeth brushing and flossing in order to establish healthy oral hygiene

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Thesis

**HABITUAL FORMATION IN TEETH BRUSHING AND FLOSSING IN ORDER
TO ESTABLISH HEALTHY ORAL HYGIENE**

by

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TO ESTABLISH HEALTHY ORAL HYGIENE**

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ABSTRACT

Oral health is essential to understand as every individual has suffered from some oral disease. Oral diseases can affect any individual at any age, whether their conditions are preventative, severe, or irreversible. Therefore, understanding the impact of oral health is crucial due to the widespread prevalence of dental caries and periodontal diseases, which are significant public health concerns globally. These conditions affect oral well-being and have systemic implications, contributing to health disparities.

Health behaviors significantly impact oral health, particularly tooth brushing and interdental cleansing. Increasing tooth brushing frequency to twice daily with fluoridated toothpaste decreases caries incidence by 50%. Regular tooth brushing, twice or more daily, correlates with a favorable oral microbiome and reduces dental plaque. In contrast, irregular brushing increases the risk of dental caries and disrupts oral microbiome composition. Frequent tooth brushing and flossing are associated with reduced risks of cardiovascular disease, gingiva bleeding, and inflammatory markers such as C reactive protein and fibrinogen. Individuals brushing twice daily have a lower risk of gingiva bleeding than those brushing once or less daily. Poor tooth brushing habits increase the

risk of cardiovascular diseases by 70% and have an increased number of inflammatory markers. Furthermore, increased tooth brushing frequency correlates with lower risks of oral diseases, malignancies, diabetes mellitus, and dyslipidemia.

This is due to the systemic-oral connection stating that oral diseases can affect an individual's health. Conversely, systemic health can affect the oral health of an individual. This is extensively seen in the relationship between periodontal disease and cardiovascular diseases, as both have a direct connection with one another. Promoting foundational oral hygiene practices like tooth brushing and flossing is essential for preventing and potentially reversing these issues.

However, successful integration requires a nuanced understanding of habit formation. Recognizing the psychological components involved, such as motivation, routine establishment, consistency, and effort, is essential. Research indicates that habits are formed through cues, routines, and rewards, forming the habit loop, which is essential in developing habits. Individuals can effectively build and sustain oral health habits by comprehending these elements. Integrating toothbrushing and flossing into daily routines becomes more achievable when guided with evidence-based habit formation strategies such as understanding the shift and transition between goal-directed and habitual behaviors. Behaviors are categorized as goal-directed or habitual, depending on the conscious decision-making and planning level involved. Goal-directed behavior requires high-level decision-making and planning, while habitual behavior is automatic and

unconscious. Two strategies, model-based and model-free, are intertwined with habit formation, with the former involving goal setting, evaluation of outcomes, and cognitive processes, and the latter focusing solely on rewards.

The habit loop, involving cue, routine, and reward, is crucial in habit formation.

Repetition and consistency are vital to instilling habits and transitioning behaviors from intentional to reflexive and automatic. The basal ganglia, particularly the dorsal striatum, plays a central role in habit formation, shifting from goal-directed to habitual behavior over time. The dorsomedial region is essential in decision-making and learning, while the dorsolateral region is associated with automatic and habitual behavior. The transition between goal-directed and habitual behavior is seen in the caudate nucleus and the putamen, increasing neuronal activity when a behavior is being performed.

Furthermore, it is essential to learn the differences in health habits between children and adults as both involve different factors and require different approaches to maintaining positive oral health and establishing habits. The process of habit formation differs between children and adults due to developmental stages and cognitive abilities, emphasizing the role of parents in instilling positive oral health habits in children and the need for adults to evaluate and adopt positive habits throughout their lives. Parental guidance requires motivation, praise, and self-regulatory skills to adapt to changes and difficulties that may arise while trying to establish routines in children.

Establishing education on oral health and habit theory empowers individuals to take proactive steps in maintaining optimal health, addressing health challenges associated with oral health conditions, and promoting overall well-being.

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LIST OF ABBREVIATIONS

ADA	American Dental Association
CDC	Centers for Disease Control and Prevention
WHO	World Health Organization

INTRODUCTION

Oral health is a critical factor in a person's overall health, specifically their well-being. Oral health, as defined by the World Health Organization (WHO), is the "state of the mouth, teeth, and orofacial structures that enable individuals to perform essential functions" (World Health Organization, 2023). A healthy mouth is vital in all aspects and years of life, especially in the ability to perform functions like chewing (eating), communicating (speaking and facial expressions), or breathing (Colombia Dental, 2023). The state of the mouth, teeth, and orofacial structures need to be free of any oral diseases and well-maintained in order to be healthy (Centers for Disease Control and Prevention, (CDC), 2023). Another indicator of a healthy mouth is having no caries (tooth decay), periodontal (gum) disease, or oral cancer (WHO, 2023).

As oral health diseases are prevalent and affect every individual, the intricate impact of prevalent oral health diseases on both the oral cavity and systemic health need to be studied. Oral health diseases compromise oral well-being, leading to severe conditions such as tooth loss and having systemic repercussions, contributing to broader health concerns (Peres et al., 2019). It is essential to scrutinize the application of habit theory in shaping oral health behaviors, emphasizing the importance of understanding the habit formation factors. Exploring these factors will uncover strategies fostering oral health habits and promoting positive oral health. Recognizing the importance of implementing

goal-directed behaviors and transitioning them into habitual behaviors in oral health will help provide interventions for individuals to improve oral health and prevent oral diseases (Bernabé & Sheiham, 2014).

LITERATURE REVIEW

An abundance of microorganisms in the oral microbiome inhabit the oral cavity (Table 1). The bacteria in the oral cavity biofilm can be beneficial and harmful (Sharma et al., 2018). However, many factors affect the composition of good and bad bacteria, and this varies depending on many factors such as diet, oral health behaviors (brushing and interdental cleaning), and any other external factors (pH and temperature) that can influence the bacteria composition. As a result, research has shown a microbial shift in the biofilm from an abundance of good to harmful bacteria (Sharma et al., 2018). The oral composition of bacteria in a healthy individual had a low diversity of microorganisms, whereas individuals who suffered from periodontal disease or caries had an increased diversity of microorganisms (Sharma et al., 2018).

Table 1. A Summary of Some of The Most Common Bacteria Groups Found Within the Oral Cavity. The bacteria inhabit different areas of the oral cavity. They are comprised of both harmful and healthy bacteria. Taken from Sharma et al., 2018.

Sample location	Major Bacterial Groups
Buccal mucosa	<i>Atopobium, Bacilli, Catonella, Pasteurellaceae, Prevotellaceae, Streptococcus, Acidobacteriaceae, Xylanibacter, Phocoenobacter, Bacteroidetes, Firmicutes, Proteobacteria, Actinobacteria</i>
Tongue	<i>Actinomycetales, Bacilli, Fusobacterium, Lactobacillales, Prevotella, Pasteurellaceae, Peptostreptococcus, Streptococcus, Veillonella, Treponema, Synergistes, Clostridiales, Firmicutes, Proteobacteria, Bacteroidetes, Actinobacteria, Chlorobi, T. denticola, T. forsythia, P. endodontalis,</i>
Saliva	<i>N. flavescens, R. mucilaginoso, S. salivarius, Prevotella histicola, Veillonella parvula, Veillonella atypica, S. salivarius, Streptococcus parasanguinis, Actinomycetales, Fusobacterium, Neisseria, Pasteurellaceae, Prevotella, Streptococcus, Tannerella, Veillonella</i>
Hard palate	<i>Mogibacterium, Catonella, Gemella, Prevotella, Streptococcus</i>
Supergingival and subgingival plaques	<i>Betaproteobacteria, Corynebacterium, Capnocytophaga, Corynebacterium, Firmicutes, Fusobacterium, Neisseriaceae, Pasteurellaceae, Prevotella, Streptococcus, Granulicatella, Porphyromonas, Actinomyces, Neisseria, Treponema, Denticola, Tannerella forsythia, E. faecium</i>
Throat	<i>Actinomyces, Firmicutes, Fusobacterium, Pasteurellaceae, Streptococcus</i>
Tonsils	<i>Firmicutes, Fusobacterium, Mogibacterium, Pasteurellaceae, Prevotella, Streptococcus</i>

Dental caries are associated with *Streptococcus mutans*, *Bifidobacterium*, and *Lactobacilli*, some common bacteria strains that form dental caries (Sharma et al., 2018).

About 80% of individuals experience some oral disease from cariogenic bacteria (Calderon et al., 2021). Similarly, individuals with periodontal disease had the presence of Parvimonas and Desulfobulbus (Sharma et al., 2018). This unbalanced composition of microorganisms leads to the development of oral diseases that can be prevented or reduced with healthy oral habits (Gallagher et al., 2009; Sharma et al., 2018).

Oral Diseases

Oral diseases are one of the most prevalent diseases worldwide. Oral diseases affect the oral-facial region (oral cavity, face, and jaw) and can deteriorate an individual's oral health (Peres et al., 2019). Oral diseases encompass a broad range of health conditions affecting oral health. They affect the conditions of the mouth, teeth, gums, and other related structures, such as the jaw. These diseases are caused by various factors: bacteria, viruses, fungi, lifestyle factors, and cancer (WHO, 2023). Consequently, these diseases can cause various disorders, from tooth decay to tooth and bone loss. Furthermore, they can cause detrimental effects on the rest of the body (Mulla, 2021).

Each disease varies in risk factors and severity on oral and systemic health. As a result, oral health can have consequential impacts on the quality of life of the affected individuals (Hunter, 1988). If diseases are diagnosed in the early stages, most oral diseases in the oral cavity can be treated and reversed (Twetman, 2018). Still, the most prominent and prevalent oral diseases are dental caries and periodontal disease. These diseases can vary in severity and impact on the oral cavity; if not treated or prevented in

early stages, they can adversely affect the oral cavity and the rest of the body (Mulla, 2021).

Dental Caries

Dental caries, tooth decay, or cavities are among the most common dental diseases. More specifically, they are among the most common non-communicable diseases (Giacaman et al., 2022; Twetman, 2018). Dental caries affect approximately three billion people worldwide (WHO, 2023). They affect individuals of all ages, making everyone at risk for tooth decay. At least 90% of adults over the age of twenty have had some tooth decay in their lifetime. One in four individuals in the United States between the ages of 20 and 64 have untreated dental caries (CDC, 2023). Untreated caries can cause pain and infection, which can affect daily activities. In severe cases, if tooth decay is left untreated, it can cause an abscess, which can be fatal causing the infection to travel to the jawbone and potentially result in sepsis (Sanders & Houck, 2023; CDC, 2023).

Tooth decay occurs when there is demineralization at the enamel and dentin of the tooth (Heng, 2016). Demineralization occurs when dental plaque containing a plethora of oral bacteria accumulates and causes a biofilm that adheres to the tooth's surface (Gao et al., 2018)). If the teeth are not adequately cared for, acid from food, beverages, and bacteria can start to deteriorate the tooth's primary surface, the enamel. The prominent tooth decay-causing bacteria are known to be streptococcus mutans and lactobacilli (Twetman, 2018; Loesche, 1996). These bacteria metabolize carbohydrates from the individual's

diet, resulting in acid production (Caufield et al., 2015). The acid is formed when the bacteria bonds with the sugars and starches, attacks, and demineralizes the tooth. Demineralization occurs by dissolving hydroxyapatite. Hydroxyapatite is a vital mineral for teeth (Habibah et al., 2022). The primary role of hydroxyapatite is to provide structural strength to the tooth and cause the regeneration of bone, in this case, the enamel. The enamel is known as the hardest substance and serves as the outer and protective layer of the tooth (Caufield et al., 2015). As a result, once the enamel begins to break down, the tooth loses its strength and becomes more susceptible to decay, which can spread to the rest of the tooth structure if not arrested (Habibah et al., 2022).

Tooth decay does not all coincide; it slowly evolves if not treated (Figure 1). The first stage of dental decay occurs subsequently after demineralization occurs. This will manifest as a white spot since the acid production from the plaque buildup has begun eroding the enamel (Heng, 2016). The second stage of tooth decay continues eroding the enamel. Once the enamel has started deteriorating, the white spots begin to brown. Once the decay has deteriorated the enamel, it will continue into the dentin, causing deterioration (Gao et al., 2018). When the decay has spread beyond repair, the tooth must be extracted entirely to prevent further damage to nearby teeth or periodontal tissue (Fransson et al., 2021). If not extracted, infections can occur and cause sepsis, putting the individual's overall health at risk (Dikbas et al., 2013).

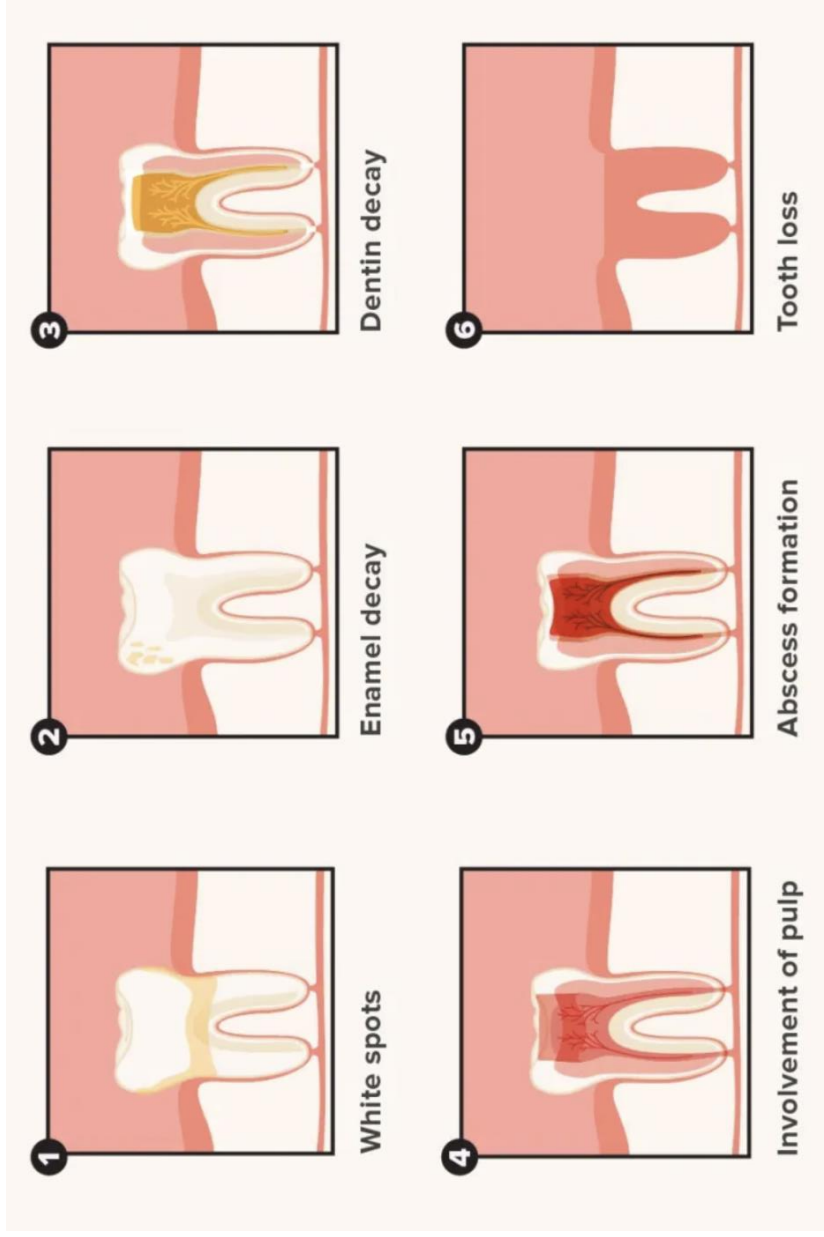


Figure 1: Progression of Dental Caries.

Dental caries will continue to deteriorate different layers of the tooth unless arrested. Figure taken from Healthline, 2023.

Periodontal Disease

Periodontal disease, also known as gum disease, is developed from infection and inflammation of the gingiva (gum) (CDC, 2023). This is a chronic inflammatory condition that affects the gums and all surrounding structures. Periodontal disease is one of the most common oral health diseases. Three out of four adults develop some degree of periodontal disease (WHO, 2023). This disease is caused by bacteria in dental plaque that adhere to and grow on the tooth surfaces. This releases toxins, particularly at or below the gumline, and the bacteria seep into the gum tissue of the surrounding tooth, causing swelling and bleeding (Gasner & Schure, 2023). This causes an infection of the gum tissue. If left untreated, the gum tissue can start to retract from the tooth structure, exposing more of the tooth and making it more susceptible to bacteria (Kapila, 2021). This stage of the disease is called gingivitis. If the condition is not adequately treated, the bacteria multiply, causing more significant inflammation and creating “pockets,” eventually leading to bone loss (Gasner & Schure, 2023). If periodontal disease progresses to this level (Figure 2), this disease now becomes periodontitis, a more severe form of the disease that can lead to further destruction of the surrounding tooth structures (Abranches et al., 2018).

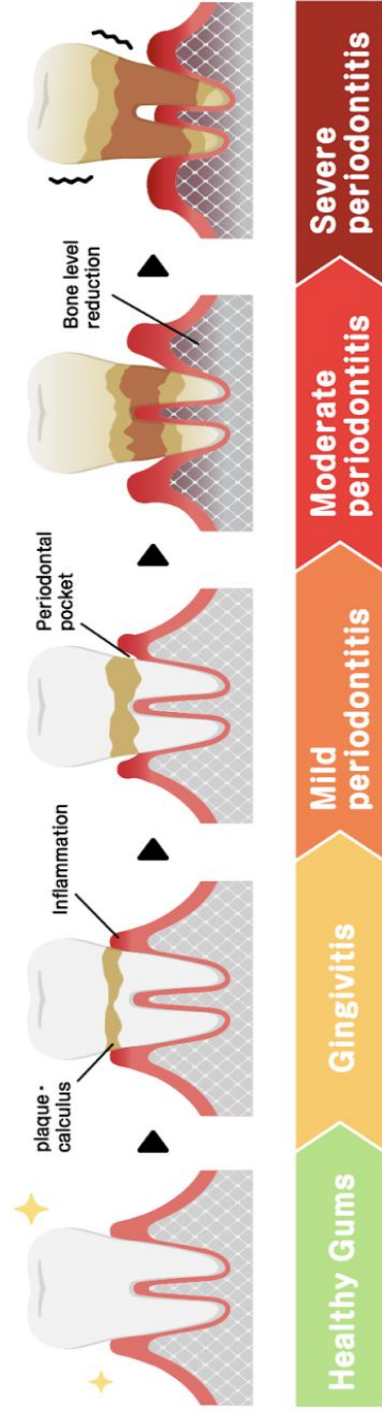


Figure 2: Progression of Periodontal Disease.

Periodontal disease progresses into different stages ranging from a mild form, gingivitis, to a severe form, periodontitis. Figure taken from The Institute for Functional Medicine, 2023.

Systemic-Oral Connection

There is a connection between oral health and systemic health. This is called the oral-systemic connection (Kapila, 2021). This connection explains how oral health can impact an individual's overall health and how the quality of their systemic health, diseases, or disorders in the body can affect their oral health (Loesche, 1996). For example, when an individual has poor oral health, it usually results in two major oral diseases: dental caries and periodontal disease (Kapila, 2021). As previously discussed, dental caries result from bacteria building up on the tooth's surface that causes decay. Periodontal diseases occur when bacteria seep into the gum tissue of the surrounding tooth, causing swelling and bleeding (Abranches et al., 2018).

Both of these infections can cause severe detrimental impacts on the overall health of an individual the more they progress (Giacaman, 2022). In addition, infections that start in the oral cavity can spread to other parts of the body, like the brain, heart, and spine.

These infections can be spread through the bloodstream, brain, or airway, which, in extreme cases, can be fatal (Loesche, 1996). Numerous studies have discovered that poor oral health can lead to heart disease, strokes, diabetes, and Alzheimer's disease.

Consequently, it has also been proven that diseases like diabetes and heart conditions can cause periodontal disease (Kapila, 2021).

Furthermore, it is crucial to understand that these oral or systemic diseases are risk factors for one another. However, many other risk factors exist for oral or systemic

diseases (Giacaman, 2022). These risk factors include but are not limited to high sugar intake, poor diet, poor hygiene, and dental care neglect. Therefore, while dental caries are common and can cause adverse effects on oral health and systemic health, it is also important to note that they can be prevented (Loesche, 1996).

Oral Health Habits

Oral health behaviors must be assessed and evaluated to the individual's needs. A number of routine behaviors can maintain good oral health and prevent oral diseases from manifesting. By establishing good oral health habits, individuals can reverse their conditions and prevent them from progressing. To some extent, poor oral health and oral diseases can be entirely prevented (Peres et al., 2019). Good oral health habits include but are not limited to tooth brushing, flossing, mouth rinsing, and regular dental visits with a dental provider. In addition to practicing good oral health habits, eliminating bad oral health habits, such as consuming dietary sugars, can immensely benefit oral health (WHO, 2023).

Tooth Brushing

One of the most essential oral health habits is tooth brushing. Tooth brushing has two characteristics: frequency and technique. In order to properly brush the teeth, one needs to brush at least twice a day for about two minutes, in the morning and before bedtime (American Dental Association (ADA), 2023). Another critical factor to consider when brushing teeth is fluoridated (1000 to 1500 ppm) toothpaste and a soft-bristled toothbrush

(WHO, 2023). Fluoridated toothpaste aids in preventing demineralization of the teeth. All surfaces of the teeth need to be brushed: the outer, inner, and chewing surfaces (Rajwani et al., 2023). In addition to brushing the teeth, the tongue must be brushed to remove all bacteria. Thorough teeth brushing removes dental plaque from the surfaces, preventing harmful bacteria from eroding the teeth and harming the gums (Choi et al., 2021).

Interdental Cleaning

Interdental cleaning (dental flossing) is essential to improving oral health. Using floss at least once daily to remove plaque from between the teeth can tremendously impact maintaining good oral health (Marchesan et al., 2020). Using either dental floss or another interdental brush or appliance is keen to clean the areas between the teeth and areas along the gumline. This is important in preventing cavities and gum disease in the areas that a toothbrush cannot reach (ADA, 2023).

Mouth Rinses

Additionally, antiseptic mouth rinses can help improve oral health. Rinsing with an antiseptic or fluoride mouthwash can help reduce plaque, strengthen tooth enamel, fight bacteria, and freshen the breath (Giertsen et al., 1999). However, there are many rinses for different conditions of the mouth. For example, xylitol rinses prevent harmful bacteria from adhering and growing on the surface of the teeth. Xylitol inhibits the growth of *Streptococci Mutans*, a harmful bacterium found in dental plaque (Nayak et al., 2014). Another beneficial facet of xylitol is its ability to increase saliva production; this can

benefit individuals who suffer from xerostomia (dry mouth). Consequently, this supports mineralization of the enamel (Spirk et al., 2019).

Routine Dental Visits

Individuals must visit a dentist at least twice a year, preferably every six months, to get a routine cleaning and examination to maintain a healthy oral cavity (WHO, 2023). Regular dental check-ups are essential in maintaining positive oral health. Routine dental cleanings and check-ups can prevent dental caries, gum disease, or other conditions from occurring or progressing (Oshima et al., 2022). Dental professionals can provide the proper oral health literacy, knowledge of care, and prevention to fit the individual's needs. Dental health professionals can identify and address issues that can negatively impact oral health and prevent further problems affecting the individual's overall health (Peres et al., 2019).

A Balanced Diet

A healthy diet is essential to maintaining good oral health. Eating a balanced diet rich in nutrients and vitamins is vital for maintaining good oral health and a healthy body (Marchesan et al., 2020). It is crucial that individuals not only consume a nutritious diet but also limit their sugar intake. As previously mentioned, sugars interact with bacteria in plaque to produce acid and allow for the destruction of the enamel. Therefore, controlling one's consumption of sugars can prevent tooth decay and other oral conditions (Moynihan et al., 2018; Shamsoddin, 2022).

Overall, good oral health begins by establishing positive routine behaviors. Individuals need to learn to integrate better habits into their daily routine schedules. They need to identify the areas that need improvement, identify their harmful habits, and learn to break them. Furthermore, individuals need to identify the factors of developing positive habits by learning how habits are formed and how they can apply these oral routines to impact their oral health positively and, consequently, their overall well-being.

Habits

The notion of habits dates back to the late 1800s when the idea that there is a behavior that occurs automatically was developed (Wood, 2016). Habits are often considered to be unconscious and automatic behaviors that repeatedly occur and are engrained in an individual's daily life. These routine behaviors and actions are performed regularly, and over time, they become instinctive acts (Watson et al., 2022). Habits can be positive and negative and influence many aspects of an individual's life.

Habits can be beneficial and detrimental to the overall well-being of a person. This depends on how these habits contribute to the daily routine. Understanding the process behind habit formation can help influence changes in one's routine. This understanding can be used to influence positive changes in one's life. Whether developing a positive habit or trying to break a negative one, the process of habit formation can be learned and utilized in developing new behavior (Kruglanski & Szumowska, 2020). With the knowledge of habit formation, individuals can guide their actions and create habits that

will better align with their aspiring goals. Habitual behavior can be categorized into two systems: one system is concerned with behaviors that are automatic, unconscious, and instantaneous, while the other system is focused on behaviors that are more controlled and conscious and require a set of cognitive processes to execute (Watson et al., 2022).

Goal-Directed Versus Habitual Behavior

Behaviors are actions performed by individuals in order to accomplish a specific goal. Goals can vary based on the time it takes to achieve them; they can be short-term or long-term (Schreiner et al., 2020). If a goal is short-term, it is a goal that takes a limited time to achieve. However, if the goal is long-term, it requires proper time and planning to achieve (Foerde, 2018). Goals can range from studying for an exam to establishing a routine like brushing teeth twice daily. When individuals set goals for themselves, they will take appropriate action to achieve them. This type of behavior is termed goal-directed behavior. Goal-directed behavior is a type of behavior that involves high-level decision-making and planning (Kruglanski & Szumowska, 2020). More specifically, this explains that goals necessitate high-order decision-making to aid a person's actions in order for them to achieve their goal. However, a new type of behavior sets in once these behaviors are completed without much thinking (Schreiner et al., 2020). This behavior is termed habitual behavior.

Habitual behavior and goal-directed behavior depend on how the behaviors are accomplished. Habitual behavior contains the notion that a behavior will be performed

automatically without exerting any mental effort (Kruglanski & Szumowska, 2020).

Goal-directed behavior involves considering a goal that needs to be accomplished, thus requiring cognitive effort to succeed in completing that goal.

Model-Based Versus Model-Free Strategies

To further highlight these differences, two types of models are interrelated with the development of the types of behavior: model-based and model-free (Watson et al., 2022).

Both the model-based strategy and model-free strategy are used as models of learning. In this case, they are used as reinforced learning approaches regarding habit formation (Schreiner et al., 2020). The model-based strategy focuses on setting specific goals that the individual wants to attain and then evaluating the results and consequences that may arise from performing these goals (Kruglanski & Szumowska, 2020). On the other hand, the model-free strategy focuses solely on the reward and outcome that the individual will receive from performing these actions, despite the results or consequences that may arise. In most cases, many individuals follow the model-free mechanism regarding habit formation (Schreiner et al., 2020). When individuals create goals, they create them with a result in mind; therefore, when performing actions to reach their goals, they will act without the consequences in mind.

The model-based strategy involves high-level cognitive processes (Kruglanski & Szumowska, 2020). This model bases its strategy on creating a mental representation of the set of actions and the outcomes that may follow those actions (Watson et al., 2022).

This will then aid the individual in creating the best plan to simulate the most desirable results for their specific goals. The cognitive processes involved, such as problem-solving and decision-making, occur to better the behavior (Schreiner et al., 2020). When using this strategy, individuals will evaluate the relationship between the actions and the outcomes and evaluate the different approaches (Figure 3). This will allow individuals to alter their behavior to reach their optimal goals actively.

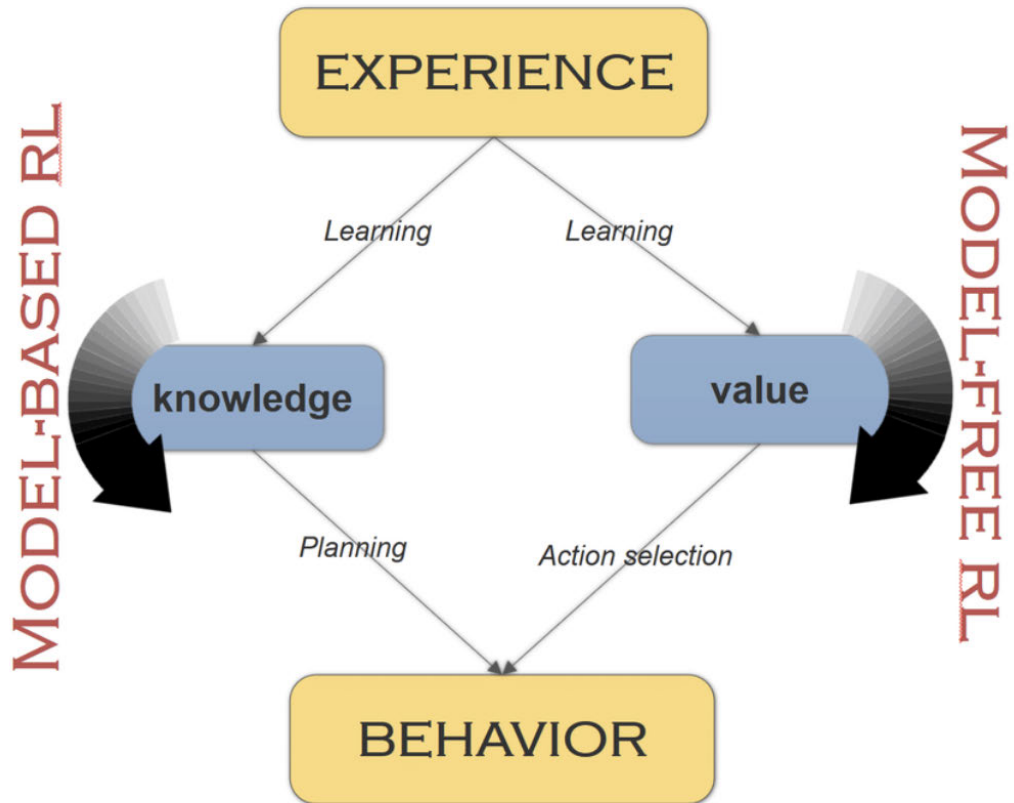


Figure 3. Model-Based Versus Model-Free Behaviors.

Depicting the difference between model-based behavior model and model-free behavior model in terms of goal directed behavior and habitual behavior. Taken from Bera et al., 2019.

Cognitive Processes Involved Through Cue-Response

Habits are described as behaviors that are automatic and consistent. They are behaviors that are repeated and, with time, become ingrained in daily life. Three steps are vital in the formation of habits (Watson et al., 2022). Step one involves a cue. This is a stimulus or a trigger that will initiate a behavior. It can be an environmental or an internal factor that prompts a signal to the brain to take action. Cues can vary and can be broad or specific. The second step is the routine. This is the action and behavior that occurs following the cue. Routines can vary from actions to emotional responses (Kruglanski & Szumowska, 2020). Lastly, the third step is the reward. The reward is usually a positive outcome or a reinforcement that follows the completion of the routine. Rewards are essential in reinforcing the habit loop because they signal the brain and provide a sense of satisfaction and relief associated with a positive consequence (Watson et al., 2022). This three-step model is referred to as the cue-routine-reward loop, also known as the habit loop (Figure 4).

The habit loop is essential when forming habits (Khatib & Barki, 2020). The brain experiences a reward in response to a routine and behavior triggered by a particular cue. This repeatedly reinforces the connection between the cue and the behavior and, over time, becomes automatic (Kruglanski & Szumowska, 2020). The more this cue and routine are repeated, the more it is reinforced, and the more this behavior becomes automatic, ingrained, and resistant to change (Schreiner et al., 2020).

In addition to the cue-routine-reward loop, there are other critical characteristics of habit formation. Repetition needs to occur in order to instill a behavior to occur habitually. The more frequently an action is repeated, the more a behavior becomes a habit (Watson et al., 2022). In addition to repetition, a behavior needs to be consistent. Not only does it need to be repeated, but it needs to be consistent in an individual's day-to-day life. With consistency and repetition, a behavior will slowly become automatic, which is essential to making it a habit (Schreiner et al., 2020). Once the behavior transitions from being intentional and thought out to reflexive and automatic, the behavior becomes habitual (Kruglanski & Szumowska, 2020).

The cue-routine-reward loop is valuable in learning how habit formation works because it can aid individuals in implanting positive habits into their lives or learning to break negative habits (Kruglanski & Szumowska, 2020). By identifying and changing the necessary cues, modifying routines, and identifying the rewards, an individual can alter the habit loop (Watson et al., 2022). With time and repeated action, the habit loop can be modified, and a new habitual behavior can occur. This can be applied to improve many aspects of life.

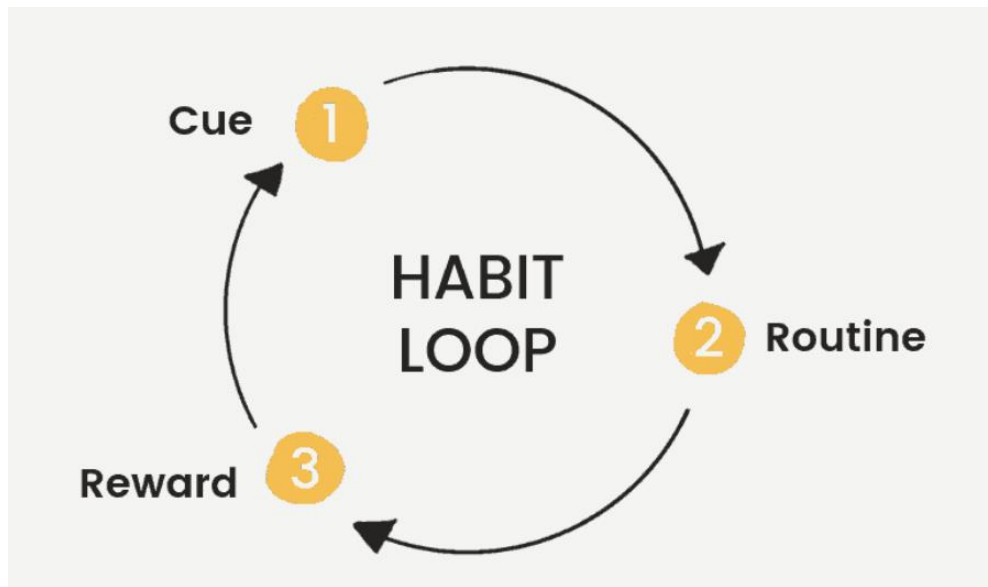


Figure 4: The Habit Loop.

Depicting the three-step model on habitual formation. Taken from Dean Yeong, 2023.

The Role of the Brain in Habit Formation

Habit formation is a complex process that involves multiple brain regions. The central region of the brain primarily involved in habit formation is the basal ganglia (Amaya & Smith, 2018). Additionally, the structures within the basal ganglia function in motor control, reward processing, and learning. The basal ganglia is a part of the cortex that contains a group of nuclei within the brain that encompasses the striatum (Amaya & Smith, 2018). The striatum, specifically the dorsal striatum, includes the caudate nucleus

and the putamen (Foerde, 2018). This area plays a crucial role in the development and execution of habits.

The process of habit formation involves transitioning from goal-directed to habitual behavior. At first, when a new behavior is learned, the prefrontal cortex and the ventral striatum are primarily involved in trying to execute cognitive processes that affect goal-directed behaviors (Foerde, 2018). Over time, with constant reinforcement and repetition of a behavior, the affected area of the brain shifts to the dorsal striatum (Khatib & Barki, 2020). This implies that the transition from goal-directed and habitual behavior occurs in the dorsal striatum. Furthermore, the dorsal striatum focuses on automatic, impulsive, and habitual behaviors (Amaya & Smith, 2018).

The prefrontal cortex is critical in shifting between goal-directed and habitual behavior (Foerde, 2018). This cortex region comprises the dorsolateral and dorsomedial, the area considered with the type of behavior that will be executed (Figure 5). The dorsomedial prefrontal cortex involves decision-making, planning, and cognitive activity (Mendelsohn, 2019). This demonstrates that this area is critical in learning and goal-directed behavior. Furthermore, dopamine, an important neurotransmitter, plays a role in habit formation's reinforcement and reward center; this is seen in the dorsolateral region, which enforces habitual behavior (Amaya & Smith, 2018). The dopamine is released in the striatum and enacts a role in reinforcing behavior through stimulating reward in habit formation (Kruglanski & Szumowska, 2020).

Noting the importance of these brain regions, especially the prefrontal cortex structures, contributes to understanding habit formation through cognitive processes involved in learning and behavior (Amaya & Smith, 2018). With this in mind, the interconnectedness of these structures can help portray how habits can be established and implemented with time and consistency.

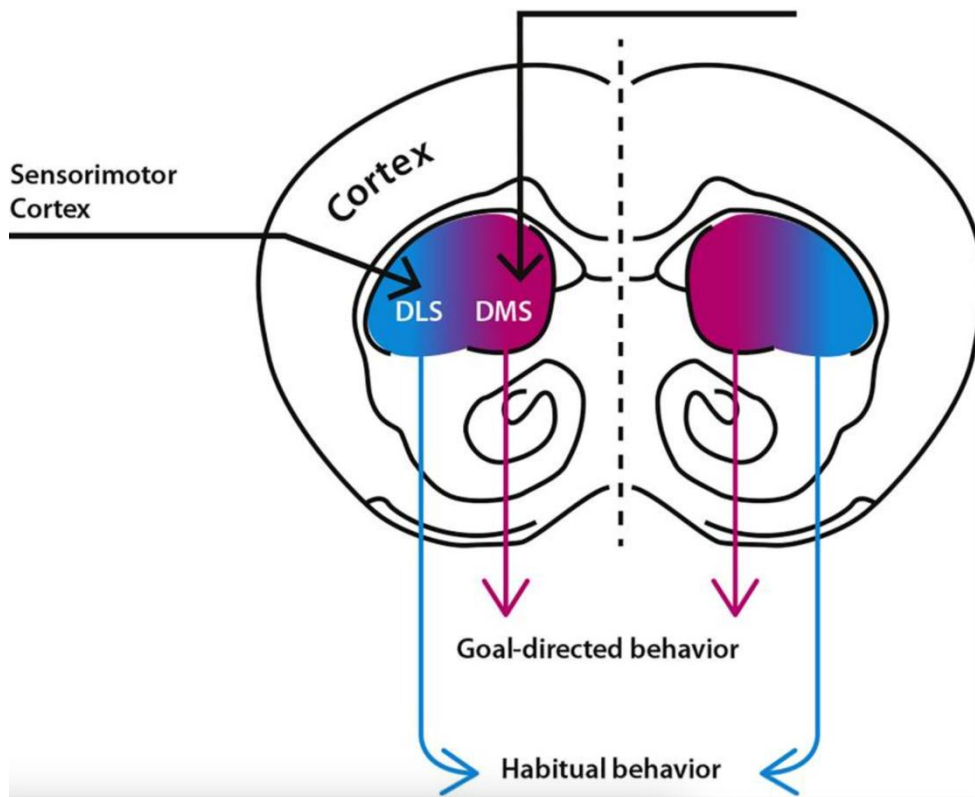


Figure 5. Goal-Directed Behavior Versus Habitual Behavior.

This figure depicts the brain regions that control the goal-directed and habitual behaviors. Taken from Mendelsohn, 2019.

Habit formation in oral health differs between children and adults due to various factors, including developmental stages and cognitive abilities (Bernabé & Sheiham, 2014).

Children are in the developmental stages of life and the formative stages of developing habits. They are not fully able to perform tasks independently without parental supervision. Meanwhile, adults have developed the proper skills and understanding to maintain and establish habits independently. Furthermore, children need help understanding the importance of positive oral health habits. At the same time, adults better understand the consequences of poor oral health and may be more motivated to maintain positive oral health habits (Kaushik & Sood, 2023). Children need to be taught the importance of maintaining positive oral health and need to be taught in a way that is comprehensible to them. While positive oral health habits are similar between adults and children, the approach toward forming habits differs. Parents play a crucial role in instilling good oral habits in their children by educating them and guiding them in their developmental stages. At the same time, adults must process and evaluate their habits to adopt positive oral habits throughout their lives (Bernabé & Sheiham, 2014).

SPECIFIC AIMS

The central objective of this study is to apply habit theory to the realm of oral health, aiming to elucidate the profound impact of effective oral health habits on both oral health and overall systemic health. The study seeks to delve into existing literature and explore the intricate relationships between consistent oral health practices - such as regular brushing and flossing - and their oral and systematic implications. Furthermore, this study seeks to emphasize the importance of cultivating and sustaining positive oral health habits as a preventive measure against common oral diseases and promoting better oral health.

A primary focus is identifying the critical components for developing and establishing enduring oral health habits. Another important aim of this study is to investigate the transition from goal-directed to habitual behavior. By understanding this shift, the study aims to unravel the mechanisms that facilitate the integration of oral health practices into individuals' daily routines in children and adults. By uncovering the psychological and behavioral components that drive habit formation, the study aspires to contribute practical insights to health initiatives, empowering individuals to seamlessly adopt and sustain new and effective oral health habits promoting long-term health benefits. The ultimate goal is to bridge the gap between knowledge and behavior, fostering a transformative shift from intentional actions to automatic, habitual behaviors in oral health, with broader implications for overall well-being.

PUBLISHED STUDIES

Behaviors – Frequency and Duration of Tooth Brushing

Oral health behaviors have been studied through the effectiveness of tooth brushing and interdental cleansing and their impact on oral health. The effectiveness of toothbrushing was observed in individuals based on two factors: the frequency and duration of brushing. However, increasing tooth brushing frequency to twice daily while using fluoridated toothpaste decreased caries incidence by 50% (Rothen et al., 2014). Similarly, populations that increased their toothbrush frequency to at least twice daily observed a favorable oral microbiome composition in their oral cavity. Meanwhile, those who brushed once or on a non-regular basis were at a higher risk for developing dental caries and had an unbalanced and unhealthy oral microbiome composition (Calderon et al., 2021).

Comparably, a study observing specific duration times of brushing and its impact on dental plaque found that the longer the brushing time, the more dental plaque was removed from the surfaces of the teeth. Brushing for a minimum of two minutes removed about a third more dental plaque than brushing for only a minute (Gallagher et al., 2009). Additionally, brushing for three to four minutes removed almost 55% more dental plaque than brushing for two minutes, increasing oral health benefits. As seen in Figure 6, dental plaque removal increases when the duration and frequency of toothbrushing are increased (Gallagher et al., 2009).

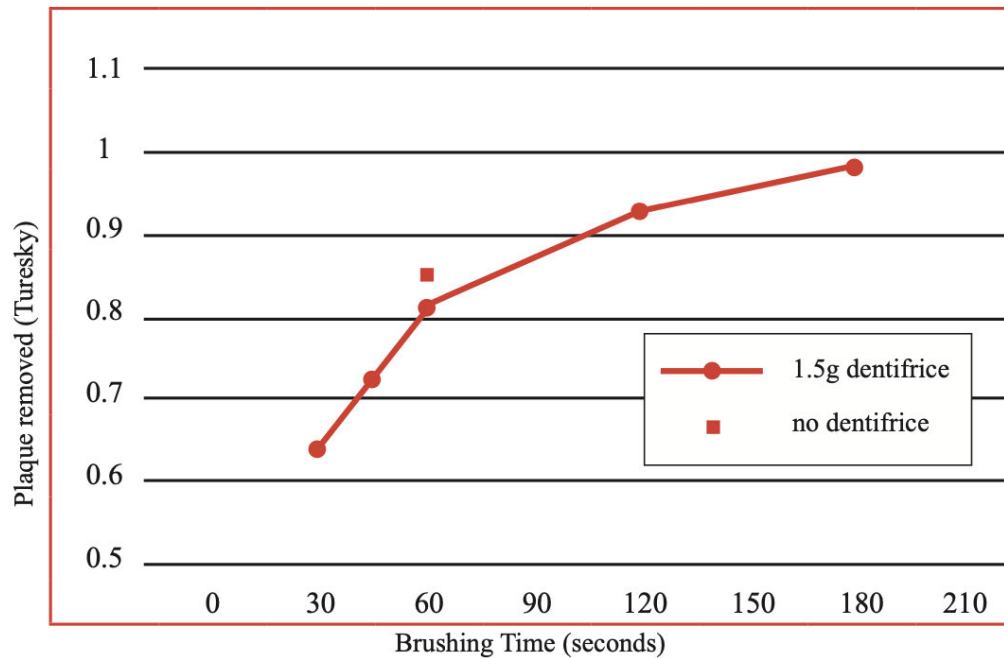


Figure 6: The Association Between Brushing Time and Dental Plaque.

The graph demonstrates how an increase in brushing time increased the removal of dental plaque. Figure taken from (Gallagher et al., 2009).

Similarly, increased frequency and duration of toothbrushing were associated with a decreased risk and development of cardiovascular disease. This was noticed in individuals' gum bleeding prevalence (Abe et al., 2022). Periodontal disease is a risk factor for many systemic diseases, especially cardiovascular disease, as they have a bidirectional relationship (Nazir, 2017). The beneficial effect of toothbrushing was noted in the inflammation of the gingiva within individuals. Increased bleeding of the gingiva is associated with a higher risk of periodontal disease. Individuals brushing twice or more

times a day had less of a risk of gingiva bleeding. Adversely, individuals who brushed once or less than once a day tripled their risk of gingiva bleeding (Figure 7). Those who decreased their toothbrushing duration from two to three minutes to one minute were twice as likely to increase their risk for gingiva bleeding (Abe et al., 2022).

More specifically, a study observed two main factors that were found in patients who experienced periodontal disease: inflammation (C reactive proteins) and coagulation (fibrinogen) (Oliveira et al., 2010). Moreover, these same factors were found in individuals with cardiovascular disease (Abe et al., 2022). Toothbrushing was observed with its effect and association of these inflammatory factors, C reactive protein, and fibrinogen. It was observed that individuals who brushed their teeth less frequently (less than once a day) had a significant increase in C reactive proteins and fibrinogen (Oliveira et al., 2010). This increased the risk of gingiva bleeding and inflammation (Abe et al., 2022) (Figure 7). There is a 70% increased risk of cardiovascular disease in individuals with these inflammatory markers present and who brush their teeth less than once a day (Oliveira et al., 2010).

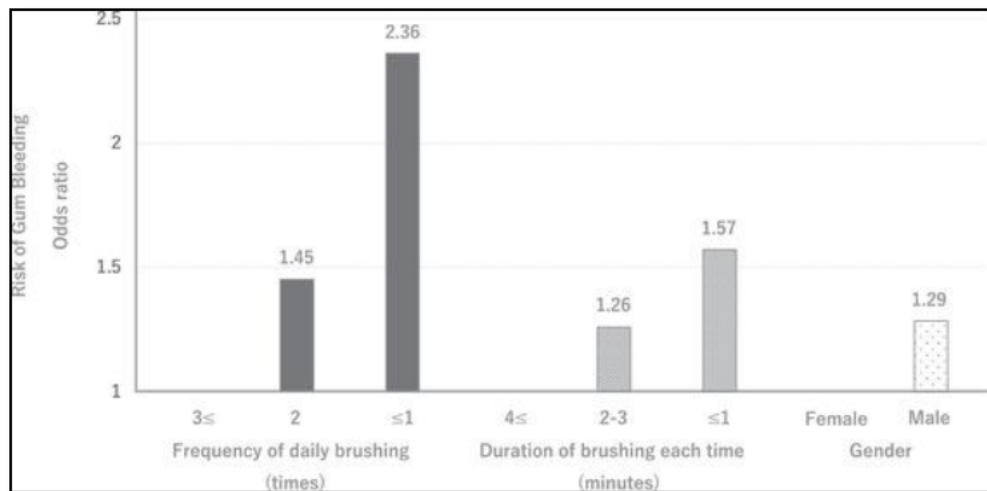


Figure 7. Toothbrushing and Its Association of Gingiva Bleeding.

Increased toothbrushing frequency and duration were associated with a lower risk of gingiva bleeding. Figure taken from Abe et al., 2022.

In addition to dental caries and periodontal disease, frequent tooth brushing twice a day compared to brushing after every meal was associated with a lower risk of many oral diseases, especially for malignancies; however, brushing after every meal did not improve oral health outcomes. The critical factor observed was the frequency of brushing regardless of when it was completed, as it decreased the risk of malignant neoplasms and cancers in the gastrointestinal tract and accessory organs (Kobayashi et al., 2019).

Moreover, another study found that increasing toothbrushing frequency decreased the risk of diabetes mellitus, a metabolic disease defined as having an abnormal increase in blood glucose levels (Liu et al., 2019). Additionally, it was observed that increasing

toothbrushing frequency decreased the risk of dyslipidemia, an abnormality in the amount of cholesterol and lipids found in the blood. Specifically, this decreased incidence was more pronounced in females than males (Figure 8) (Kuwabara et al., 2017).

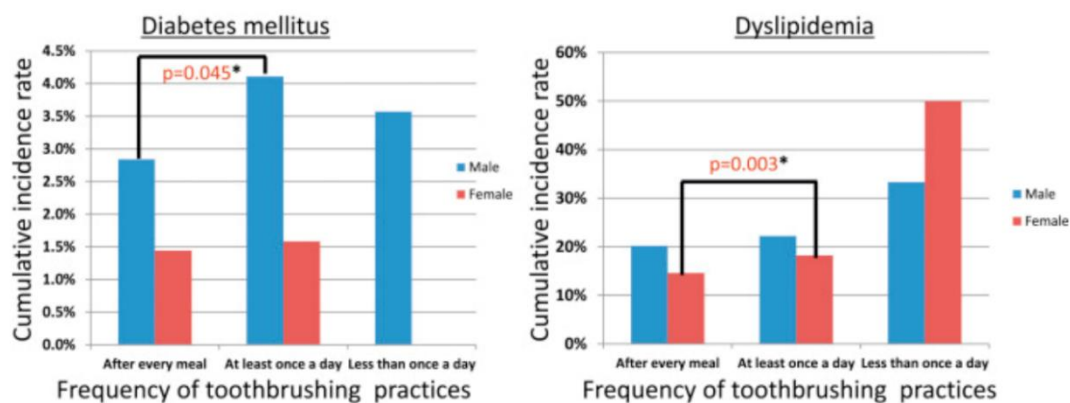


Figure 8. Increased Toothbrush Frequency in Comparison to The Development of Health Disorders.

Increased toothbrush frequency decreased the development and risk of diabetes mellitus in males. Similarly, increased toothbrush frequency decreased the risk and development of dyslipidemia in females. Figure taken from Kuwabara et al., 2017.

Overall, increased toothbrush frequency and duration positively improved individuals' oral health. The beneficial impacts of toothbrushing were observed in the oral health and the systemic health of these individuals (Liu et al., 2019). In addition to toothbrushing, oral behaviors such as interdental cleaning have shown similar results in oral health (Raison et al., 2020). Using an interdental appliance, such as dental floss, reduced plaque

along the tooth structure and the gingiva (Liu et al., 2019). A recent study observed dental plaque removal with toothbrushing alone compared to toothbrushing combined with interdental flossing. It was observed that toothbrushing combined with dental flossing decreased dental plaque by 15.9% within the first month (Shamsoddin, 2022). While toothbrushing removed surface plaque on the teeth, removing interdental plaque was not as effective with a toothbrush alone. Toothbrushing and dental flossing combination profoundly reduced interdental plaque and improved gingiva health. In addition, it decreases the risk of dental caries and periodontal disease (Raison et al., 2020).

Behaviors – Efficacy of Tooth Brushing

Positive oral health habits are not only confined to increasing the frequency and duration of toothbrushing or applying an interdental appliance at least once to the daily oral health behaviors but also add effort to toothbrushing and interdental cleaning efficacy (Figure 9) (Weik et al., 2023). While many individuals brush their teeth twice a day and floss at least once, most do not brush their teeth to the best of their ability (Raison et al., 2020).

Many individuals will perform these oral health behaviors to maintain good health.

However, many of them need to apply their optimal efforts when cleaning the surfaces of the teeth, resulting in an ineffectiveness of dental plaque removal (Weik et al., 2023).

In a recent 2023 study, individuals were asked to increase their contact time in tooth brushing, improve their brushing movements, and brush all surfaces of their teeth. In

addition to brushing, they were also asked to use the appropriate flossing techniques, including flossing between the teeth by gliding the floss between the teeth and flossing at the gumline margin (Weik et al., 2023). By increasing the efforts of brushing, individuals brushed all surfaces of the teeth: occlusal, outer, and inner surfaces (Raison et al., 2020). It was observed that individuals spent more time on their oral hygiene efforts by increasing their brushing duration and applying more effort to their interdental hygiene. Moreover, dental plaque removal increased, especially in the interdental areas where 80% of the plaque resides (Weik et al., 2023)—expanding efforts to brush and floss the interdental areas improved oral health efforts. This experiment raised awareness among individuals about their brushing and flossing techniques. In addition, these efforts worked to eliminate food impaction in all surfaces and areas of the teeth and gingiva. This increase in effort helps eliminate the sucrose impact on the teeth by eliminating the risk of dental erosion, which can lead to dental caries and periodontal disease (Attin & Hornecker, 2005).

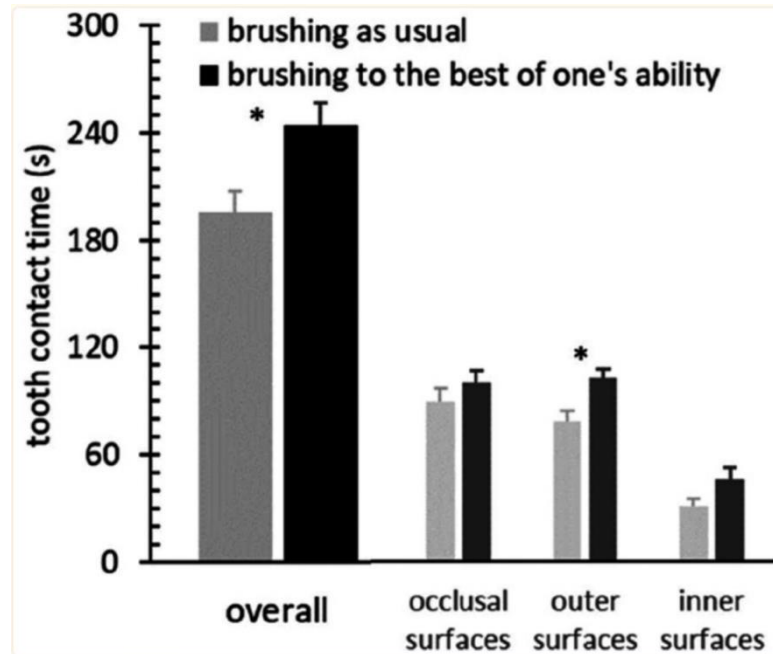


Figure 9. Effort of Toothbrushing on Teeth Surfaces.

There was an increase in the contact time and toothbrushing duration on each tooth surface when individuals were asked to increase their toothbrushing efforts. Figure taken from Weik et al., 2023

Goal-Directed Behaviors: Motivation and Effort

Developing positive oral health habits requires multiple attributes. One is the motivation and effort to develop positive oral health habits (McCloskey & Johnson, 2021). When an individual performs an oral health behavior, it contains two primary components: an initiation, “deciding to do the behavior,” and an execution, “doing the behavior” (Raison et al., 2020). The initiation components require a motivational (morning and evening)

factor. Morning motivators for many individuals were based on aesthetic purposes and social acceptability (Walker et al., 2015; Raison et al., 2020). Individuals were motivated to brush their teeth in the morning to decrease bad breath and increase the aesthetic perception of their teeth (Walker et al., 2015). In turn, this increases social acceptability for individuals.

Evening motivators were observed as being dependent upon the individual (McCloskey & Johnson, 2021). However, the cleansing component was a significant motivator for maintaining good oral health habits, toothbrushing, and interdental cleaning. Individuals felt the need to brush the day away and felt they deserved a clean and fresh mouth at the end of the day (Raison et al., 2020). While motivators vary from person to person, many motivators can influence good oral health habits, such as maintaining good oral health and systemic health, aesthetics, and cleansing (Walker et al., 2015). Once the motivational factor has been addressed, the execution will occur (Raison et al., 2020).

When a behavior occurs, it is often embedded in an everyday constant and repetitive cycle of events (Gardner, 2022). It is much easier for a behavior to become habitual if embedded in an already-established routine (Judah et al., 2013). This routine is created to establish a goal. Within this routine, some sub-routines called the event-coarse level, are specific routines that occur in the overall routine (Figure 10). Within these sub-routines are the events of the behavior, which are described as event-fine level; these are

behaviors that one needs to perform consistently to create these habits (Judah et al., 2013).

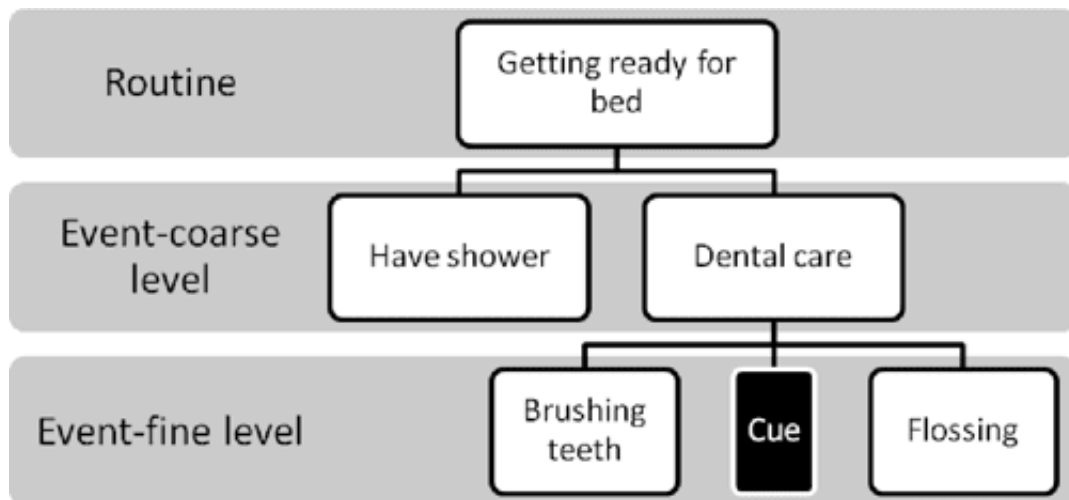


Figure 10. The Events Following an Established Routine.

In order for a behavior to take place, a complex routine will be followed by more simpler routines. Figure taken from Judah et al., 2013.

In many individuals, it has been observed through various studies that they have an established morning and evening routine (Judah et al., 2013). Suppose an already established routine, like getting ready for bed, is ingrained in the evening behavior. In that case, the individual will be more likely to perform other behaviors, such as

showering or performing oral health-related behaviors (Gardner, 2022). The main routine and the overall goal that is being accomplished is the act of getting ready for bed. For this to occur, the individual usually performs two sub-routines: showering and performing their dental care routine. Once that has been established, the individual will perform the appropriate behaviors within those sub-routines to accomplish the overall goal of getting ready for bed (Gardner, 2022). These behaviors within these sub-routines are typically the behaviors that become habitual (Judah et al., 2013).

Since the goal has already been established, the routine to establish that goal will take place. This is goal-directed behavior (Gardner, 2022). A study observed that for a habitual behavior to occur, a stimulus/cue must first present itself and take place. This stimulus/cue might be the shower or dental care products for these individuals (Raison et al., 2020). The cue will trigger a response for a behavior to occur. This behavior is the routine that will take place. This study prompted individuals to shower or perform their oral care routine (Judah et al., 2013). The order of these behaviors is dependent upon the individual. However, once the routine is performed, it will stimulate the individual to perform further behaviors to execute and accomplish the goal (Raison et al., 2020).

Furthermore, it was observed that following one of the two sub-routines, the individual will be prompted to perform the other sub-routine and perform those specific behaviors in that routine (Judah et al., 2013). With time, this routine will become habitual. While the order of the cue and response might differ for many individuals, individuals always

follow a set of goal-directed behaviors (Gardner, 2022). Almost always, individuals will perform these actions in order; however, as long as the cue instigates an unconscious trigger to initiate a behavior, the routine will be performed, and the habitual behaviors will occur (Raison et al., 2020).

Habitual Behaviors

For a behavior to transition from goal-directed to habitual, a constant and precise routine behavior must occur repeatedly. A behavior needs to become a routine that is constantly performed for it to become habitual (Gardner, 2022). In order to create a habit or to instill a change in oral health behavior, it was observed that behavior was reinforced if the individuals had a positive attitude towards the behavior and had a motivating factor that cued them to initiate the behavior (Judah et al., 2013). These behaviors are usually triggered by cues and stimuli that are either external (toothbrush, shower, or bed) or internal (fatigue or the feeling of needing to cleanse). These stimuli will trigger the routines and their specific behaviors to occur (McCloskey & Johnson, 2021). However, if an individual needs to establish a new oral health behavior, they must reinforce that behavior in an already established routine (Judah et al., 2013).

In a study observing habit formation interventions, it was easier for individuals to reinforce a new behavior in their already established routine than create a new behavior without a set routine (Gardner, 2022). Since habit formation is developed from an automatic response to cues, the behavior must be reinforced and repeated into that routine

until it becomes engrained as part of the routine (McCloskey & Johnson, 2021).

Individuals found that specific placement of new behaviors became simpler to develop and reinforce following another habitual behavior. For instance, individuals were more likely to floss their teeth after toothbrushing, a new prospective habit. Following this routine with constant repetition and a positive attitude led to the formation of new and established oral health behavior (Judah et al., 2013).

Regarding habitual behaviors in children, a recent study found that parental supervision in children's oral health habits is majorly dependent upon their self-regulatory behaviors (Hamilton et al., 2018). It was observed that parents' self-regulatory behavior begins with an intent that will later manifest into a behavior. Once the intention to do something is there, self-efficacy and planning occur. Following this, action control takes place to evaluate the process of what needs to occur for the behavior to occur. The combination of self-efficacy and action control are two concepts that play an interconnected role in the process of habit formation; they give an understanding of how behaviors can be initiated, maintained, and changed in the early stages of habit development. It was seen that parents face multiple challenges when it comes to supervising their children and helping them develop positive oral health habits. Therefore, self-regulatory skills, planning and action control are essential in helping transform intentions for behaviors into actual behaviors. Furthermore, findings from the study emphasized that these self-regulatory skills, in addition to planning and action control, are essential when parents supervise their

children's oral health habits and assist them in creating behavior changes (Hamilton et al., 2018).

Furthermore, when it comes to forming oral health habits in children, another study assessed that in addition to self-regulatory skills, parental supervision in children's oral health habits is a crucial function in their motivation and their volition, which are crucial in children's development of oral health behavior (Hamilton et al., 2018; Smith et al., 2021). The motivational aspect in children includes a sense of accomplishment, praise for completing the task, and social influence from family and peers by encouraging positive behavior. Parents connect these values with the habits they want to enforce and make these behaviors relevant to a child's daily routine. By doing so, parents enhance their children's motivation. The volitional aspect occurs when parents assist children in setting achievable goals, planning, and executing, and allowing children to self-reflect on their behavior and identify their areas of self-improvement. This combination of motivation and volition can advise strategies for habit formation in children and adults and sustain positive oral health habits and other behaviors (Smith et al., 2021).

Additional studies were conducted to assess the formation of new habits in oral health behaviors and to examine how to change or strengthen these habits. It was found that habits were better formed and strengthened using the dual-process perspective. This dual process integrates the model-free and model-based theories by combining the reflective and instinctive theories and behaviors and forming a new habitual behavior. The study

assessed that using intentional and habit-based interventions can help form new habitual behaviors. When individuals in the study used the dual-process perspective, they formed oral health behaviors more effectively (Zhang et al., 2022).

Research involving a neuroimaging study explored performance in sequential decision tasks that involved habit-based (model-free) learning and goal-directed behavior (model-based) (Triandis, 1977). The findings align with mapping habitual and goal-directed control onto associative and sensorimotor cortico-basal ganglia loops. Excitatory neuronal activity in the posterior putamen was linked to habit-based completed behavior (Aarts et al., 1997). Meanwhile, the anterior caudate nucleus exhibited excitatory neuronal activity during goal-directed behavior. This link in the dual system model proposed that the ventromedial prefrontal cortex integrates and connects model-free and model-based neuronal signals (Daw et al., 2011). Furthermore, the inferior lateral prefrontal cortex and the anterior cingulate cortex showed some neuronal connection between the areas encompassing the model-based and model-free behaviors.

Furthermore, a study in rats showed an overlap in the engagement of the neurons in the areas of the dorsolateral striatum, dorsomedial striatum, and orbitofrontal cortex (Gremel & Costa, 2013).

The intention-based intervention involved reflective thinking of the actions, considering the consequences, and making deliberate decisions to take measured actions (Zhang et al., 2022). Individuals consciously decided to brush twice daily, considered the long-term

benefits and consequences, and planned their oral health routine. Habit-based interventions focus on automatic and instinctive behaviors when it comes to oral health (Trubey et al., 2015). This was described as instinctively reaching for the toothbrush and floss when seeing it in the bathroom, morning, or the evening. In the dual process perspective, combining these two explains habit formation by consciously establishing better toothbrushing and flossing habits and understanding their benefits. Over time, these toothbrushing and flossing behaviors will become instinctive and automated routines through repetition and constant reinforcement (Zhang et al., 2022).

DISCUSSION

Furthering research in habitual theory for oral health is crucial in maintaining a healthy overall well-being. Habit theory is essential in oral health and other areas of life and medicine. It is imperative in the everyday routines of individuals. As oral health issues continue to become some of the most common public health issues, it is essential to learn ways that individuals and healthcare professionals can implement education and drive individuals to acquire the skills and knowledge to help themselves procure better health routines. As education and intervention efforts continue in individuals, knowledge of habitual behavior must be obtained to apply them to their routines further.

Oral Health

Maintaining good oral health is paramount for the overall well-being of an individual, influencing not only the condition of the oral cavity but also the systemic health and the overall quality of life. A healthy mouth is fundamental to efficient digestion and other vital functions such as speaking (WHO, 2023). Proper oral hygiene practices, such as regular brushing and flossing, prevent common dental diseases such as dental caries and periodontal disease, contributing to the longevity of natural teeth and averting the need for costly and invasive treatments (CDC, 2023).

The significance of oral health extends beyond the mouth, as research consistently links it to broader systemic conditions. Poor oral health has been associated with an increased risk of many systemic conditions, such as cardiovascular disease, diabetes, and osteoporosis. The oral cavity houses an abundance of microorganisms and serves as a gateway for harmful bacteria; therefore, untreated oral infections can potentially contribute to systemic inflammation, impacting various organs and systems in the body and leading to systemic health complications (Tavares et al., 2014).

This research showed that tooth brushing effectiveness is assessed based on frequency and duration. Increasing tooth brushing frequency to at least twice daily, especially with fluoridated toothpaste, is associated with a significant decline in caries incidence and a favorable oral microbiome composition (Rothen et al., 2014). The brushing duration also plays a crucial role, with longer brushing times leading to increased dental plaque removal. Improving tooth brushing efficacy involves increasing contact time, brushing movements, and coverage of all tooth surfaces. This leads to enhanced dental plaque removal, particularly in interdental areas, where a significant portion of plaque resides (Choi et al., 2021).

Moreover, increased tooth brushing frequency and duration are linked to a reduced risk of systemic health diseases, specifically cardiovascular disease, as observed through lower gum bleeding prevalence. Individuals brushing twice or more times a day exhibit a lower risk of gingiva bleeding (Abe et al., 2022). In contrast, those brushing less frequently face

an elevated risk, indicating a connection between oral health and systemic health through the bidirectional relationship between cardiovascular and periodontal disease.

Inflammatory markers associated with periodontal disease, such as C-reactive proteins and fibrinogen, significantly increase in individuals who brush their teeth less frequently. These same markers were seen in individuals with cardiovascular disease (Oliveira et al., 2010).

The positive impact of tooth brushing extends beyond oral health, influencing the risk of various health disorders. Frequent tooth brushing, regardless of the time of day, is associated with a lower risk of many oral diseases and systemic diseases such as malignancies, diabetes mellitus, and dyslipidemia (Liu et al., 2019). The research highlights the importance of establishing positive oral health habits. It emphasizes the efficacy of combining tooth brushing with interdental cleaning for optimal results in the person's health.

Beyond the physiological implications, oral health plays a crucial role in social and psychological well-being. This is an issue that studies need to further research and observe the implications and roles of the relationship between social and psychological well-being and oral health statuses. A healthy smile contributes to self-esteem, confidence, and positive social interactions. Conversely, oral health issues, such as damaged or missing teeth, may lead to self-consciousness and social withdrawal and affect the individual's psychological state (Davis et al., 2000).

Preventive oral care reduces the likelihood of dental pain and discomfort and can relieve the economic burden associated with extensive dental treatments. Regular dental checkups will allow for early detection and intervention, prevent the progression of oral health issues, and reduce healthcare costs (Borah et al., 2022). In the end, oral health is not merely about maintaining a healthy smile but the cornerstone of an individual's overall well-being and health. It impacts systemic health, social interactions, and the overall quality of life and accentuates the crucial need for comprehensive oral practices.

Habit Formation

Habit formation is crucial across various aspects of life, particularly medicine and general well-being, due to its profound impact on behavior and long-term outcomes.

Understanding the distinction between goal-directed and habitual behaviors is paramount in optimizing healthy habits in all aspects of life. Habits play a central role in efficiency and automaticity. In medicine, habitual behaviors, such as exercising and sleeping, must be managed and modified to maintain a healthy lifestyle. Consistent practice of preventive measures and partaking in healthy behaviors is vital for long-term health outcomes. Habits simplify complex tasks into automatic routines, reduce the cognitive load associated with decision-making, and enhance the likelihood of sustained adherence to these behaviors (Gardner et al., 2012).

Distinguishing between goal-directed and habitual behaviors and learning about the components and how to use them to transition between the two types of behaviors is

essential for creating interventions. Whether it is to disrupt a harmful habit or create a healthy one, it is vital to understand the intricate details of these behaviors to apply them to the daily routines of life. Conscious intentions drive goal-directed behaviors and require ongoing cognitive effort, which is vital in developing habitual behaviors (Raison et al., 2020).

On the contrary, habitual behaviors are automatic behaviors that require little to no cognitive effort. Understanding this distinction can help individuals and healthcare providers design interventions to facilitate the transition from goal-directed to habitual behaviors to improve individuals' health and well-being.

Understanding that many components play a significant role in the transition between goal-directed and habitual can provide further knowledge on developing habits.

Consistency and routine provide a structured framework for repeated actions in which individuals can establish healthy oral hygiene routines. Additionally, efficiency and automaticity are required to implement these behaviors in the daily routine further and, through repetition, turn them into habits. These behaviors will become automatic and require no cognitive processes as long as they are efficiently performed by routinely maintaining oral health behaviors (Gardner, 2022). Most importantly, goal achievement is the most critical factor as it helps individuals stay motivated and helps maintain consistent and effective routines. Creating habits around oral health routines will ensure

that individuals are more likely to sustain positive behaviors like toothbrushing and flossing.

The findings highlight the intricate process of habit formation in oral health behaviors, emphasizing the role of goal-directed behaviors and motivation. Positive oral health habits involve two components: initiation and execution. Morning motivators contribute to tooth brushing, often driven by aesthetic purposes and social acceptability. Evening motivators vary, with cleansing being a significant factor (Raison et al., 2020).

The study introduces the concept of routine behaviors and their role in habit formation. An established routine, getting ready for bed, serves as a foundation for sub-routines and specific behaviors within the overall routine. This structured routine, with embedded cues and routines, facilitates goal-directed behavior (McCloskey & Johnson, 2021). The transition from goal-directed to habitual behavior involves the repetition of a constant routine, often embedded in everyday life. This research found that habitual behaviors are more likely to develop when integrated into existing routines, supported by positive attitudes and motivational cues.

The study underscores the role of parental supervision in children's oral health habits, emphasizing self-regulatory skills, motivation, and volition. Parental supervision and self-regulatory skills are critical in forming positive oral health habits in children.

Motivational factors, such as a sense of accomplishment and praise, and volitional aspects, like goal setting and planning, contribute to sustained positive oral health habits

in children and adults (Hamilton et al., 2018). Children require guidance and motivation from parents to help them promote these habits. The goal is that through learned knowledge from the parents and repetition of the behavior, children create a routine involving healthier toothbrushing habits in the mornings and evenings. They can reinforce these habits with time, especially since their teeth develop as they age. Children will grow older and lose their parents' guidance and motivation. This would mean that children need to develop their own volition towards brushing, and they can also start to integrate interdental cleaning habits (Smith et al., 2021). As children grow older, their habits should slowly shift and transition to becoming more ingrained in their routine and become a behavior that is done instinctively.

The dual-process perspective, combining intention-based and habit-based interventions, proves effective in forming and reinforcing oral health habits. Reflective thinking and deliberate decisions initiate conscious efforts, which, over time, transition into automatic and instinctive behaviors—this dual approach leverages reflective and instinctive pathways, promoting long-term adherence to oral health habits (Trubey et al., 2015). Furthermore, combining intentional and habit-based interventions, the dual-process perspective is proposed as a practical approach for forming and strengthening new habitual behaviors. This perspective involves conscious decision-making for oral health actions, considering long-term benefits, and gradually transitioning these behaviors into automated routines through repetition and reinforcement.

Neuroimaging studies further support the dual-system model, mapping habit-based and goal-directed control onto specific brain regions. This shift was seen in neurons being excited in the posterior putamen (habit-based behavior) and anterior caudate nucleus (goal-directed behavior), which proved that habitual behavior included an integration of goal-directed behavior and past learned habits to initiate new habit formations (Aarts et al., 1997).

Dual-process perspectives, combining intentional (goal-directed) and habit-based interventions, offer a comprehensive understanding of habit formation. The findings suggest that consciously establishing better oral health habits and understanding their benefits lead to automatic and instinctive behaviors over time.

Furthermore, in other areas of medicine, habitual behaviors contribute to preventive care, reduce the risk of chronic diseases, and improve overall health outcomes. For example, just like toothbrushing and flossing prevent dental caries and periodontal disease, exercise and a healthy diet can prevent systemic diseases such as cardiovascular disease and diabetes, in which both systems affect the other in the oral-systemic connection.

Final Conclusion

Further research can refine personalized habit formation strategies for oral health, exploring social influences and diverse populations. Studies can investigate the dynamics of habit transition, from goal-directed to habitual behaviors, and create targeted interventions for diverse populations, especially those with severe health complications.

Furthermore, studies can explore the psychological components driving oral health habits, facilitating the development of effective public health initiatives and promoting long-term adherence to these oral health habits, including overall health habits (Bagramian et al., 2009).

Public health interventions can focus on implementing better educational programs for the general population, most notably focusing education on oral hygiene, its importance, and how to implement healthy habits to lower oral disease incidence rates. Furthermore, research can focus on creating educational programs for parents and educating them on how to help their children best. This way, they can build better habits and educate their children on the importance of these habits. More importantly, these interventions and educational programs can help aid individuals with poor oral health literacy who are more susceptible to dental caries due to their limited knowledge and awareness of dental care. When this occurs, dental caries are left untreated and, as a result, affect their overall health (Bagramian et al., 2009).

In these individuals, dental care is often not prioritized, leading to a lack of access to adequate dental care. Dental caries are often not considered dangerous in most communities, leading to severe health consequences. Due to the high cost of dental treatments, these individuals cannot get the proper care and treatment they need due to the lack of knowledge or awareness of their available resources (Bagramian et al., 2009).

Consequently, dental caries have become a significant public health issue. Many communities have needed more access to the proper care and treatment for their dental needs (Bagramian et al., 2009). Future research can study habitual behavior influences and interventions that can increase oral health literacy in young patients. This will positively impact patients' oral care habits in children and adults. More specifically, its goal is to improve patients' overall oral and systemic health to increase public health focus and awareness to battle one of the most common health issues: oral diseases. Prioritizing oral health is investing in one's well-being and promoting a healthy mouth, body, and mind. Therefore, implementing positive oral health habits through applying habit theory by learning to shift these goal-directed behaviors to habitual ones is prominent in sustaining these long-term habits.

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