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Running Head: Theories of Physical Activity

Theories of Physical Activity Behavior Change: A History and Synthesis of Approaches

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Running Head: Theories of Physical Activity

Theories of Physical Activity Behavior Change: A History and Synthesis of Approaches

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Abstract

Background: Most people in developed countries are not physically active enough to reap optimal health benefits so effective promotion strategies are warranted. Theories of behaviour change of physical activity are essential to understand physical activity and provide an organizing framework for effective intervention. The purpose of this paper was to provide a narrative historical overview of four key theoretical frameworks (social cognitive, humanistic, dual process, socioecological) that have been applied to understand and change physical activity over the last three decades. **Methods:** Our synthesis of research included the brief history, basic efficacy, strengths, and potential weaknesses of these approaches when applied to physical activity. **Results:** The dominant framework for understanding physical activity has been in the social cognitive tradition, and it has provided valuable information on key constructs linked to physical activity. The humanistic framework for understanding physical activity has seen a surge in research in the last decade and has demonstrated initial effectiveness in both explaining and intervening on behaviour. The most recent and understudied framework for understanding physical activity is dual process models, which may have promise to provide a broader perspective of motivation by considering non-conscious and hedonic determinants of physical activity. Finally, the individual-level focus of all three of these approaches is contrasted by the socioecological framework, which has seen considerable research attention in the last 15 years and has been instrumental in understanding the role of the built environment in physical activity behaviour and critical to shaping public health policy in government. **Conclusions:** Despite the strengths of all four frameworks, we noted several weaknesses of each approach at present and highlight several newer applications of integrated models and dynamic models that may serve to improve our understanding and promotion of physical activity over the next decade. **Key Words:** Social Cognitive theories, Dual Process theories, Self-Determination Theory, Socioecological Model, Exercise

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115 Evidence continues to accumulate on the health benefits of regular physical activity (Lee et
116 al., 2012; Rebar et al., 2015; Rhodes, Bredin, Janssen, Warburton, & Bauman, 2017; Warburton &
117 Bredin, 2016). Despite this accrual of evidence and best practice recommendations, population
118 physical activity rates are modest (Hallal et al., 2012). As a result, physical activity promotion has
119 been of paramount importance for at least over a quarter of a century (Bouchard, Shephard, &
120 Stephens, 1994; Pate et al., 1995), although duly noted as critical to population health much earlier
121 (American College of Sports Medicine, 1978; Karvonen, Kentala, & Mustala, 1957). In response to
122 this call, research attempting to predict, explain, and intervene upon physical activity has followed
123 suit for over 30 years.
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134 Early physical activity psychology research was largely atheoretical. Investigators utilized
135 available measures in secondary data analysis, often at hand from physiological trial and
136 epidemiological cohort data, to predict and explain physical activity participation and adherence (see
137 Dishman, 1988 for an overview). This first-wave of research created great breadth in the use of
138 potential determinants of physical activity but rendered a list of variables that lacked cohesiveness
139 and offered little depth to these variables under study (Courneya, 2004). Further, it became apparent
140 that simply providing physical activity guidelines wherein the message was “get this much physical
141 activity” or “exercise more” was not sufficient to produce behaviour change. Rather, to enhance
142 individuals’ physical activity, we needed to consider a range of behavioural influences, both internal
143 (e.g., beliefs, cognitions) and external (e.g., social needs, contextual factors). As a consequence, the
144 application of theoretical frameworks marked a critical transitional point for the study of physical
145 activity in the late 1980s and early 1990s. Theoretical frameworks create a context for
146 understanding, explaining, and ultimately intervening upon physical activity (Michie, West,
147 Campbell, Brown, & Gainforth, 2014; Rothman, 2004). They define the variables under study,
148 provide structure among variables, overview assumptions for how the variables should operate,
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171 allow for study replication and generalization, and enable a dialog for the testing and falsification of
172
173 hypotheses. Thus, theoretical frameworks are generally considered an essential feature in physical
174
175 activity science (Rhodes & Nigg, 2011).
176

177 The purpose of this paper is to overview the main theoretical frameworks that have been
178
179 applied to understand and change physical activity over the last three decades. As the discipline of
180
181 physical activity psychology has matured, so too have the frameworks employed and the scrutiny
182
183 applied to these frameworks. Thus, we highlight four main frameworks: social cognitive approaches,
184
185 humanistic/organismic approaches, socio ecological approaches, and dual process approaches with
186
187 their historical application to physical activity from the 1980s until present day. Our intent in the
188
189 paper is not to provide a systematic review or meta-analytic approach to the efficacy of these
190
191 frameworks, as this is already readily available in the published literature (e.g., Bauman et al., 2012;
192
193 Rebar et al., 2016; Teixeira, Carraça, Markland, Silva, & Ryan, 2012; Young, Plotnikoff, Collins,
194
195 Callister, & Morgan, 2014). Instead, we provide our historical interpretation and assessment of how
196
197 and why each of these frameworks became dominant in the psychology of physical activity
198
199 discipline over a 30-year span. We overview the strengths of each approach and their potential
200
201 drawbacks. We conclude by highlighting newer applications of integrated theoretical approaches
202
203 and advancing technology that may serve to further improve our understanding and promotion of
204
205 physical activity.
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207

208 **The Social Cognitive Framework and Physical Activity**

211 The social cognitive framework evolved from a growing desire by social psychology and
212
213 developmental psychology researchers to expand beyond behaviourism to a cognitive paradigm that
214
215 involved social learning and mental representations of motivation (Atkinson, 1957; Kerlinger, 1973;
216
217 Locke, 1968). This approach was applied to health behaviours soon thereafter (Rosenstock, 1974).
218
219 The framework is based on the premise that people form, and subsequently act upon, expectancies
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226
227 of behavioural events and outcomes. In particular, valued outcomes and expectancies that carry the
228
229 most weight of importance are considered critical to subsequent action, which gave rise to the terms
230
231 expectancy value or reasoned action approaches within theories that employ the social cognitive
232
233 framework (Ajzen & Fishbein, 1977; Head & Noar, 2014). Expectancies are often given different
234
235 labels in various social cognitive theories but generally involve expectancies focused on behavioural
236
237 outcomes (pros/cons, benefits/barriers, attitudes, outcome expectations) or on one's capability to
238
239 perform the behaviour in order to derive an outcome (self-efficacy, competence, perceived
240
241 behavioural control), which subsequently are hypothesized to form an intention to act that
242
243 determines actual behavioural action (Rhodes, 2017). In other words, individuals will intend to be
244
245 physically active if they believe that (a) physical activity is important, and (b) they are truly capable
246
247 of enacting activity. Intervening upon physical activity using the social cognitive approach is
248
249 therefore assumed to follow a rational and value-based approach to appealing to one's values and
250
251 beliefs and/or building an expectation of capability via factors such as personal/observational
252
253 accomplishments, and social encouragement (Biddle & Nigg, 2000; Conner & Norman, 2015).
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255

256
257 The social cognitive framework is the dominant approach to understanding physical activity
258
259 with hundreds of observational and experimental applications (Cardinal, 2014; Rhodes & Nasuti,
260
261 2011)(see also Beauchamp & Jackson this issue). For example, the theory of planned behaviour
262
263 (Ajzen, 1991) has been applied to predict physical activity in over 100 studies (Hagger,
264
265 Chatzisarantis, & Biddle, 2002; McEachan, Conner, Taylor, & Lawton, 2011; Symons Downs &
266
267 Hausenblas, 2005). The theory of planned behaviour suggests that attitude (evaluation of a
268
269 behaviour), subjective norm (perceived social pressure to perform the behaviour) and perceived
270
271 behavioural control (ability to perform the behaviour) predicate the formation of an intention which
272
273 subsequently determines behaviour. In support of the theory, observational research shows that
274
275 attitude ($\beta = .40$) and perceived behavioural control ($\beta = .33$) have medium effects upon intention,
276
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282
283 and intention ($\beta = .42$) has a medium-sized effect upon future physical activity (McEachan et al.,
284
285 2011). Prediction of physical activity from social cognitive models has shown results of similar
286
287 magnitude in applications of other variants of the social cognitive approach such as Roger's (1983)
288
289 protection motivation theory (Plotnikoff & Trinh, 2010), Prochaska and DiClemente's (1982)
290
291 transtheoretical model (Nigg et al., 2011), or Bandura's (1998) social cognitive theory (Young et al.,
292
293 2014).

295
296 Intervention upon physical activity, however, has not been as successful as mere prediction
297
298 of physical activity using the social cognitive paradigm (Conn, Hafdahl, & Mehr, 2011; Prestwich et
299
300 al., 2014). It may be that social cognitive constructs require greater targeted focus or active
301
302 manipulation in future intervention research but results have been modest thus far. For example,
303
304 interventions targeting people's expectancies about the value of physical activity outcomes have
305
306 often not shown significant subsequent behaviour change compared to control groups in systematic
307
308 reviews (Rhodes & Pfaeffli, 2010; D. M. Williams, Anderson, & Winett, 2005) or meta-analysis
309
310 (effect size $d = -0.02$; Conn et al., 2011). Interventions targeting expectations of one's own physical
311
312 activity capability have shown small-trivial ($d = 0.14$ to 0.21) changes in behaviour (French,
313
314 Olander, Chisholm, & Sharry, 2014; S. Williams & French, 2011), and a similar outcome ($d = 0.17$)
315
316 has been shown for the effect of changes in intention on physical activity (Rhodes & Dickau, 2012).
317
318 Given the overlap among specific theories using this approach, it should come as no surprise that no
319
320 particular social cognitive theory has been more effective in producing physical activity behaviour
321
322 change than any other (Gourlan et al., 2016).

323 324 **How and why has the Social Cognitive Approach Endured?**

327
328 Adoption and application of the social cognitive framework in physical activity science
329
330 followed the rise of this approach in psychology, education, business and public health. The social
331
332 cognitive framework also links perfectly to the central rationale for studying physical activity in a
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339 public health context. Specifically, physical activity promotion is founded on its health benefits, so
340
341 theories that assume a behaviour is performed for such expected outcomes aligns with the exact
342
343 rationale for the discipline and the scientists/clinicians who pursue the discipline. The continued use
344
345 of the social cognitive framework in physical activity science, however, is likely a result of many
346
347 factors. First, social cognitive variables such as intention and self-efficacy represent reliable
348
349 correlates of physical activity (Bauman et al., 2012; Rhodes et al., 2017). Thus, certain variables
350
351 within the framework have earned their utility in predicting physical activity. Second, the
352
353 assumptions of the social cognitive framework are sensible and intuitive. As much of the study of
354
355 physical activity features exercise, which is defined as “physical activity that is planned, structured,
356
357 and repetitive and has a final ...objective of the improvement or maintenance of physical fitness
358
359 (Caspersen, Powell, & Christenson, 1985),” it stands to reason that social cognitive models that
360
361 propose purposeful and planned action based on an expected outcome would fit for the study of the
362
363 behaviour.
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365

366
367 There are also pragmatic factors that may have contributed to the dominance of the social
368
369 cognitive framework, that are not entirely based on its scientific merit as much as market forces in
370
371 research. For example, as the first framework to establish itself in physical activity psychology, it
372
373 had the benefit of collateral networks and cross-generation transmission/learning across supervisors
374
375 to their trainees. As research training is founded on a mentorship model, the social cognitive
376
377 framework would have been taught, applied, and then re-taught to perpetuate its practice and
378
379 research within the discipline. Further, from an efficiency standpoint, the social cognitive
380
381 framework was easy to proliferate in early research. It relies on questionnaire-based assessment at
382
383 an individual-level and most of these social cognitive models lend themselves to path analyses that
384
385 can be performed with cross-sectional designs or short-term prospective designs. Thus, research
386
387 accumulation is cost-effective and relatively simple in comparison to other means of measurement
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395 (e.g., environmental scans, detailed interviews, lab-based observations) and design (longitudinal
396
397 cohorts, experimental designs, etc.).

398
399 The social cognitive framework is still the dominant research approach in physical activity,
400
401 but the premise that physical activity solely a result of deliberation about values and expectancies is
402
403 now under debate (Conroy & Berry, 2017; Ekkekakis & Zenko, 2016; Rebar et al., 2016; Rhodes,
404
405 2017; Sallis et al., 2006; Sniehotta, Penseau, & Araújo-Soares, 2014). Some of the reasons for the
406
407 shift from a complete social cognitive explanation for physical activity again parrots the shifts in
408
409 other disciplines such as social psychology, education and public health, where complementary or
410
411 competitive frameworks are now developed and receiving research attention. Other reasons for this
412
413 shift include the growing concerns over the modest and short-lived effects of social cognitive
414
415 interventions (Conn et al., 2011; Foster, Hillsdon, & Thorogood, 2009), the large disconnect
416
417 between population knowledge of physical activity's benefits (Martin, Morrow, Jackson, & Dunn,
418
419 2000; O'Donovan & Shave, 2007) and population prevalence of physical activity, the discordance
420
421 between intention and behaviour that underpins this framework (Rhodes & de Bruijn, 2013), the
422
423 over-reliance on the individual as the agent of change (Sallis et al., 2016), and the efficacy of
424
425 frameworks that also highlight fast, non-conscious factors in determining physical activity (Rebar et
426
427 al., 2016). The shift has been slow. Indeed in a recent debate, the lead author of this paper jokingly
428
429 compared the social cognitive framework to the undead (i.e., zombie apocalypse), because of its
430
431 resilience under continued evidence for its inadequacies (Rhodes, 2016). Nevertheless, other key
432
433 frameworks have now begun to receive research attention and form the basis of the remainder of this
434
435 review.
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438 439 **Humanistic/Organismic Framework and Physical Activity**

440
441 Much like social cognitive theorists, early organismic and humanistic theorists also sought to
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443 move beyond the mechanistic view of human behaviour that was held by behaviourists, such as
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450
451 Pavlov (1849-1936), Watson (1878-1958), and Skinner (1904-1990). Contrary to behaviourism,
452
453 these perspectives propose that humans have inherent needs and that behaviour is not merely a
454
455 response to reinforcement or punishment. Rather, human action is thought to be motivated by an
456
457 innate drive to grow, develop, and realize one's potential—a concept often referred to as *self-*
458
459 *actualization* (Goldstein, 1995/1934; Maslow, 1943; C. R. Rogers, 1995/1961).
460

461
462 The most common theory borne out of these organismic/humanistic perspectives of growth
463
464 and development that has been applied to understanding physical activity is *self-determination*
465
466 *theory* (SDT) (Deci & Ryan, 1985, 2000). The basis of SDT is that humans are active, growth-
467
468 oriented organisms who are naturally inclined to form a unified sense of self and to integrate
469
470 themselves into their larger social structures (Deci & Ryan, 2000). SDT is comprised of five mini-
471
472 theories, including *causality orientations theory*, *goal contents theory*, *cognitive evaluation theory*,
473
474 *basic psychological needs theory*, and *organismic integration theory* (Deci & Ryan, 2002).
475

476
477 Together, these mini-theories inform our understanding of motivation by considering: (1) individual
478
479 differences in one's tendencies towards motivation (*causality orientations theory*); (2) the type of
480
481 goals that individuals strive to attain (*goal contents theory*); (3) the conditions in one's environment
482
483 that can impact one's motivation (*cognitive evaluation theory*); (4) the psychological needs that each
484
485 individual has in relation to motivation (*basic psychological needs theory*); and (5) individuals'
486
487 innate tendencies to engage in interesting activities and to refine their inner representation of
488
489 themselves (*organismic integration theory*) (Deci & Ryan, 2000; 2002).
490

491
492 Two commonly employed mini-theories that have been used to examine physical activity
493
494 behaviour include *basic psychological needs theory* (BPNT) and *organismic integration theory*
495
496 (*OIT*). The central tenet of BPNT is that humans have an innate drive to fulfill three basic, universal
497
498 needs. These include experiencing meaningful connections with other individuals in one's
499
500 environment (i.e., *relatedness*), having a sense of choice and control over one's behaviour (i.e.,
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506
507 autonomy), and feeling capable and effective when completing a task (i.e., competence). OIT posits
508
509 that motivation is considered as a continuum of self-determination, with *amotivation*—the absence
510
511 of motivation to perform a behaviour (e.g., having no desire or drive to exercise)—falling on the
512
513 lowest end of the continuum, and *intrinsic motivation*—performing an activity for its own sake (e.g.,
514
515 exercising because it is enjoyable)—at the other end of the continuum. A third general form of
516
517 motivation, *extrinsic motivation*, falls between these two ends of the continuum and involves
518
519 engaging in an activity in order to obtain some outcome that is separate from the activity itself
520
521 (Ryan, Williams, Patrick, & Deci, 2009). Four types of behavioural regulation comprise extrinsic
522
523 motivation. The least self-determined form of extrinsic motivation is *external regulation*, wherein
524
525 behaviour is controlled by some external contingency. Next, *introjected regulation* involves
526
527 behaviour that is partially internalized and controlled by emotions or self-perceptions. A more self-
528
529 determined form of extrinsic regulation is *identified regulation* whereby a behaviour is valued and
530
531 deemed important. Finally, the most self-determined form of extrinsic regulation is *integrated*
532
533 *regulation* in which a behaviour is part of one's sense of self. It is hypothesized that individuals can
534
535 experience a higher level of self-determination by fulfilling their needs of relatedness, autonomy,
536
537 and competence (Deci & Ryan, 2000, 2002). In turn, individuals whose motivation is self-
538
539 determined are more likely to then experience better levels of physical activity, health, and overall
540
541 well-being compared to those whose motivation is extrinsically controlled or altogether absent.
542
543

544
545 The hypothesized relationships between physical activity with psychological need
546
547 satisfaction as well as self-determined motivation has been evident across a range of populations
548
549 (Teixeira et al., 2012). With regard to the specific types of motivational regulation, a systematic
550
551 review by Teixeira et al. (2012) demonstrated that more autonomous forms of motivation were
552
553 consistently related to physical activity behaviour, while controlled forms of regulation were not.
554
555 Interestingly, the researchers also found that identified regulation predicted short-term adoption of
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562
563 physical activity more strongly than intrinsic motivation, while intrinsic motivation was more
564
565 predictive of long-term exercise adherence. With regard to the three psychological needs,
566
567 competence was found to be the most commonly-examined and consistent positive predictor of
568
569 exercise behaviour (Teixeira et al., 2012). More mixed findings were shown in the relationships
570
571 between exercise and autonomy, while there was often an absence of an association between
572
573 exercise and relatedness. It should be recognized that the latter finding may have emerged due to the
574
575 fact that exercise is a solitary behaviour for many individuals. As such, relatedness may be more
576
577 relevant within group exercise settings—indeed, many primary studies within these group contexts
578
579 have shown positive relationships between relatedness and exercise-related outcomes (e.g.,
580
581 engagement during PE class, intentions to be physically active outside of class; Standage, Duda, &
582
583 Ntoumanis, 2001, 2003).

586 Experimental studies have also found that SDT-based interventions can enhance physical
587
588 activity (e.g., Fortier, Sweet, O'Sullivan, & Williams, 2007; Silva et al., 2010). For example, Fortier
589
590 et al. (2007) found that physical activity behaviour was greater among individuals who received
591
592 autonomy-supportive physical activity counselling over the course of three months compared to
593
594 individuals who only received a brief counselling session at the beginning of that timeline.
595
596 Moreover, it has been demonstrated that leaders of group exercise can be trained effectively in need-
597
598 supportive communication styles, which can subsequently enhance a range of group member
599
600 outcomes (Cheon, Reeve, & Moon, 2012; Ntoumanis, Thøgersen-Ntoumani, Quested, & Hancox,
601
602 2017). For example, Cheon et al. (2012) examined the effect of an SDT-based intervention delivered
603
604 to PE teachers on an array of student outcomes. They found that, in comparison to students whose
605
606 teachers did not receive the intervention, students within the experimental condition showed greater
607
608 levels of self-determined motivation, classroom engagement, skill development, intentions towards
609
610 future activity, and academic achievement; moreover, the effect of the intervention on these
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619 outcomes were mediated by increases in psychological need satisfaction. Taken together, this
620
621 collection of research suggests that SDT not only provides a viable framework for explaining
622
623 physical activity behaviour, but can also be used to guide exercise intervention programs.
624

625 **How and why has the Humanistic Approach Endured?**

626
627 A systematic review conducted in 2012 on the relationships between SDT and physical
628
629 activity found that 53 of the included 66 papers had been published within the previous five years of
630
631 that review (Teixeira et al., 2012). This review has since been cited nearly 1000 times (according to
632
633 Google Scholar), which highlights the continued expansion of research examining physical activity
634
635 from a humanistic perspective. Why has there been such growth in this area over the past decade?
636
637 Perhaps the most obvious answer to this question—as it pertains to physical activity—lies in the
638
639 empirical support (noted above) that has been demonstrated in using humanistic-based approaches
640
641 to both explain and promote physical activity. Moreover, compared to other theories that have an
642
643 extensive number of components, the concept of self-determined motivation (from OIT) and the
644
645 three psychological needs (from BPNT) is arguably easier to teach. Indeed, as previously
646
647 mentioned, research has provided support for the efficacy of teaching key stakeholders (e.g., group
648
649 exercise leaders, PE teachers) strategies that they can utilize to help foster autonomy, competence,
650
651 relatedness, and, in turn, intrinsic motivation (Cheon et al., 2012; Ntoumanis et al., 2017).
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654

655 As with the other theories described in this paper, SDT is not without its critics. Perhaps the
656
657 most common query is whether there truly are only three psychological needs or if other needs
658
659 should be identified (Sheldon, Elliot, Kim, & Kasser, 2001). For example, although autonomy,
660
661 competence, and relatedness have emerged as the most dominant needs, Sheldon (2011) argued that
662
663 other positive psychological experiences (e.g., self-esteem, pleasure, security) explain variability in
664
665 behaviour and well-being. The impact of one such experience on exercise behaviour that has
666
667 recently been tested within the SDT framework is the concept of *variety*, which involves the
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674
675 provision or experience of diverse opportunities, activities, and behaviour (Sheldon & Lyubomirsky,
676
677 2012; Sylvester et al., 2016). Specifically, Sylvester and colleagues have found that variety is a
678
679 unique predictor (that is, independent of autonomy, relatedness, and competence) of exercise
680
681 behaviour and exercise-related well-being. This research underscores the question of whether
682
683 autonomy, relatedness, and competence truly cover the gamut of individuals' psychological needs.
684
685 Deci and Ryan (2008, p. 659) posit that the "criterion for distinguishing a need from a motive, again,
686
687 pertains to its necessity for growth, integrity, and wellness". Might there be other universal needs
688
689 that promote these necessities that have not yet been uncovered? As with any psychological theory,
690
691 SDT could evolve over time if there is an accumulation of evidence supporting the integration of
692
693 additional needs.
694

695
696 There may also be similar critiques for the motivational regulations embedded within SDT—
697
698 specifically, the four extrinsic regulations identified under OIT. That is, do the four types of
699
700 extrinsic regulation encompass all forms of behaviour that is externally controlled or only partially
701
702 internalized, or might there be others? Furthermore, self-determined motivation is said to consist of
703
704 a continuum from controlled to autonomous regulation. If motivation indeed consists of a single
705
706 continuum, then individual's motivation should fall at one point on this spectrum. However,
707
708 individuals may have more than one reason for being physically active and, as such, self-determined
709
710 motivation might be better conceptualized as involving six separate continuums rather than one
711
712 general spectrum. Indeed, participants are typically scored corresponding to the six behavioural
713
714 regulations as opposed to one score of self-determined motivation (Markland & Tobin, 2004).
715
716 Moreover, whereas some researchers have examined the independent effects of each regulation on
717
718 physical activity, others have examined the combination of these regulations by creating
719
720 "motivational profiles" for each participant (Gourlan et al., 2016). These inconsistencies in
721
722 conceptualization and measurement can create challenges in understanding how exactly motivation
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730
731 relates to physical activity behaviour—improving this consistency in future SDT studies remains a
732
733 challenge for researchers. Finally, with regard to the organismic/humanistic perspective more
734
735 broadly, a question arises as to whether humans truly act on an innate drive to grow, develop, and
736
737 realize one’s potential. Individuals could likely think of many actions that they perform each day
738
739 that do not contribute to self-actualization and flourishing but, rather, are a result of other forces of
740
741 behaviour regulation, such as those that have been learned through operant conditioning or through
742
743 hedonic motivation (Rhodes, Williams, & Conner, 2018). While physical activity is one possible
744
745 behaviour through which individuals could seek self-actualization, there are, of course, many others.
746
747 In future studies, researchers could consider physical activity in concert with other behaviours and
748
749 examine how these behaviours interact to contribute to individual flourishing.
750
751

752 **Dual Process Framework and Physical Activity**

753

754 In their most basic application, dual process frameworks are the mapping of individual level
755
756 behavioural determinants onto one of two different types of influence – *reflective* processes which
757
758 are deliberative, effortful, and intentional effects, and *non-conscious* or *automatic* processes, which
759
760 are spontaneous, harder to notice, and more difficult to control (Chaiken & Trope, 1999; Evans &
761
762 Frankish, 2009; Strack & Deutsch, 2004). Dual process frameworks put forth that reflective
763
764 processes include the conventional social-cognitive approach variables (e.g., intentions, values,
765
766 expectations), and non-conscious processes include the comparatively less understood and less
767
768 tested determinants of physical activity such as habits, automatic evaluations, automatic self-
769
770 schemas, and automatic motivation (Rebar et al., 2016; D. M. Williams & Evans, 2014). Recently,
771
772 dual process frameworks have been integrated with hedonic motivational premises (Brand &
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774 Ekkekakis, 2018; Rhodes & Kates, 2015; D. M. Williams & Evans, 2014) (see also Ekkekakis this
775
776 issue), providing insight into the reflective and non-conscious processes through which the feelings
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787 people have during (but not following) physical activity impacts their future physical activity
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789 behaviour (Rhodes & Kates, 2015).

791 Underpinning most theories of non-conscious regulation of physical activity are notions of
792
793 associative learning and connectionist models of memory. The basic premise being that memory can
794
795 be conceived as a network of associated concepts, which are activated when cues (i.e., experienced
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797 or perceived representations of a concept) are processed, and that the activation of these mental
798
799 networks of associations manifest into behavioural influences through the elicitation of urges to
800
801 approach or avoid circumstances – cognitive adaptations of humans’ fight-or-flight autonomic
802
803 responses. Conroy and Berry (2017) operationalized the influence of automatic evaluations as the
804
805 manifestations of learned associations between pleasant affective experiences and physical activity.
806
807 They go on to articulate how cues activate these associations in memory and influence the quantity
808
809 and quality of a person’s physical activity behaviour. Similarly, Rebar (2017) lays out a foundation
810
811 for understanding how non-conscious processes may be distinct but interconnected, in that they all
812
813 form an interwoven network of mental associations, such that the same cue may activate different
814
815 (coinciding or opposing) non-conscious influences on behaviour through approach or avoidance
816
817 tendencies. Most dual process theories take on a default-interventionist architecture – a preface that
818
819 people tend to act in line with their non-conscious processes (like a default setting), unless they have
820
821 sufficient motivation, opportunity, and self-control resources to inhibit them (Evans & Stanovich,
822
823 2013; Strack & Deutsch, 2004). The premise that people tend to ‘default’ to their more efficient
824
825 non-conscious motivational processes describes the psychological mechanism of action for the
826
827 effectiveness of *nudge* choice architecture interventions, in which subtle environmental or system-
828
829 level changes are made to indirectly influence decision making or behavior (Thaler & Sunstein,
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833 2008).
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843 Most physical activities studies apply dual process frameworks by simultaneously testing
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845 non-conscious and reflective processes in the prediction of behaviour, although much of the research
846
847 has been correlational (Rebar et al., 2016) (see also Hagger, this issue). Aggregate work has shown
848
849 evidence of positive associations of physical activity behaviour with habit and automatic evaluations
850
851 (Rebar et al., 2016). Self-reported habit tends to be associated with physical activity behavior with
852
853 medium-to-strong effects (fixed effects $r = 0.43$, random effects: $r = 0.44$; (Gardner, de Bruijn, &
854
855 Lally, 2011); whereas automatic evaluations tend to be associated with physical activity behavior to
856
857 a more modest degree ($r = .11$; Chevance, Bernard, Chamberland, & Rebar, 2018). Most evidence
858
859 demonstrates that the associations between these non-conscious factors and behaviour remain
860
861 significant when statistically controlling for reflective motivation. For example, in 13 of the 15
862
863 studies reviewed of self-reported habit and in 8 of the 9 studies reviewed of automatic evaluations,
864
865 the non-conscious factors remained significantly associated with physical activity behaviour after
866
867 accounting for reflective processes (Rebar et al., 2016). Although there is comparatively less
868
869 evidence, research is also suggestive of positive associations of physical activity behaviour with
870
871 automatic self-schemas (Banting, Dimmock, & Lay, 2009), automatic motivation (Williams et al.,
872
873 2018), and approach/avoidance tendencies (Cheval, Sarrazin, Pelletier, & Friese, 2016).
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877 Non-conscious influences were initially applied in physical activity science as a single-
878
879 variable supplement to social-cognitive approaches. Since then, however, more developed
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881 theoretical conceptions with more straightforward translation into behavior change efforts have
882
883 emerged. For example, Williams and Evans (2014) put forth a dual process framework (the Affect
884
885 and Health Behaviour Framework) for conceiving the effects of affect processing on behaviour,
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887 suggesting that people's future behaviour is influenced both through learned automatic associations
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889 (e.g., automatic evaluations, affective associations) and through reflective motivational processes
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891 such as affective judgments (e.g., affective forecasting, affective attitudes). This framework
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898
899 proposes that automatic affective processing is biased toward more immediate affective responses
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901 (e.g., pain and discomfort during exercise); whereas reflective processes are biased toward more
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903 distal ones (e.g., pride of accomplishment after exercising). Should non-conscious and reflective
904
905 influences conflict, the person will experience affectively charged motivational states such as
906
907 craving, desire or dread. Williams and Evans (2014) also note that these processes and the impact
908
909 they will have on behaviour will be influenced by other simultaneous motivational processes for
910
911 competing behaviours (such as sedentary behaviour) and incidental affect (such as current mood).
912

913 **How and why has the Dual Process Approach Endured?**

914
915 In early research, dual process models served as one solution for the revelation that not all
916
917 physical activity was predicted by intentions. It also allowed for a rationalization of the strong link
918
919 between past and future physical activity that was powerfully present even after accounting for
920
921 intentions and self-efficacy (Hagger et al., 2002). However, as evidence emerged showing consistent
922
923 links between non-conscious processes and physical activity behaviour, theory has evolved. It must
924
925 be noted that, although it would make researching physical activity motivation easier, unfortunately,
926
927 the binary distinction of physical activity determinants as being either reflective or non-conscious is
928
929 likely an oversimplification of the felt experience of interconnected complex, multifaceted
930
931 cognitive, neurological and physiological processes (Melnikoff & Bargh, 2018). It is probably more
932
933 accurate to describe influences as being automatic to a certain degree on a continuum somewhere
934
935 between completely reflective or completely non-conscious. As such, dual process frameworks
936
937 should be considered a heuristic for conceptualizing the relative efficiency and automaticity of types
938
939 of influences on physical activity rather than as a defined theory with a specific set of constructs and
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941 operational pathways. That physical activity science is now more attuned to the non-conscious
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943 influences on behaviour opens up new opportunities for how to intervene with physical activity
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945 behaviour.
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955 With the infant state of this area of research comes limitations that have yet to be overcome.
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957 For example, the field is awash with a hodgepodge of terminology issues (e.g., the terms ‘implicit’,
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959 ‘automatic’, ‘impulsive’, and ‘non-conscious’ are pretty much used interchangeably; ‘habit’
960
961 continues to be used as a synonym for frequent behaviour). The most rigorously disputed weakness
962
963 of the field surrounds measurement issues. Measurement of non-conscious constructs requires
964
965 making inferences about processes that people may not have full awareness. As a result, these
966
967 constructs are typically assessed implicitly, with measures not requiring subjective reporting of the
968
969 direct target construct (Gawronksi & De Houwer, 2007). For example, automatic evaluations are
970
971 primarily assessed through inferences about people’s response times and accuracy on two-choice
972
973 timed response tasks (Greenwald, McGhee, & Schwartz, 1998). There is skepticism and controversy
974
975 regarding the psychometric soundness of these response-timed measures (De Houwer, Teige-
976
977 Mocigemba, Spruyt, & Moors, 2009; Fiedler, Messner, & Bluemke, 2006). In addition, the ‘low-
978
979 hanging fruit’ of measurement controversy of non-conscious processes of physical activity is that
980
981 habit continues to be primarily assessed through self-report (Hagger, Rebar, Mullan, Lipp, &
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983 Chatzisarantis, 2015; Sniehotta & Pesseau, 2011). Self-report measures of habit could be
984
985 interpreted as implicit, such that indirect inferences are made about habit strength from people’s
986
987 reported experiential symptoms of habit (Rebar, Gardner, Rhodes, & Verplanken, in press);
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989 however, psychometric testing of the automatic nature of self-reported habit is still under developed.
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991 Advancements in research of the psychometric properties of measures of non-conscious processes is
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993 essential to ensure this area of research progresses with sound rigour.
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996 997 **Socioecological Framework and Physical Activity** 998

999 The socioecological framework is based on this premise that behaviour is the result of direct,
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1001 indirect and interactive influences from multiple levels of influence that span from the individual to
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1003 environment and social policy. The original concept for an ecological framework dates to Lewin
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1010 (1951), who observed that behaviour is a function of persons and their environments. This was
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1012 expanded by Barker (1968) to include that behaviour was both discriminable at the level of the
1013
1014 individual, but also by environmental settings. The grandfather of the contemporary socioecological
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1016 framework, however, is Bronfenbrenner (1979), whose ecological systems model posited there are
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1018 multiple levels of influence from the environment that influence a person's behaviour. This has been
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1020 adapted slightly for health behaviour to include five layers that form concentric rings: an
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1022 intrapersonal core (e.g., age, sex, cognitive processes), an interpersonal level (persons and groups),
1023
1024 an organizational level (clubs, schools, churches, etc.), a community level (community, environment
1025
1026 structure), and a policy level (public policies from local to federal) (McLeroy, Bibeau, Steckler, &
1027
1028 Glanz, 1988; Stokols, 1992).
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1031
1032 Application of the socioecological model to physical activity has focused heavily on the
1033
1034 environmental settings level, perhaps because the social- and individual- level rings of the model
1035
1036 have received so much attention in other approaches (e.g., social cognitive, humanistic) in physical
1037
1038 activity science (Biddle & Nigg, 2000). It should be noted here that the socioecological framework
1039
1040 is entirely complementary with individual-level approaches as they merely place individuals as
1041
1042 actors amidst broader systems (Sallis, Owen, & Fisher, 2015; Sniehotta et al., 2017). Overall, there
1043
1044 are many reviews of the literature linking physical activity to environmental features of the built
1045
1046 environment such as land-mix use, street or pedestrian network connectivity, safety, quality of
1047
1048 physical activity infrastructure, and aesthetics (Araujo, Brymer, Withagen, & Davids, in press; e.g.,
1049
1050 Ferdinand, Biasakha, Raturkar, Engier, & Menachemi, 2012; McCormack & Shiell, 2011; Van
1051
1052 Holle, Deforche, & Van Cauwenberg, 2012). The effect sizes for these environment-behaviour
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1054 relationships are generally small ($r < .20$) and sometimes inconsistent across these reviews.
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1058 The relative magnitude of association between the different levels of influence in
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1060 socioecological models on physical activity has not been systematically reviewed, though
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1067 comparative effect sizes suggest that the individual-level factors provide the largest contribution
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1069 (approx. $\beta = .20$ to $.50$) compared to the social and built environment (approx. $\beta = .05$ to $.30$),
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1071 though all levels can have independent associations as per the tenets of the framework (Giles-Corti
1072
1073 & Donovan, 2002; McCormack, Friedenreich, Giles-Corti, Doyle-Baker, & Shiell, 2013; McNeill,
1074
1075 Wyrwich, Brownson, Clark, & Kreuter, 2006; Rhodes, Brown, & McIntyre, 2006; Sallis, Saelens,
1076
1077 Frank, Conway, & Cain, 2005). The interaction hypothesis among levels of influence upon physical
1078
1079 activity has received recent systematic review (Rhodes, Saelens, & Sauvage-Mar, 2018). Overall,
1080
1081 there were few examples that the built environment interacted with individual social cognition to
1082
1083 explain physical activity. There were two exceptions with interactions in the small effect size range
1084
1085 ($R^2 < .03$). First, larger intention-behaviour relations were observed under conditions where access
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1087 to recreation was close compared to far away. Second, those individuals who did not enjoy physical
1088
1089 activity were more likely to be active under conditions of better environmental aesthetics compared
1090
1091 to those who enjoyed physical activity (who had no such increase). Taken together, the
1092
1093 socioecological framework has supportive, though sometimes inconsistent, observational evidence
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1095 for its assumptions that physical activity is a result of direct, indirect and interactive influences from
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1097 multiple levels of influence.
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1100 **How and why has the Socioecological Approach Endured?**

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1102
1103 The dominance of the individualist focus of the social cognitive framework in physical
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1105 activity science in the 1990s left a vacuum for understanding behaviour through the environment
1106
1107 and policy that was filled by the socioecological framework (Sallis & Owen, 1997). This mimicked
1108
1109 the rise of this approach in public health and the importance of social determinants of health more
1110
1111 generally (Stokols, 1992). Growth trajectory in research interest in the built environment and
1112
1113 physical activity was dramatic. Over 30% of all published research in physical activity featured
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1115 environmental variables during the first decade of the new millennium (Rhodes & Nasuti, 2011).
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1123 Indeed, a socioecological approach to understanding physical activity has almost become
1124
1125 synonymous with the built environment even though this is not an accurate appraisal of the
1126
1127 framework. The continued focus on the socioecological approach is likely for several reasons. First,
1128
1129 as noted in the previous section, there is evidence to support the central premise of the
1130
1131 socioecological framework that physical activity has multiple levels of potential influence. Thus, the
1132
1133 socioecological model is slowly refining its research evidence as it moves from exploratory
1134
1135 correlational studies to natural experiments and urban redesign across time (Sallis et al., 2015).
1136
1137 Second, the socioecological framework offers not only multiple levels of influence on behaviour but
1138
1139 also for a broad understanding of physical activity which often occurs within a single individual
1140
1141 across several contexts such as occupation/work, transport and leisure (Sallis et al., 2006). This
1142
1143 advances beyond the social cognitive framework, which is more inherently aligned with planned
1144
1145 physical activities such as exercise and sport (Rebar & Rhodes, in press). There are also pragmatic
1146
1147 aspects to why the socioecological model endures in physical activity science. Specifically, the
1148
1149 focus on policy and environmental levels of behaviour change provide targets for government to
1150
1151 focus on attempting to improve health outcomes. Settings-based interventions such as schools, urban
1152
1153 design, parks, and recreation facilities are targets where governments can take action (Heath et al.,
1154
1155 2012). These approaches can align with public health policies for a more environmentally friendly
1156
1157 urbanization and thus avoid blaming individuals for their roles in unhealthy behaviour. The
1158
1159 approach also aligns well with translational efforts to improve community-wide physical activity
1160
1161 promotion, rather than a small clinical focus (Estabrooks & Glasgow, 2006). In essence, the
1162
1163 socioecological framework is a perfect structure for the current ethos of western society at this time
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1165 by advocating a shared responsibility for health among all sectors.
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1168
1169 Still, the socioecological model is not without its criticisms and there are potential
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1171 weaknesses in the approach. First, while there is no question that physical activity has correlates at
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1178
1179 multiple levels of influence, these are not equally distributed in their relative contribution (Giles-
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1181 Corti & Donovan, 2002; McNeill et al., 2006; Rhodes et al., 2006). Social cognitive variables, such
1182
1183 as intention, self-efficacy, and enjoyment remain the dominant explanations for physical activity
1184
1185 (Bauman et al., 2012; Rhodes et al., 2017). This is not an inherent refutation of the socioecological
1186
1187 framework because individual factors are an important feature and interconnected with the
1188
1189 environment (Sniehotta et al., 2017). Nevertheless, it dampens the overall unique contribution of the
1190
1191 socioecological framework over and above the social cognitive approach, when additional explained
1192
1193 variances are small. Thus, in some ways, urban design interventions represent an expensive risk
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1195 because the formative research has shown such small projected effect sizes for the time, effort and
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1197 expense required to transform the environment. Second, the socioecological framework has such a
1198
1199 minimized theoretical formulation that it becomes difficult to falsify and thus refine, adapt, or refute.
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1201 Ostensibly, any variable can fit somewhere in this framework so it has no list of specific operational
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1203 constructs. It is almost a certainty that some relationship will be found with such a high probability
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1205 of family-wise error. Overall, the socioecological framework would benefit from continued
1206
1207 refinement into a series of testable theories.

1210
1211 Finally, policy intervention targets at higher levels than the individual, such as the social and
1212
1213 built environment, are laudable because they focus on providing greater opportunities for health
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1215 behaviours like physical activity (Michie, van Stralen, & West, 2011). Trying to change or
1216
1217 understand individual physical activity motivation without consideration for the opportunities
1218
1219 afforded to a person within their given circumstances is impractical (Michie, Rothman, & Sheeran,
1220
1221 2007; Rebar & Rhodes, in press; Sniehotta et al., 2017). Nevertheless, individual motivation and
1222
1223 subsequent decision-making is still fundamental to physical activity and there is no indication that
1224
1225 mere opportunity is enough to determine behaviour (Rhodes, 2017). This dilemma of when people
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1227 make a free choice against physical activity participation despite being enabled and informed
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1234
1235 represents a serious ethical temptation within the socioecological paradigm. There is a big difference
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1237 between providing opportunities to be active (Michie et al., 2011) and modifying choice architecture
1238
1239 to make physical activity more likely (Thaler & Sunstein, 2008), compared to removing
1240
1241 opportunities to choose otherwise (Duncan & Cribb, 1996; Tannahill, 2008). The balance of making
1242
1243 physical activity the sensible choice to making physical activity the only choice is something that
1244
1245 requires careful future thought in the socioecological intervention framework because it is far more
1246
1247 likely to straddle over civil liberties, free choice, and conflict with disability access than any other
1248
1249 framework in physical activity psychology.
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1251 **Future Directions and Conclusions**

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1253 As humans are complex and dynamic, the explanations for many behaviours (including
1254
1255 physical activity) are likely to be equally complex. For example, a child may engage in exercise due
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1257 to some combination of the positive reinforcement she receives from her parents (i.e., operant
1258
1259 conditioning influences), her attitudes toward exercise (i.e., from a social-cognitive perspective), the
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1261 opportunities within her surrounding environment to be active (i.e., social-ecological influences),
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1263 and her level of self-determined motivation to be active (i.e., from an organismic/humanistic
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1265 perspective). Thus, integrated theoretical frameworks across the traditions noted above likely serve
1266
1267 physical activity science best. In essence, all of the above noted frameworks have some integration,
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1269 yet several new models and adapted frameworks continue to serve this purpose. For example, one of
1270
1271 the cornerstones of the social cognitive framework is the intention construct as the primary
1272
1273 antecedent of behaviour, yet this relationship is modest (McEachan et al., 2011) and asymmetrical
1274
1275 (Rhodes & de Bruijn, 2013). Specifically, while nearly all people who engage in physical activity
1276
1277 have positive intentions to do so, only half of those with good intentions succeed in actually
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1279 performing the behaviour (Rhodes & de Bruijn, 2013). The need to bridge intention into behaviour,
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1281 has thus spawned several recent theoretical models that include the merging of different traditions,
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1291 such as the health action process approach (Schwarzer, 2008), action phases model (Heckhausen &
1292 Gollwitzer, 1987), integrated behaviour change model (Hagger & Chatzisarantis, 2014), multi-
1293 process action control framework (Rhodes, 2017), I-Change model (de Vries, Mesters, van de Steeg,
1294 & Honing, 2005) and temporal self-regulation theory (Hall & Fong, 2007), among others. All of
1295 these approaches have shown some preliminary effectiveness (Rhodes & Yao, 2015) and may be
1296 useful for physical activity promotion in the next decade.
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1303 In particular, the health action process approach (HAPA; Schwarzer, 2008) has seen
1304 considerable application in the physical activity domain over the last decade. HAPA was developed
1305 to address the intention-behaviour gap with pre-intentional constructs identical to the traditional
1306 social cognitive approach, yet it includes volitional constructs of action (where, when, how) and
1307 coping (contingencies when barriers may arise) planning as well as self-efficacy to maintain the
1308 behaviour and recover from relapse. Observational and experimental evidence suggests that the
1309 volitional constructs of HAPA, in particular, may help augment physical activity intentions as well
1310 as maintenance self-efficacy (Carraro & Gaudreau, 2011; Rhodes & Yao, 2015; Zhang, Zhang,
1311 Schwarzer, & Hagger, 2018). For example, Carraro and Gaudreau (2013) found that interventions
1312 focused on action ($\phi = 0.43$) and coping ($\phi = 0.39$) planning amounted to small effect size changes
1313 in physical activity compared to control groups who did not receive the intervention.
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1327 Theoretical frameworks are also developing by their level of abstraction and the functions
1328 they serve for physical activity science. The social cognitive tradition or humanistic tradition, for
1329 example are generally micro-theories, focused on critical interrelationships among their key
1330 constructs (i.e., all variables defined and paths accounted for, high detail). The socioecological
1331 framework, by contrast, is a macro-theory that has breadth at the expense of precision (i.e.,
1332 amorphous and all-inclusive with few defined paths). As our discipline matures, these approaches
1333 differentiate some of the basic and applied science needs required to understand and promote
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1347 physical activity. For example, micro-theories, with their focus on mediating pathways among
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1349 constructs to explain the chain of events and conditions for why physical activity occurs, are often
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1351 not a critical focus for health promoters, who merely want to know how and what to use to change
1352
1353 the behaviour. In our observations, this has often created a derision toward theory among the
1354
1355 community of applied health promoters. On the other hand, macro-level theoretical approaches, in
1356
1357 our observations, are derided by basic scientists as being too simplistic or invalid due to a lack of
1358
1359 mechanistic (internal) validity. The most noteworthy example of this case in physical activity
1360
1361 science has been the transtheoretical model (Prochaska & DiClemente, 1982), which has arguably
1362
1363 been the most successful framework to upscale to the applied sector of physical activity promotion
1364
1365 but has seen due criticism among basic scientists (Nigg et al., 2011).
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1368 A recognition of the level of scale and purpose of the theoretical framework in physical
1369
1370 activity may alleviate these previous critiques. Indeed, what may be most useful to bridge the basic
1371
1372 and applied sectors of physical activity are meso-level theoretical frameworks (Rebar & Rhodes, in
1373
1374 press; Rhodes, 2017). Meso-level theoretical approaches contain constructs with a strong evidence
1375
1376 base and some operational paths for understanding behaviour change but they are built for applied
1377
1378 science and health promoters more than basic scientists. The behaviour change wheel is an example
1379
1380 of this approach (Michie et al., 2011), as it includes key constructs thought to determine behaviour
1381
1382 (ability, motivation, opportunity) that can be subdivided to particular intervention techniques. The
1383
1384 theoretical domains framework is another example of a meso-level approach to using theory for
1385
1386 implementation science (Cane, O'Connor, & Michie, 2012). Relatedly, Lubans et al. (2017) presents
1387
1388 a model of evidence-based principles and aligned teaching strategies targeted toward practitioners
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1390 for simple delivery of effective physical activity interventions. These types of frameworks represent
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1392 important future approaches to theory in physical activity because they may service implementation
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1394 while still remaining accountable to scientific scrutiny and revision.
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1403 Finally, the most critical future impact on physical activity theory design, testing, and
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1405 refinement may come from technological developments applied to research. The theories noted
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1407 above have largely been created by theorists using deductive processes and designed for face-to-face
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1409 clinical or education-based (small group) intervention with a limited series of assessments. Analyses
1410
1411 that utilize big data and real-time data may assist to develop dynamic theoretical models, create
1412
1413 unique insights into theory development via inductive approaches, as well as lead to intervention
1414
1415 design that can more effectively capture the momentary idiographic needs of people who are
1416
1417 attempting to increase physical activity. Dynamic models explore how psychological processes
1418
1419 unfold over time and occur within or across contexts and individuals (Wright & Hopwood, 2016).
1420
1421 They are particularly well-suited for the study of physical activity because of the shifts from
1422
1423 decision, to adoption, and then to behavioural maintenance (Rhodes, 2017). In addition to the
1424
1425 dynamic nature of physical activity itself, predictors of physical activity may vary through time and
1426
1427 context, which is not captured through static assessments (Dunton, 2017, 2018). These models also
1428
1429 allow for the examination of idiographic behaviour changes (i.e., a person's change over time) that
1430
1431 may be more accurate for testing the tenets of a theory and precision in intervention compared to
1432
1433 group (nomothetic) behaviour changes (Dunton, 2017). Specifically, there has been a growing body
1434
1435 of work using dynamic models by leveraging mobile technology to develop Just-In-Time Adaptive
1436
1437 Interventions (Dunton, 2017, 2018; Nahum-Shani et al., 2016; Spruijt-Metz et al., 2015). Exploring
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1439 the effectiveness of this approach to further develop and refine current theories and interventions has
1440
1441 considerable promise.
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1445 In summary, the health benefits of physical activity are well recognized but many people in
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1447 developed countries are not physically active enough to reap optimal health benefits. Theories of
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1449 physical activity are essential to understand behaviour change and provide an organizing framework
1450
1451 for effective intervention. The purpose of this paper was to overview the main theoretical
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1459 frameworks that have been applied to understand and change physical activity over the last three
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1461 decades. The dominant framework for understanding physical activity has been in the social
1462
1463 cognitive tradition, and it has provided valuable information on key constructs linked to physical
1464
1465 activity such as self-efficacy and intention as well as demonstrating changes to behaviour when
1466
1467 applied in intervention. The humanistic framework for understanding physical activity has seen a
1468
1469 surge in research in the last decade and has demonstrated initial effectiveness in both explaining and
1470
1471 intervening on behaviour through autonomous motivation and meeting basic human needs. The most
1472
1473 recent and understudied framework for understanding physical activity is through dual process
1474
1475 models. These have promise by complementing the prior frameworks with better understanding of
1476
1477 non-conscious and hedonic determinants of physical activity and alternate approaches to
1478
1479 intervention. Finally, the individual-level focus of all three of these approaches is contrasted by the
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1481 socioecological framework, which has seen considerable research attention in the last 15 years and
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1483 focuses on the interplay between multiple levels of influence (from individual to organizational and
1484
1485 environmental policy). The socioecological model has been instrumental in understanding the role
1486
1487 of the built environment in physical activity behaviour and critical to shaping public health policy in
1488
1489 government. Despite the strengths of all four frameworks, we noted several weaknesses of each
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1491 approach at present and highlighted several newer applications of integrated models and dynamic
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1493 models that may serve to improve our understanding and promotion of physical activity.
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