

บทความปริทัศน์
(Review article)

The review of habit-forming theories and tools for well-being ทบทวนวรรณกรรมด้านทฤษฎีและเครื่องมือของการสร้างนิสัยเพื่อสุขภาวะ

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ABSTRACT: Many tools were designed to develop a good habit for learning, well-being or safety habit. Nevertheless, interventions on the tool fail to take habitual behaviour into account, limiting their potential impact. This failure is that many habit tools cannot make behaviour repeatedly until creating automaticity. The study is a review of the theories and tools that used to change the habit. Dual Process Theory, modern habit theory, and Goal Setting Theory, which together model how users form and break habits, to drive effective digital interventions. The analysis of variables used in most theories are shown. We identify opportunities and challenges in designing tools that support habit changing.

Keywords: Behaviour change technology, Persuasive technology, Habit forming technology, Habit-trigger process, Automaticity

บทคัดย่อ: เครื่องมือหลายตัวถูกออกแบบมาเพื่อที่พัฒนาให้เกิดนิสัยที่ดีเพื่อการพัฒนาการเรียนรู้ สุขภาวะ นิสัยของความปลอดภัย แม้กระนั้นตัวเครื่องมือที่ใช้ในการแก้ไขพฤติกรรม มีข้อจำกัดที่ทำให้เกิดผลกระทบอย่างแท้จริง ความล้มเหลวของเครื่องมือคือไม่สามารถทำให้พฤติกรรมนั้นเกิดขึ้นซ้ำๆ หรือพฤติกรรมแบบอัตโนมัติ การศึกษานี้จะทบทวนวรรณกรรม ด้านทฤษฎี โมเดลที่สามารถเปลี่ยนแปลงนิสัย เช่น ทฤษฎีการทำงานคู่ขนาน ทฤษฎีนิสัยสมัยใหม่ และทฤษฎีการตั้งเป้าหมาย ซึ่งสามารถที่จะก่อให้เกิดหรือเลิกนิสัยได้ และสามารถที่จะ ทำให้เกิดการแก้พฤติกรรมโดยใช้เทคโนโลยีดิจิทัล การวิเคราะห์ตัวแปรในทฤษฎีจะถูกนำเสนอและการวิเคราะห์ผลลัพธ์ที่ทำให้เกิดนิสัยอัตโนมัติเป็นโอกาส และความท้าทาย ในการออกแบบเครื่องมือที่ช่วยสนับสนุนให้เกิดการเปลี่ยนแปลงนิสัย

คำสำคัญ: เทคโนโลยีการเปลี่ยนแปลงพฤติกรรม; เทคโนโลยีการโน้มน้าว; เทคโนโลยีการสร้างนิสัย; กระบวนการกระตุ้นนิสัย; ระบบอัตโนมัติ

1. INTRODUCTION

In order to enhance well-being of mankind, a change of man's habits or an action of forming a new behaviour need to be introduced into this. To achieve this purpose, man has long used and explored several kinds of models and technologies with the aim to change one's habit or to form a new behaviour. This is done with a hope of habitual alteration, or a new behaviour will improve man's well-being. Furthermore, habit is used to improve safety and safety cultures with the use and formation of safety habits¹. Several studies had been conducted in the field of psychology, business, and digital behaviour change interventions-DBCI². Many mobile applications and technology have been produced with and without underlying theories. In this review, three topics have been considered. The first topic is about habit theory and models. Many theories have been used across various fields, such as psychology and behaviour science. Several practitioners outside the field of psychology theories have also developed models that help people to form specific kind of habit such as Atomic habit, Power of Habit and Tiny habit.

The second part of this review is about the application and technology that have developed both knowledge and applications in the Human-centered computing field. In practice, many habit

apps and hardware are available in the market. There are a number of studies on how to use application for a certain habit, such as study, meditation and exercise. Stojanovic et al.,³ found that the app-based intentional habit building works, as automaticity of behaviour could be predicted by habitual repetition. On the other hand, motivational impairments during studying can be reduced by building habits. Stawrz et al.,⁴ found event-based cues led to increased automaticity; positive reinforcement was ineffective. They argued that existing apps focus on self-tracking and reminders and do not support event-based cues. The habit can be formed with contextual cues and implementation intentions. Cue selection was primarily influenced by a desire to minimize effort, e.g., keeping related objects at hand or in a visible place; prior experience with similar behaviours⁵. The third of this review is the future research challenge. The part shows a gap of knowledge that a majority of existing research did not discover or have not been successful in the implementation in terms of technology.

2. THERORIES AND MODELS IN HABITS

For this study, we selected eight prominent theories in the bodies of literature, both in academic and in practice, then analyzed their application to habit changing. Theories that focus in addressing habits, namely (Behaviourism; Theory of Interpersonal Behaviour; Dual Process Theory, Habit loop and Fogg Behaviour Model), are commonly used in behaviour changing. Some touch on a subject of goal and plan, such as Theory of Planned Behaviour and Goal setting theory. Social Cognitive Theory and Happiness Chemical are theories that target on the social part element. The reason to choose these theories is the ones that are the most cite in academic paper. Moreover, the practical method that has not shown in academic paper and popular among practitioner also includes such as the Atomic habit and Tiny habit.

Habitual behaviour is a learned behaviour that one acts repeatedly and frequently until one perform such as task automatically. This repeatedly action forms habitual behaviour. It is cued in a stable context⁶. Automaticity means that habitual behaviours can be performed nonconscious with the ability to perform without knowing. It is a learned nonconscious behaviour, which subsequently becomes a second nature to oneself. This concept is similar to Dual process theory. Strack & Deutsch⁷ states that the two processes consist of an implicit or automatic, unconscious process and a controlled or explicit, conscious process.

Table 1 and Fig. 1 demonstrates the scale of the issue: researchers who focuses on behaviours changes have found eight of different behaviour changing theories and models. Such theories can be used to build applications and products aiming for shaping man's habits. This section reviews the use of theory in behaviour changing in general.

Table 1 Theory/model in the past.

<i>Theory/model</i>	<i>Citation source</i>	<i>Key determinants of behaviour</i>	<i>Domains</i>
1. Operant conditioning behaviourism	[8]	The interaction forms stimulus-response association.	Eco-friendly behaviours; exercise
2. Habit loop	[9]	Cuing environment, routine, rewards	Craving behaviour
3. Social cognitive theory	[10]	Expected behavioural outcomes, environment and personal factors including self-efficacy and self-regulation.	Physical activity & diet; snacking
4. Theory of planned behavior	[11,12]	Intention and Perceived Behaviour Control	Exercise; recycling, general behaviour change.
5. Goal setting theory	[13]	Intentions, Contextual constraints	Physical activity, Stress, Learning
6. Dual Process theory	[7]	Interaction of two sets of cognitive processes. Type 1 processes (fast, automatic, nonconscious) and Type 2 processes (slower, deliberative, conscious)	Eating, Physical activity, decision making
7. Fogg Behaviour model	[14]	Motivation, ability and trigger.	Physical activity, work breaks
8. Happiness Chemical	[15]	Pain killer, rewards, emotion, social	Neurotransmitters that can be classified into two parts - self and social.

2.1 Operant condition theory: rewards and punishments

Operant condition theory (Fig. 1a) explains a process of learned habits which results in either reinforcement/rewards or punishments⁸. This theory aims to increase or decrease a conduct of one's behaviours by adding consequences. This results in him or her changing particular behaviours to fit either to earn reward or to avoid punishment. The model result can be either positive and negative depending on where the consequence falls on either reinforcement and punishment. In order to introduce a new behaviour to a person, "controlled" process (i.e., with an agenda to gain either rewards or punishments) acts as a consequence in the learning process. The operant condition theory can be used to create products that stimulate users to become addicted or obsessed to a certain thing¹⁶. For example, Twitter and Facebook make a never-ending content as rewards that make users constantly checking their news feed for new updates or exploring news and unpredictable content. Another key aspect of the operant conditioning theory is a concept of extinction. When reinforcement does not happen, a behaviour decline. When there is little or no opportunity to respond to stimuli, conditioning can be forgotten or in decline.

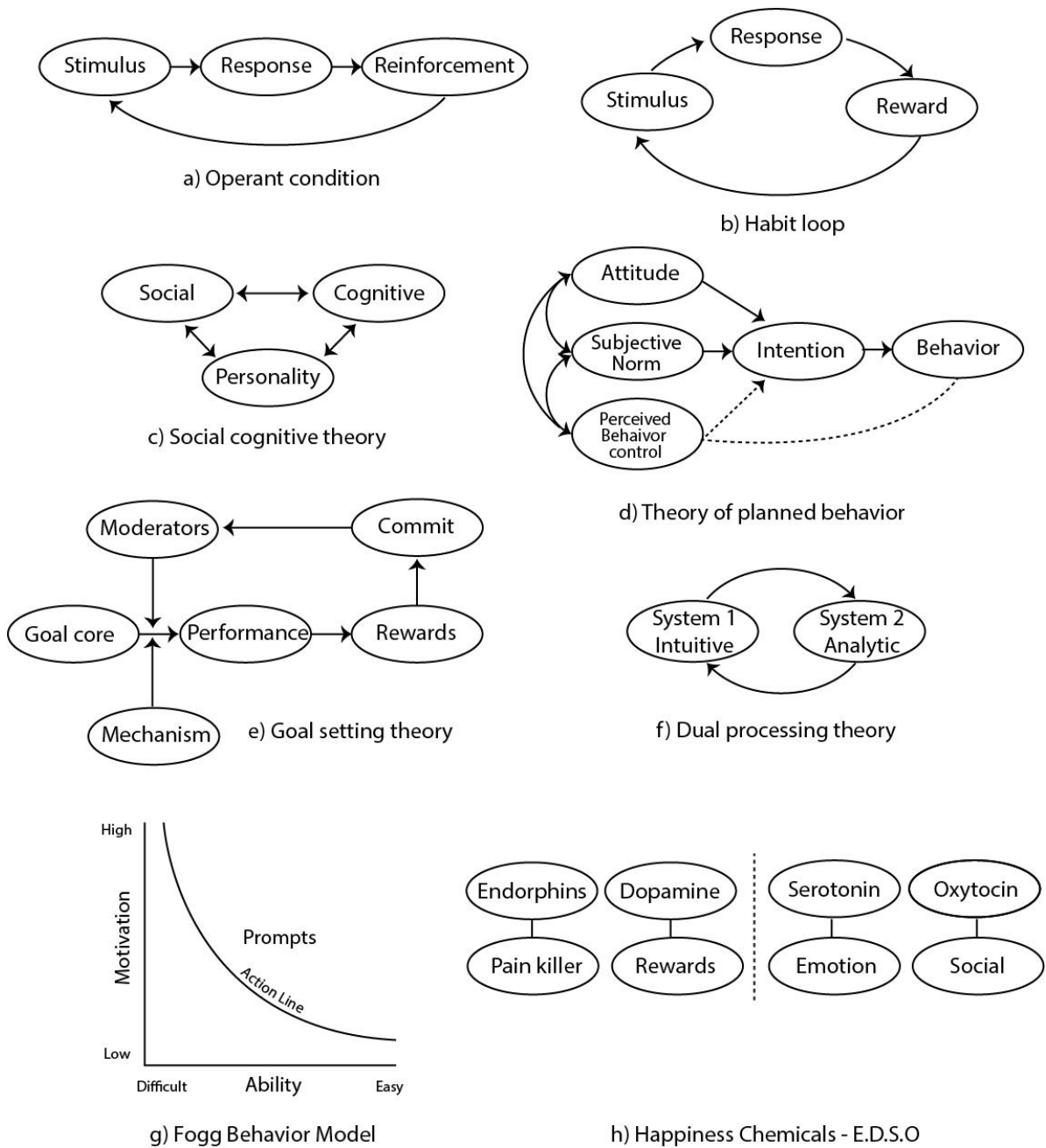


Fig. 1 Theory of habit-forming models and its variables.

2.2 Habit loop model is derived from operant conditioning.

In reference to the book of the power of habit, it introduces the habit loop (Fig. 1b) in 3 steps - Cue, Routine and Reward⁹. This model helps to understand the habit as routine behaviours. It explains the habit that continues automatically in the unconscious part of the brain. This behaviour continues automatically even when people are still conscious. It derives from a routine from conscious mind which where they will perform without awareness.

“When cue and behaviour and a reward become neurologically intertwined, what’s actually happening is a neural pathway is developing that links those three things together in our head.”⁹

To alter or form a new habit, cue is created as a trigger telling the brain what action needs to be taken. Routine is which action needs to be taken and Reward is the pleasure that is received after completing the task. This new habit can be performed when it has been repeated many times as it was told by many that “Practice makes it perfect”.

In this scenario, the limitation of this is that it is not possible to know when this new habit will appear. The time frame and duration cannot be predicted and create a measurement on the actual date that set out that the new habit will occur. This is likely that the new habit only appears when the unconscious thought reacts to precise situation. It is also possible that it might not appear at all.

2.3 Social cognitive theory: behaviour learning through modelling

Social cognitive theory (Fig. 1c) develops on a interaction of people's behaviour toward social influence and environments¹⁰. It separates learning and performing, which a demonstrate the learned process without requiring learning. Social cognitive theory is a combination of a good part of the behaviour system and cognitive system. There are five assumptions on this model. 1) Learning by observation – people learn by watching what others do; 2) Learning as internal behaviour that can reflect in their behaviour; 3) Cognitive system in learning and motivation; 4) Reciprocal causation; 5) Develop self-regulation. Ideally, self-efficacy is the main capability to influence, help or encourage a person to complete a task. For instance, someone cheers you on to complete the task. One might think he or she can perform a specific task from a model that is presented in front of him and her as an example to follow. Another element is the influence on environment to complete the task. Self-regulation is the element for a person to control his or her action. This theory is about changing a mental structure and creating a potential for different behaviours to form. This model helps in understanding a learning context of individual behaviour and how to maintain performance in person's behaviour. To shape up the theory, the reinforcement of experience on personal expectation and one's past or history will be the key element of helping people developing new specific habits and engaging in new experience. The main achievement of this theory is to control behaviour, developing a goal-direct behaviour and maintain it as a long-term behaviour. To create a new dynamic behaviour on social observation, self-control, self-awareness, expectation, expectancies and learning observation are the keys development in behaviour changing.

The best thing about this model is that they can promote learning through observation, modelling, monitoring, increasing self-efficacy and encouraging self-regulation. The model can be utilised for the teaching of new habits. The model also provides abilities to think, engage and simulate response. The theory changes a mental structure and creates a potential for different behaviours to establish. The limitation of this theory is one can feel irritated in receiving bad feedback. In addition, this theory cannot help a person to maintain long-term behaviour after this or her habitual alteration. The environment changes can affect a person's development. Here, one's development can also change in response to the introduction of new environment. Also,

this cannot measure on the focus points, such as emotion, motivation and intentionally. The past experience cannot be applied to measure and predict new behaviour. Another threat is that people have less intention or willpower to develop the new dynamic habit. Nabavi et al.,¹⁷ stated that the theory's comprehensiveness and complexity neglect behaviour on self-efficacy.

2.4 Theory of planned behaviour

Theory of planned behaviour (Fig. 1d) is used to understand and predict people's behaviour¹¹. The theory explains all behaviours over which people have ability to exert self-control. The key three components that lead to intention and desire to perform the behaviour: 1) attitude, 2) subjective norms, and 3) perceived behavioural control.

These together shape an individual's behaviour intention for example, health behaviour or individual exercise. This intends to predict performance behaviour attitude combined with opinion and their immediate determination in perceiving behaviour control. There is an argument that most habits are, in principle, controllable (e.g., by deliberate thinking and planning), it often appears difficult to overrule strong habits^{18, 19}. Uncontrollability, lack of awareness, and efficiency would be the features that characterize the experience of habits in everyday life. In order to succeed in this theory, a intention of a person toward the task, an opportunity and resource of his or her willpower are main support for successful performance.

2.5 Goal setting theory

Goal setting focused on the intention (Fig. 1e). The example of goal setting is the Objective Key Result (OKRs), KPI and performance measurement; they are applications of goal setting. Goal setting explores how well the goal can drive repetition of behaviours. The key factor of goal setting is that the proposed goals must be accepted by the user. To measure the goals progress and level of effectiveness, the tasks can determine the range of difficulty and specific goals for deliberating the outcomes. The difficult goal improves performance and motivation. Contextual constraints are a moderator¹³. At the beginning, goal setting theory focuses on conscious goals. The research has changed incorporation with the nonconscious area.

Both goal tracking result and goal setting are a Key Performance Index (KPIs). To design a working goal to follow, difficulty and specific performance are set and tracked down user's performance result in limited periods of time. Indeed, the result can reflect the effectiveness of the most motivated in the assignments and rewards. The limitation of this theory is a lack of key performance to measurement on the commitment of users. Further research also shows that goal setting theory is suitable for people who are conscious and on a high of extraversion.

2.6 Dual processing theory

Dual processing theory (Fig. 1f) provides an account of how thought can arise in two different ways, or as a result of two different processes⁷. Often, the two processes consist of an implicit (automatic), unconscious process and an explicit (controlled), conscious process. Dual processing

relates to two processing systems: 1) unconscious process (System I): a new habit is the transferred from the conscious system, resulting from the embedding of the new learned behaviour. The repeatedly learned behaviour takes over the process when one learns the way it works long enough to the point of it becomes a second nature. This system is more important than the conscious system as it processes more information. 2) conscious process (System II): it is a way of thinking of information not in the dominance method but in logical thinking. Rational way of thinking is to be very conscious of how to process properly. Dual process models are very common in the study of social psychological variables, such as attitude changing. The system II of intention is similar to the goal setting theory that intention is a requirement for decision making. Pinder et al.,² created a HAM framework that uses Type I and II for their studies. They suggest that dual process theory does not in itself provide a practical framework of applying the theory to habit-targeting DBCI.

2.7 Fogg behaviour: ability of subject to form the habit.

Fogg's behaviour model (Fig. 1g) concentrates on captology that fits to the DBCI²⁰. Ideally, the model explains three main elements that cause the behaviour changes - Trigger, Ability and motivations. These three main elements appear when behaviour occurs. The Fogg behaviour model (FBM) uses for describing general behaviour. Fogg model explains the 35 ways possible behaviour could have changed by using behaviour grid¹⁴. For behaviour to happen, three things need to come at the exact same moment, which are a trigger to initiate, a ability and a motivation. For example, in the scenario of a one ringing 3 elements occur at the same time: a trigger start when the phone first ring; picking-up the phone illustrates an ability and answering the phone shows a motivation. Clearly, behaviour performs under these circumstances. The limitation of this model is the theory shows that low motivation and difficulty tend to lead to failure more than success.

2.8 Happiness chemicals

There are four elements of happiness chemical; endorphins, dopamine, serotonin, oxytocin (Fig. 1h). These are the main factors responsible for human happiness and they are from neurotransmitters in the brain²¹. Endorphins are pain-masking chemicals that help us push ourselves through tough circumstances. Endorphins running or weightlifting is called a "Runner's High" that helps people push their bodies through tough workouts. This feeling is addictive. Dopamine is what produces that irresistible urge to check every notification on a mobile phone. Alcohol, nicotine, cocaine, and even cell phones send dopamine through the body whenever people use them, which is what makes those things so highly addictive. Serotonin is a chemical that produced when one feels the feeling of being respected, admired, and given preferential treatment. For example, graduate students are proud when they receive the certificate on the stage or runners are happy when audiences applaud them at the end of the finish line. Serotonin boosts people's confidence and makes them feel astonishing. The feeling derives from emotional bonds and physical touch results in a production of Oxytocin and makes a person to feel happy.

Oxytocin comes from the warm feeling when spending time with someone who we enjoy being around, even if we are not doing anything special. Sinek¹⁵ claims that dopamine and endorphins are produced within from oneself which may not last long. On the other hand, the production of serotonin and oxytocin are simulated by social factors that seems to last long. The result of work that they do benefit others helps to increase these two chemicals.

Table 2 Analysis of theory/models

<i>Theory/model</i>	<i>Operant conditioning</i>	<i>Habit loop</i>	<i>Theory of planned behaviour</i>	<i>Dual processing theory</i>	<i>Social cognitive theory</i>	<i>Goal setting theory</i>	<i>Fogg Behaviour model</i>	<i>Happiness chemicals</i>	<i>Total</i>
1. Stimulus/Cue/Prompts	●	●					●		3
2. Reinforcement	●								1
3. Rewards		●				●		●	3
4. Attitude							●		1
5. Motivation							●		1
6. Intention			●	●					2
7. Goal						●			1
8. Subjective norm			●						1
9. Perceive behaviour control			●						1
10. Response	●	●							2
11. Behaviour			●						1
12. Action							●		1
13. Intuitive/Emotion				●			●	●	3
14. Analytics				●					1
15. Self-efficiency					●	●			2
16. Self-regulation					●	●			2
17. Cognition					●			●	2
18. Personality					●				1
19. Commit						●			1
20. Mechanism						●			1
21. Moderators						●			1
22. Ability							●		1

Table 2 shows an analysis of variables in 8 theories and models. Some of the terminologies are called in different terms, albeit having the same meaning. For example, the stimulus, cue and prompt giving very close definition: their meaning is about something that provokes, causes, signals something to happen in response to specific action. The commonly used are the stimulus, response, rewards, intentions and emotion. There might have some overlap among terminologies. For example, the rewards and reinforcement appear to be very misunderstood. Reward refers to the fact that certain environmental stimuli have the property of eliciting approach responses. *Reinforcement* refers to the tendency of certain stimuli to strengthen learned stimulus-response tendencies²². As a result, the variables will be classified as individual not to combine them together.

In summary, Habit loop and Fogg's behaviour model are similar to the Operant conditioning behaviourism that requires the trigger such cue and stimulus. If there is no cue, the goal setting and theory of planned behaviour is more appropriated. The goal setting still has a component of rewards that is similar to the Operant conditioning behaviourism. It drives the behaviour by using the intention. While the Social cognitive theory and Happiness chemicals relate to the social factor that can drive the habit. Dual processing theory drives the behaviour by intuitive of system I. There is no any confirmation with types of variable can make the habit automatically. It could be a holistic of many variables rather than one.

3. TOOLS - APPLICATIONS AND PRODUCTS

Several applications and products have been developed for habit forming. Some of DBCI supports the goal tracking, notification, social support, contextual cue and self-control. DBCIs may implement two forms of priming behaviour: the activation of instinctive paths to achieve certain behaviour, or the activation of learned constructs such as goals. The instinctive context-response paths already exist within humans. It is easier primed than learned goals, for example, to change the unhealthy snack to encourage more positive snacking behaviour. Table 3 shows examples of applications and products. Some of them have an underlying theory and others are the mixture of several theories and models together.

Goal Setting Theory apps - Strides (Fig. 2a) is a mobile app that enables its users to keep a track of all their goals and tasks that need to be completed²³. The app follows the principles of goal setting theory. This app considers promoting a person's self-improvement and self-control. The apps can assist a user in term of performance measurement by plotting a graph or showing a dashboard to track his or her progress.

Table 3 Software and hardware tool for habit forming.

Example of Apps or products	Theory/model	Key determinants of behaviour	Purpose
Strides [23], Momentum Tracker, Productivity habit tracker.	Habit goal setting theory, Theory of planned behaviour	Feedback on behaviour, Self-monitoring, Goal setting	Tracking performance
Habitica [24]	Operant conditioning behaviourism	Rewards & incentives	Gamification, badge
Habitshare [25]	Social supports	Social support, Feedback on behaviour	Sharing habit to friends
Pavlok - shock bracelet [26]	Aversive conditioning	Punishment	For bad habit - wake up late
Moti [27]	Habit loop	Cuing environment	Continuing behaviour with rewards



a) Strides



b) Habitica



c) Habitshare



d) Pavlok



e) Moti

Fig. 2 Habit products

3.1 Operant condition apps

Habitica (Fig. 2c) is an app that uses the principles of gamification. Habitica is an online task management application run by HabitRPG, Inc²⁴. Unlike most task management programs, Habitica takes the form of a role-playing game. The main elements that this app utilizes for users to reach their of achievement are habit, diary and to-do list. For this game application, users need no experience in RPG games to operate. The game motivates user to accomplish the set tasks.

After analysis, this game uses goal setting and habit loop theory for its strategy has a daily goal or OKR to complete each day. After accomplishing the goal, users receive a reward for each task that builds toward the end of the final task; users then receive bonus and prize at the end of the game.

3.2 Social support apps

Habitshare (Fig. 2c) is a social habit tracker app that allows users to track habits along with their friends for extra accountability²⁵. This app uses the principle of the social support by committing the user's habit to their friends on their social media. There is still a room to explore and further develop social related apps for the general use for now and in the future, for example, a social relates app that creates for the aim of voluntarily providing assistance to others.

3.3 Aversive conditioning products

Pavlok shock (Fig. 2d) is a bracelet that sends a 350-volt jolt to the wearer every time they find themselves falling victim to a habit they're working to change²⁶. This device uses the punishment and coercion strategy as in the operant condition. The company says the behaviour training device uses negative stimuli (the shock) and association (the habit) to teach users' brain to associate the two stimuli together, called aversive therapy, until their brain no longer likes the bad habit.

3.4 Habit loop apps

Moti (Fig. 2e) uses in study of context cues²⁷. The study subject tends to select cues that lack effectiveness for prompting behaviour. Stawarz et al.,⁴ study the contextual cues that play an important role in facilitating change. Subjects were assigned to eat vitamins for the study as a habit. They placed the vitamins bottle in the place that could help them remember and provide the new behaviour automatically through a formation of new routines. They claim that physical robots motivate more than digital ones on screens. When people interact with technological products that are semi-anthropomorphized and live in the real world, their brains interpret them differently and such products are held more accountable. Nevertheless, there is no study of how an interactively physical product can form the habit.

4. DISCUSSION

From these theories, the main target point is to create a new habitual behaviour by using the differences of process to gain new behaviour. According to the habit loop, three variables are cue,

routine and rewards. The contextual cue is beneficial since it links to objects at hand that are visible to subjects. The routine is an automatic behaviour that gets triggered by the cue. To make an automatic behaviour, the rewards could be from self or social support. Based on social cognitive models the device is self-efficacy with a determined goal to control the frequency and consequence. Although in automaticity of habit, operant condition, Fogg's model and habit loop are designed to create a reinforcement type of habit as users receive either a reward or satisfaction. There are broadly and various questions to be asked from the behaviour theory angle. Such questions are How do we make a new habit into a permanent behaviour for long term? Does reinforcement or reward help to fasten the new behaviour process? Which theories can be integrated into the application and device? Many tools were designed to track habit and show the performance based on the goal setting theory. Nevertheless, the tools can be designed as a contextual cue or self-reflective tool for habit forming. When will the automaticity happen? What kind of rewards or cues make the behaviour repetitive? Those questions still need to be investigated in term of experiments as longitude studies.

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