Chapter 6
Physical Activity Habit: Complexities and Controversies

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Introduction

The health benefits of regular physical activity participation among adults support a reliable dose–response relationship with risk reduction of all-cause mortality, cardiovascular disease, stroke, hypertension, colon cancer, and breast cancer (Warburton, Charlesworth, Ivey, Nettlefold, & Bredin, 2010). Furthermore, regular physical activity has been linked to reduced mental health problems such as depression and anxiety symptoms (Rebar et al., 2015). The recommended dose of physical activity for optimal health benefits is 150 min of moderate intensity or 75 min of vigorous intensity activity for adults per week (World Health Organization, 2012). Unfortunately, few people meet these guidelines, particularly in higher income countries (Hallal et al., 2012). For example, less than 20% of North American adults are physically active at the recommended guidelines (Colley et al., 2011; Troiano et al., 2008). Thus, promotion of regular physical activity is paramount to public health and effective interventions are needed.

By far, the dominant theoretical approach employed to intervene on physical activity has been social cognitive in nature (Rhodes & Nasuti, 2011) and typically includes applications of social cognitive/self-efficacy theory (Bandura, 1998), theory of reasoned action/planned behaviour (Ajzen, 1991), or the transtheoretical model of behaviour change (Prochaska & Velicer, 1997). Social cognitive theories applied to physical activity emphasize reasoned, deliberative, reflective processes such as attitudes, self-efficacy, and intentions. Commensurate with these theories,

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B. Verplanken (ed.), *The Psychology of Habit*,
https://doi.org/10.1007/978-3-319-97529-0_6

physical activity interventions have focused predominantly on techniques to educate about physical activity benefits, build perceived capability to perform physical activity, and self-regulate behavioural action (Chase, 2015; Conn, Hafdahl, & Mehr, 2011; Rhodes, Bredin, Janssen, Warburton, & Bauman, 2017). Meta-analyses of physical activity interventions using these approaches tend to show short-term behaviour changes in the small but meaningful range, particularly those that emphasize self-regulation strategies such as self-monitoring, feedback, and planning (d = 0.27; SD = 0.13 Rhodes et al., 2017). Thus, while intervention approaches based on traditional social cognitive models do show some effectiveness in physical activity promotion, there is room to expand upon different targets to change behaviour.

In line with this thinking, more recent innovations in the physical activity domain have attempted to incorporate constructs that reflect the non-conscious, automatic, reflexive processes that lead to action (Rebar et al., 2016). This approach is consistent with dual process frameworks that identify two types of routes to action: a more non-conscious route that involves minimal deliberation and is experienced as fast, efficient, low effort, and uncontrollable, and a more conscious route that requires deliberation of the goal-relevance of the action and its consequences and is experienced as slow, effortful, and controlled (Evans & Stanovich, 2013; Strack & Deutsch, 2004). Research adopting such dual process approaches have frequently reported direct effects of non-conscious constructs on physical activity (Conroy & Berry, 2017; Gardner, de Bruijn, & Lally, 2011; Rebar et al., 2016). Although there are several different constructs that follow the non-conscious route of influence such as implicit attitudes, affective responses, and automatic self-schema, one of the most compelling, and controversial, concepts in the physical activity domain is habit because the theorized automatic and unintentional features of habit seemingly contradicts the complexity and effort required for this behaviour. In this chapter, we overview current evidence and conception of physical activity habit formation with a focus on its controversial nature among physical activity scientists and how specific streams of research may advance our knowledge from earlier work.

Overview of the Habit Concept

Habit is the process by which behaviour is influenced by well-learned cue–behaviour associations, as is depicted in the top half of Fig. 6.1 (Gardner, 2015; Rebar, 2017; Wood & Rünger, 2016). About half of people's daily behaviour is performed at the same time of day and in the same context (Epstein, 1979; Wood, 2017). Over time, as behaviour is reliably performed in the same context, people can learn to associate certain cues (e.g., time of day, part of routine, locations, routine events) with the initiation of the behaviour. These associations are stored in procedural memory and influence behaviour through elicitation of behavioural approach tendencies. Upon experience of the cue, the approach tendency is triggered and results in an urge to engage in the habitual behaviour. Whether the urge translates into

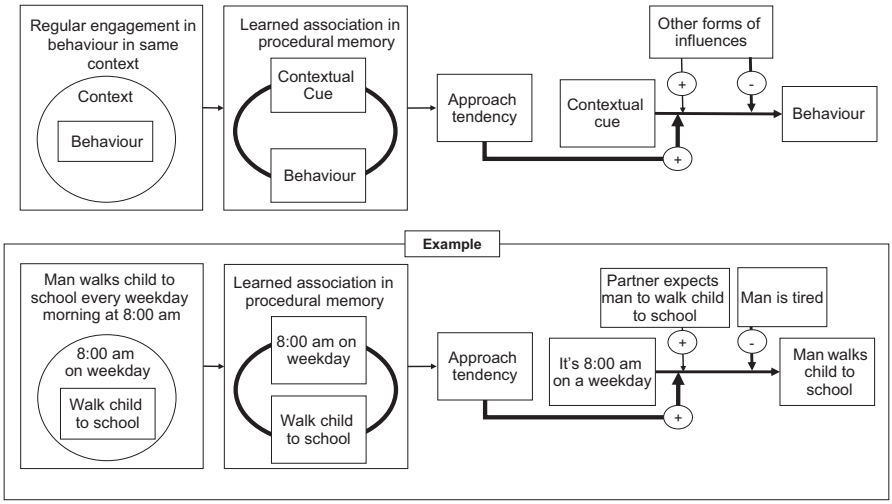

Fig. 6.1 Schematic of the process (top) and an example (bottom) of habit influencing behaviour through learned cue–behaviour associations manifesting as approach behavioural tendencies

behavioural engagement or not depends on the strength of the learned cue–behaviour association and the strength of any opposing or supporting motivational influences (e.g., feelings of fatigue, opposing motivation or self-regulation). Because the urge to act is automatically triggered by the cue, there is less need to deliberate about why and how to engage in habitual behaviours. Habits are the mind's 'short cuts'—allowing us to successfully engage in our regular daily life behaviours while reserving our reasoning and executive functioning capacities for other thoughts and actions.

An example of a physical activity habit is shown in the bottom half of Fig. 6.1. A man walks his child to school every weekday morning at 8:00 a.m. and, over time, develops a learned association between the cue of it being *8:00 a.m. on a weekday* and the physical activity behaviour of *walking the child to school*. This learned cue–behaviour association translates into an approach tendency such that when the man encounters the cue of it being *8:00 a.m. on a weekday*, he feels an urge to enact the behaviour of *walking the child to school*. This approach tendency elicits an influence on behaviour. Even though the man also experiences a countering influence from being tired, the approach tendency from the habit as well as that of the partner's expectation lead to the enactment of the habitual behaviour, and the man walks the child to school.

Importantly, this perspective of habit as an automatic process of behavioural influence is a relatively recent conceptual advancement. Up until about 15 years ago, habit was conceptualized as a reflection of frequency of past behaviour, whereas now habit is considered as a psychological determinant of behaviour (Gardner, 2012; Verplanken, 2006; Wood & Rünger, 2016). This evolution in thinking was based on the reasoning that defining habit as frequency does little to provide insight into *why* the behaviour is performed. Just like future behaviour is predicted by an

assortment of motivational influences, so too is past behaviour. When past behaviour is applied as a predictor of future behaviour, it encompasses any and all reliable predictors of behaviour and not just habit (Ajzen, 2002). Thus past behaviour does little to help describe the psychological processes behind engagement in behaviour or inform behaviour change interventions.

The transition from viewing habit as a description of frequent physical activity behaviour to that of an automatic psychological influence on physical activity behaviour has been slow and tenuous. The literature remains fraught with colloquial use of the term 'habit' as a synonym of 'behaviour' which makes summative work exasperating (not that we're complaining…). Additionally, the study of habit superseded most applications of dual process theories in the study of health behaviours such as physical activity. So, early physical activity habit research elicited scrutiny on theoretical terms in that it required shifting from traditional theoretical perspectives of physical activity motivation as well as scrutiny of the empirical validity of the measurement and study of physical activity habit.

Habit and Physical Activity Research

Although there was earlier theorizing about habit as an essential determinant of physical activity (e.g., Triandis, 1977), regular study of physical activity habit was not prevalent until the twenty-first century. In 2008, Verplanken and Melkevik adapted the Self-Report Habit Index (SRHI) for exercise behaviour (Verplanken & Melkevik, 2008). Their initial studies demonstrated that the measure was reliable, stable over time, and—most importantly—that habit was distinct from exercise behaviour frequency, intentions, and perceived behavioural control. Not long after the initial self-report measure of physical activity habit was introduced, Gardner, Abraham, Lally, and De Bruijn (2012) validated their abbreviation of the Self-Report Habit Index—the Self-Report Behavioural Automaticity Index (SRBAI)—allowing for isolated measurement of the automaticity aspect of habit. Likely, a result of the validation of these measures, the study of habit within physical activity research has grown exponentially in the last 15 years.

Two systematic reviews have aggregated the evidence of physical activity and habit (Gardner et al., 2011; Rebar et al., 2016). The latter review found that of the 37 studies on physical activity habit, 70% showed significant, positive associations between self-reported habit and behaviour. Both reviews concluded that the strength of the association between habit and physical activity behaviour was typically found to be moderate/strong ($r = 0.43$, Gardner et al., 2011; $r = 0.32$, Rebar et al., 2016). Of the 15 studies which simultaneously tested habit with other motivational influences on behaviour (e.g., intentions, perceived behavioural control, attitudes), the positive association between habit and physical activity behaviour remained positive and statistically significant in all but two studies (Rebar et al., 2016). Given that most of the traditionally applied models of exercise motivation set intentions as the necessary and sufficient precursor to behaviour (Rhodes, 2017; Rhodes & Rebar,

2017), these findings that habit explains variability in physical activity behaviour beyond intentions is noteworthy for the field. In summary, current observational research supports a medium-sized relationship between habit and physical activity that remains salient after controlling for social cognitive explanations of the behaviour.

Advancing Habit Research in Physical Activity

Conceptions of Habit for Physical Activity

While observational evidence supports the potential role of habit in physical activity, there have been strong positions that it makes little sense for such a complex behaviour (e.g., Maddux, 1997). Indeed, in our own experiences, reactions to presentations of physical activity habit research are divergent and dependent on the audience. Explanations and definitions of habit do not seem to be the source of this controversy. Instead, the disagreement over habit seems to be based on the nature of physical activity itself and whether the behaviour can be habitual. Physical activity is different from other health behaviours, and the traditional theories that are applied to understand physical activity from other domains may not take these aspects into account adequately (Rhodes & Nigg, 2011).

When considering whether exercise can be habitual, there are a few unique characteristics of the physical activity experience that require consideration. First, the behaviour takes a lot of time to enact. Current public health recommendations for physical activity suggest that accumulation of 10 min bouts may be sufficient for attaining the 150 min per week adult guidelines (World Health Organization, 2008), but the physical activity experience also often includes time-consuming preparation (transport to a location, changing clothes) and transition actions (showering, changing) (Kaushal, Rhodes, Meldrum, & Spence, 2017). Taken together, lack of time for the physical activity experience is considered its most common barrier (Bauman et al., 2012) and it would not be unreasonable to suggest that it takes anywhere from 30 to 120 min to perform a single bout. This is an immediate red flag for early habit explanations of physical activity, given the automaticity assumption that people will have minimal awareness and control of habitual behaviours (Bargh, 1992). In fact, we would be very concerned if exercisers could not account for or control where they have been or what happened during a 30+ min period several times per week! Memory recall issues are often considered a limitation of self-reported physical activity (Prince et al., 2008), but loss of awareness is an entirely different matter.

Second, physical activity takes the body out of a resting state and activates affective and physiological responses (Ekkekakis, Hall, & Petruzzello, 2008) that are contrary to the evolutionary aims of energy conservation (Lee, Emerson, & Williams, 2016). As the intensity of the physical activity increases (particularly above the ventilatory threshold), the potency of discomfort increases. This experience also runs counter to the automaticity assumptions of habit. The probability of someone having intense experi-

ences of affective and physiological activation from a stimulus like vigorous intensity physical activity and simultaneously not having a conscious experience is low.

Third, enactment of physical activity is not a simple behaviour like some other health behaviours (e.g., taking prescribed medication, health screening) but actually requires a complex series of behaviours from preparation and initiation to the sequencing behaviours during enactment. Habit may explain why someone turns off the light switch as they leave a room, but the sequencing for physical activity is extremely complex (Hagger, Rebar, Mullan, Lipp, & Chatzisarantis, 2015; Maddux, 1997). Thus, a habit explanation of external cues regulating the entire complex chain of behavioural sequences involved in physical activity behaviour seems improbable.

Taken together, there are very sensible arguments to refute a habit explanation for physical activity. It should come as no surprise that the field of exercise psychology is dominated by motivational theories of conscious deliberative constructs such as behavioural regulation, attitudes, intentions, and self-efficacy (Biddle & Nigg, 2000; Rebar & Rhodes, in press). Still, there are some characteristics of physical activity that support the possibility of habit formation. Regular physical activity is a repeated behaviour. This is considered an essential aspect of habits and habit formation (Wood & Rünger, 2016). Physical activity also has a high likelihood of being reliably performed in the same context as part of a routine. Routine itself is not habit, but it does increase the likelihood of exposure to similar contextual cues, which is a predisposing factor in habit formation (Gardner, 2015). Finally, habit is a consistent predictor of physical activity, even after past behaviour and deliberative constructs such as intentions are used as controls in the models (Rebar et al., 2016).

Some advances in the conception of habit within physical activity science may help bridge criticisms and support that physical activity can be habitual. Specifically, as previously noted, it is important to acknowledge that physical activity is not a simple behaviour but a description of a variety of complex behaviours made up of many sub-actions. Thus, while the argument that physical activity is too complicated to be habitual has been used to suggest that habit cannot account for physical activity, what it actually refutes is the notion of a bifurcated habit explanation for physical activity in its entirety. Habit and deliberative motivation may be an all or nothing phenomena (i.e. one type of influence can only account for behaviour at one point in time), but this does not need to hold true across the 30+ min of physical activity behaviour. Gardner, Phillips, and Judah (2016) outline this process with an action-phase perspective based on the theorizing of Cooper and Shallice (2006). They suggest that complex behaviours like physical activity portray an action hierarchically, where actions are composed of lower-level sub-actions and give the example of going for a run:

For example, ‘going for a run’ may be decomposed into sub-actions including ‘putting on sneakers’ and ‘leaving the house’, each of which can be decomposed further (e.g., ‘putting on left sneaker’, ‘tying laces’, ‘putting on right sneaker’). (p. 615).

This approach to understanding physical activity allows for various behavioural sequences to begin to chunk into automatically regulated actions (Graybiel, 2008). For example, a new exerciser who begins a running program will first need to deliberate each aspect of this physical activity behaviour from preparation decisions

(choice of time, clothing, etc.) to enactment aspects (route taken, running speed, pace, and style) (see Fig. 6.2a). Over time, several of these aspects may become automated through skill acquisition of simple sub-actions (running style) or through habit formation of the more higher order choices and actions (traveling to facility, deciding what activities to do; See Fig. 6.2b). Over time, as people form memories of associating the end of the previous sub-action with the initiation of the next, each sub-action will no longer require deliberation, but rather will be automatically cued into action from the approach tendency triggered by the context.

Taking this approach to understanding physical activity habit formation requires an identification of the critical aspects of the behavioural sequence. An assessment of every possible sub-action would be unwieldy and thus ineffective. Building off the initial work of Verplanken and Melkevik (2008), Gardner and colleagues (Gardner et al., 2016; Phillips & Gardner, 2016) have suggested that an initiation/selection phase (decision to act over other potential stimuli) and an execution phase (the subsequent sequenced actions) could be a useful way to conceptualize the complex physical activity sequence (see Fig. 6.2). In a similar fashion, Kaushal, Rhodes, Spence, and Meldrum (2017) suggested that a preparation phase (pre-physical activity behaviours and initiation) and an execution phase may be a useful approach to understanding physical activity habit. While both the instigation and execution phases could become habitual, as noted previously, all sets of researchers have argued that the instigation phase is likely more important for understanding regular physical activity because it denotes the antecedent selection process. By contrast, the execution phase could explain physical activity duration or effort exertion but would not seemingly explain why physical activity would be repeatedly selected

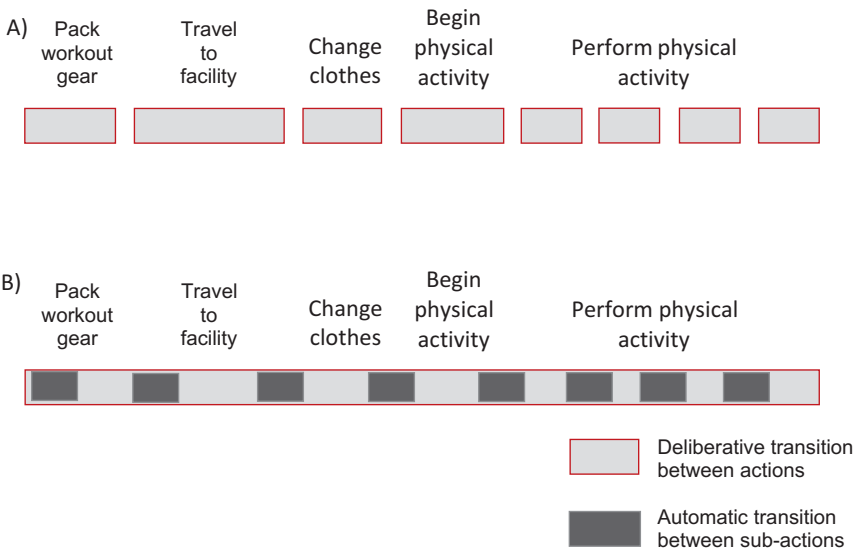

Fig. 6.2 Proposed transition between consciously deliberated physical activity and habit-facilitated physical activity

and initiated (Gardner et al., 2016). Specifically, we put forward that instigation habits for physical activity likely serve a dual role: they serve to drive an impulse/urge to initiate regular engagement in physical activity as per the noted role of habit outlined in Gardner (2015) and block the selection of alternative actions in reflective decision making (Verplanken, Walker, Davis, & Jurasek, 2008; Walker, Thomas, & Verplanken, 2015), similar to the process outlined by Markus (1977) in schema theory. In essence, instigation habits create an energy to perform physical activity and a tunnel vision toward that behaviour instead of alternative actions.

In initial support of this theorizing, several studies have now shown that the instigation phase is the dominant predictor of frequency of physical activity participation (Gardner et al., 2016; Kaushal, Rhodes, Meldrum, et al., 2017; Phillips & Gardner, 2016). Furthermore, instigation phase habit formation seems to be what is represented in generalized measures of habit such as the SRHI (Gardner et al., 2016), so the results are concordant with past evidence but help elucidate the more exact process of habit in physical activity. This finding also overcomes some of the common criticisms for a habit explanation of physical activity. First, the instigation phase is inherently much shorter than the execution phase—arguably very short as a moment in time, in which case it rebuffs the argument that the long duration of physical activity makes it unlikely to be driven by automatic processes such as habit. Second, the instigation phase is not during the process of physical exertion whereby the affective and physiological activation response to physical activity occurs. This alleviates the contrasting viewpoints between automaticity and aversive affect in physical activity as intensity increases. Overall, fine-tuning of the instigation habit phase is still needed but the distinction of these phases has contributed to a richer understanding of how the habit concept may operate in physical activity.

The Relationship Between Motivation and Habit in Physical Activity

One of the defining features of the automaticity of habit is the lack of necessary awareness of the behavioural action (Gardner, 2015; Oullette & Wood, 1998; Verplanken & Aarts, 1999; Wood & Rünger, 2016). Furthermore, Wood and Rünger (2016) consider the desensitization of outcomes and experiences as a critical aspect of what separates a habit from other implicit or non-conscious concepts and behaviour. Consequently, deliberative motivation and habit are sometimes represented as mutually exclusive in their function on behaviour. This provides an immediate challenge to disentangle when understanding health behaviours such as physical activity, because there is considerably strong evidence to support the role of deliberative motivation and self-regulation. For example, intention to engage in physical activity is associated with behaviour to a large effect (McEachan, Conner, Taylor, & Lawton, 2011) and self-regulation techniques such as goal setting (McEwan et al., 2016) and self-monitoring (Michie, Abraham, Whittington, McAteer, & Gupta, 2009) are among the most reliable components of physical activity change efforts.

As a result, several models of how goals, deliberative motivation and habits may relate to each other have been postulated (Fleig et al., 2013; Oullette & Wood, 1998; Rhodes, 2017; Verplanken & Aarts, 1999; Wood & Rünger, 2016) and the blend of these factors represents the heart of dual process approaches to understanding behaviour (Evans & Stanovich, 2013; Strack & Deutsch, 2004). There are minor deviations in these models, but most suggest that behaviour change originates with motivation and subsequent goal-driven behaviour. Over time, if the behaviour is performed in a context with similar cues, the supposition is that a habit elicits a cue-to-action that replaces the deliberative and goal-based determination of the behaviour. From a dual process model perspective, this habit response is considered the more efficient default, as attention and effort can be freed to other aspects requiring deliberative attention (Wood & Rünger, 2016). Only noteworthy changes to the system (e.g., removed cues, changes to mental state) will return the focus to the more conscious and deliberative system.

Tests of this proposed relationship between habit and deliberative motivation—typically measured with the intention construct—in physical activity have been mixed. Recent overviews (Gardner, 2015; Gardner et al., 2011; Rebar et al., 2016) have found about half of the studies do support a negative interaction between intention and habit on physical activity, but several of these tests have shown a positive interaction (Orbell & Verplanken, 2015). The confounded results are almost certainly due to the conceptual arguments about physical activity noted above. While habit and deliberative motivation may be mutually exclusive influences at any particular point in time, the complex sequence of physical activity behaviours allows for aspects of physical activity behaviour to be both deliberative and habitual. The oversimplified all-or-nothing concept of habitual physical activity is not an appropriate approach to investigating its relationship with deliberative motivation.

The relationship between physical activity and intention has also been given insufficient attention in this three-way interaction with habit. Intention to perform regular physical activity has an asymmetrical relationship with subsequent behaviour (Rhodes & de Bruijn, 2013a). Specifically, participants inhabit three of the four possible quadrants of this relationship: non-intenders who are subsequently inactive, intenders who are subsequently inactive, and intenders who are subsequently active. There are very few people (often <2%) who do not intend to engage in physical activity but are subsequently active (Rhodes & de Bruijn, 2013a). It is important to pause and reflect on this because it has serious implications for habit theory when applied to physical activity. The result refutes the concept that those with habits are acting without intention because almost no one is engaging in unintended physical activity. Indeed, given that habit is positively correlated with intention, the results are likely due to a statistical artifact in forcing asymmetrical relations to fit onto a linear regression model. The effect is likely from the restricted range in intention-behaviour variability in the high habit quadrants (i.e. no range in low intention/low behaviour or low intention high behaviour) compared to more range in the intention–behaviour relationship in the low habit quadrants (because those with low habits can be low intenders/low behaviour, high intenders/high behaviour, and high intenders/low behaviour). This issue was pointed out by

Rhodes, de Bruijn, and Matheson (2010) in their tests of the habit, intention, and physical activity relationship using regression, compared to a 2 × 2 × 2 contingency analysis of the constructs. What they found, and have subsequently replicated several times (see Rhodes & de Bruijn, 2013b), is that high habit is a predictor of action control (i.e. the translation of intentions into behaviour) after the confounding empty quadrant (low intention, high behaviour) is eliminated. One other reason why intention and habit are sometimes positively correlated may stem from self-perception (Wood & Rünger, 2016), where participants, when asked to express an intention, use one's habit as the salient piece of information to build on.

Taken together, it seems an opportune time to advance conceptions of deliberative motivation and habit considering the changing conceptions about physical activity and habit noted in the prior section. One way to do this may be to include the recent call for re-conceptualization for the intention construct in physical activity science (Rhodes & Rebar, 2017), given that intention is often used as a key proxy for deliberative processes. Rhodes and Rebar (2017) have demonstrated that intention comprises two conceptually and functionally different constructs: (1) a mental aim or determination for a specific end state, highlighting a binary decision and (2) a process of deliberative planning and/or behavioural actions, highlighting a continuum of motivational intensity. They suggest that the term *decisional intention* should be used to denote a mental aim and *intention strength* should be used when conceiving of a continuum of motivational intensity.

The properties of physical activity noted previously (time costs, energy and affect costs, complexity of actions) make it clear that the behaviour involves some deliberative processing, and past research indicates that almost all people who are physically active had a premeditative intention. Thus, decisional intention seems to be a guiding determinant in physical activity (Rhodes, 2017). That said, habit formation of physical activity could still co-occur with decisional intention. This is akin to synchronous dual processes (Verplanken & Aarts, 1999), and allows goal-directed behaviour to be achieved without heavy reliance on self-regulation. By contrast, intention strength and habit would seemingly not be able to co-occur because the habit response is characterized by lowered motivational intensity. Decisional intention may act as a guiding direction to perform regular physical activity but how this aim is selected, initiated, and carried out could be through conscious determination (intention strength) or habit; most likely there's some influence from both. Daily diary studies of this process provide within-person examples of how the interplay between habit and intention strength may unfold (Rebar, Elavsky, Maher, Doerksen, & Conroy, 2014). Under circumstances of low intention strength, people act in line with their physical activity habits; by contrast, when intention strength is high, the habit response is more likely to be overridden by intentions. Future research involving decisional intention, intention strength and habit is needed to fully explore this possibility and the roles of these constructs across phases of behaviour such as instigation and execution.

Forming Physical Activity Habits

Habit formation is reliant on what Lally and Gardner (2011) referred to as *context-dependent repetition*, which simply means that, for a behaviour to become habitual, the behaviour must be reliably and frequently initiated in the same context (also see Gardner & Lally, Chap. 12 in this book). If the behaviour and context are not regularly experienced as a pair, the learned cue–behaviour association never has a chance to form in procedural memory (Wood, Quinn, & Kashy, 2002). However, over time as the habit forms, what may initially be experienced as quite a willful process can become less arduous. People describe habit formation as being difficult to do at first but over time becoming easier and like 'second nature' (Allom & Mullan, 2014; Lally, Wardle, & Gardner, 2011).

One of the major benefits of having habits is that it reduces the need for using self-control; however, quite ironically, literature on habit formation often suggests the process requires self-control (Judah, Gardner, & Aunger, 2013; Lally et al., 2011; Lally & Gardner, 2011). For example, Lally and Gardner (2011) advocate goal setting, self-monitoring, and planning as strategies for forming health-promoting habits. Indeed if the behaviour is goal-directed initially then, until habits form, enacting the behaviour in the same context will be reliant on self-control. Although missing one cue–behaviour pairing is not necessarily detrimental to habit formation (Lally, van Jaarsveld, Potts, & Wardle, 2009), multiple or many consecutive missed opportunities likely hinders habit formation processes (Armitage, 2005).

When taken on as a goal to be achieved with self-control, habit formation can feel like a count-down process. Based on this mentality, people typically want to know how long it takes for a habit to form because then they have a tangible date they can strive toward. Studies that tracked health behaviour habit formation over time show substantial between-person variability in the process, with one study suggesting that forming habits can take anywhere from 1 to 4 months (Lally et al., 2009) and a study tracking gym-based exercise habit formation found the process tended to take roughly between 6 weeks and 2 months (Kaushal & Rhodes, 2015). Given that the research suggests the timing of habit formation for health behaviours is unpredictable and likely quite slow, reliance on self-control until habits form would seem crucial, yet merely sticking to a program long enough in the hopes one will form a habit may be too simplistic.

It may be that habit formation does not need to rely on self-control though. It could be argued that most habits are actually the result of incidental, rather than goal-directed, cue–behaviour pairings. The people most likely to be regularly active are not those who most value the benefits of it but rather it is those who intrinsically enjoy it (Rhodes, Fiala, & Conner, 2009; Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Indeed, the few studies that have been conducted on habit formation of physical activity indicate that intrinsic motivation plays an instrumental role in the process. In their study tracking new gym members' habit formation processes, Kaushal and Rhodes (2015) showed that exercise habits were more likely to be formed if people found the exercise experiences to be pleasant. Radel, Pelletier,

Pjevac, and Cheval (2017) showed that habit formation of a variety of health behaviours including physical activity was partially mediated by self-determined motivation, in that people who found the behaviour more intrinsically rewarding were more likely to form stronger habits. For people who found physical activity intrinsically rewarding, frequent physical activity behaviour was more likely to be habitual than for people who did not find it as intrinsically rewarding. It seems likely that physical activity habit formation will be most achievable if the context-dependent repetition of physical activity is intrinsically rewarding.

Although there have been a few studies which targeted habit formation of physical activity as part of weight loss interventions (Beeken et al., 2005; Carels et al., 2011; Lally, Chipperfield, & Wardle, 2008), the field still lacks many rigorous trials of habit formation interventions for physical activity specifically. In one of the first of these trials, however, Kaushal, Rhodes, Spence, et al. (2017) showed that an 8-week intervention focused on planning of contextual repetition of behaviour paired with cue resulted in more objectively measured and self-reported moderate-vigorous physical activity than a control group provided with education material. The next major step is to continue this line of research on habit formation strategies as well as system-level approaches that make physical activity the default, easiest, salient, and most pleasant option (Sheeran, Gollwitzer, & Bargh, 2013). Although helping people to form physical activity (instigation) habits will not make performing the activity less physically strenuous or difficult, it could be a key catalyst for reducing physical inactivity rates.

Future Directions and Conclusions

While the conception of habitual physical activity has improved in clarity since early research and initial intervention studies are promising, this is still an area in its infancy. The reliance on self-reported habit is likely the largest limitation to this field of inquiry (Hagger et al., 2015), but there are also several interesting streams of future research needed in physical activity science. For example, as the field moves beyond the basic questions of whether there is a role for habit in physical activity and the basic interplay between deliberative and habitual processes, an important series of questions involve individual and environmental differences in physical activity habit formation.

There are likely several individual difference factors that could potentially mitigate the formation of a habit. As mentioned in the prior section, those people who have low affective judgements and/or affective responses from physical activity are less likely to achieve the automaticity component underlying habitual physical activity (de Bruijn, Gardner, van Osch, & Sniehotta, 2014; Kaushal & Rhodes, 2015), and this is likely due to anticipated or experienced displeasure that forces one to deliberate on the experience. Whether affect can be intervened upon to improve habit formation would seem a useful topic of future research. Given the repetitive aspects of physical activity needed to form a habit, those individuals with a high need for variety (Sylvester et al., 2016) may also have difficulty in habit formation.

This need for variety may not affect initiation/preparation habit as much as execution habit (Kaushal, Rhodes, Meldrum, et al., 2017), but the extent of need for variety on habit formation warrants future research.

There are also external lifestyle factors that could mitigate physical activity habit formation. People with changing work schedules, such as shift work, often have difficulty adhering to physical activity (Kirk & Rhodes, 2011), and one reason may be that the lack of routine reduces the opportunity for habit formation of physical activity because one is not exposed to consistent contextual cues. Similarly, people with an erratic or demanding and changing home life circumstances (e.g., early parenthood, caring for others who are ill or unstable, bereavement, unemployment) often have difficulty with maintaining regular physical activity (Allender, Hutchinson, & Foster, 2008). These changing demands, like shift work, may reduce the consistency of physical activity contexts and practices and thus lower the opportunity to form cue–behaviour connections through repeated experience. Future research on whether this conjecture is accurate would be helpful, and may set the stage for important intervention research.

While research thus far has focussed exclusively on physical activity habit formation, there is a growing focus on viewing human movement on an interactive continuum that also includes sedentary behaviour and even sleep (Ekelund et al., 2016; Tremblay et al., 2016). Thus, the role of sedentary behaviour habits and their potential negative impact on habitual physical activity would seem a prudent area for future research (Marchant, Chevance, & Boiché, 2016). This mimics the literature that has explored the cross-relations of unhealthy eating and screen time habits with healthy eating behaviour (Naughton, McCarthy, & McCarthy, 2015; Verplanken & Faes, 1999) and would also complement past research on the deliberative aspects of conflicting and facilitative physical activity goals (Rhodes, Quinlan, & Mistry, 2016).

Another potentially interesting area of research is to explore who may benefit most from the development of a physical activity habit. Currently, our understanding of habitual physical activity is over-represented by university students (Rebar et al., 2016). It would be interesting to explore habitual physical activity formation with clinical populations, vulnerable populations, or other groups at risk for inactivity who may have the most to gain from increased regular physical activity. Overall, we would expect that those who may benefit the most from habit interventions are people who are not intrinsically motivated by physical activity but seek its health benefits. This is a paradox because those who intrinsically value physical activity are less likely to be concerned about forming a habit (Maddux, 1997), but seem more likely to have one regardless of this desire (Radel et al., 2017).

In conclusion, in this chapter we overviewed the current evidence and conception of physical activity habit formation. We highlighted that physical activity scientists have often been skeptical of habitual physical activity based on several unique aspects of the behaviour that highlight its deliberative and regulatory aspects. Despite this reticence among many scientists, observational evidence is clearly supportive of a relationship between self-reported habit and physical activity, even after controlling for motivational and self-regulatory processes. We suggested that the more recent separation between the phases (initiation, execution) of physical activity has helped delineate where habit may determine physical activity overcome its past

controversial nature among physical activity scientists. Furthermore, separations among different concepts of intention (decision, strength) may help improve our understanding of how deliberative motivation and habituation interact and co-determine behaviour. While intervention research of habitual physical activity is scarce, early results suggest attending to specific conditions (contextual repetitions, cues, scripts) can expedite and improve the likelihood of habit formation.

Habit Research in Action
Can exercise be habitual?

Some people have a hard timing thinking about exercise as possibly being habitual. Unlike other behaviours studied in habit research, exercise takes a lot of time to enact, involves intense experiences of affective and physiological activation, and is complex—involving a sequencing of a lot of small, simple behaviours. How could this all be done automatically with little awareness or intent? There have been recent advancements distinguishing between habit of the *preparation* and *instigation* of the behaviour (e.g., 'I am going to exercise now') and the subsequent *execution* (e.g., complete exercises), which help clarify what it means for exercise to be habitual (Gardner et al., 2016; Kaushal, Rhodes, Meldrum, et al., 2017; Phillips & Gardner, 2016). Typically, when considering exercise habits and its impact of frequency of future exercise behaviour, researchers are interested in capturing habitual instigation—the degree to which the initial decision to start the exercise behaviour process is habitual. Precise terminology is important in self-reported measures of habit so that respondents clearly understand what specific aspect of the exercise behaviour experience you are inquiring about (e.g., 'The decision to start exercising…').

Even if only accounting for the simple, initial decisional action of exercise behaviour, it is unlikely that habit influences exercise entirely without motivation. It is oversimplified to think of exercise as either intentional or habitual. Taken into account with recent distinctions in the conceptualizations of decisional intention (i.e. directional aim to engage in behaviour or not) versus intention strength (i.e. the degree of commitment to engaging in the behaviour or not) (Rhodes & Rebar, 2017), the refinement of exercise habit as separate instigation and execution processes helps clarify how habit and self-regulatory motivation may interact to influence behaviour. While habit and deliberative motivation may be mutually exclusive influences at any particular point in time, the complex sequence of physical activity behaviours allows for aspects of physical activity behaviour to be both intentional and habitual.

Acknowledgement R. E. R. is supported by funds from the Canadian Cancer Society, the Social Sciences and Humanities Research Council of Canada, the Heart and Stroke Foundation of Canada, and the Canadian Institutes for Health Research. A. L. R. is supported by funds from the National Health and Medical Research Council of Australia.

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