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1 Child Sun Safety: Application of an Integrated Behavior Change Model

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Abstract

Objective: Childhood sun exposure increases risk of skin cancer in later life. Parents of young children play an important role in minimizing childhood sun exposure. The aim of the current study was to identify the motivational, volitional, and implicit antecedents of parents' sun-protective behaviors based on an Integrated Behavior Change model. **Methods:** Parents ($N = 373$) of 2 to 5 year-old children self-reported their intentions, attitudes, subjective norm, perceived behavioral control, autonomous and controlled motivation, action plans, habit, and past behaviors with respect to sun-protective behaviors for their children. Two weeks later ($n = 273$), the parents self-reported their participation in sun-protective behaviors for their child. **Results:** Data were analyzed using variance-based structural equation modelling. Results showed significant direct effects of attitudes, subjective norm, perceived behavioral control, and past behavior on intentions, and significant direct effects of autonomous motivation, perceived behavioral control, intentions, action planning, habit, and past behavior on parents' participation in sun-protective behaviors for their child. There were also significant total indirect effects of autonomous motivation on intentions mediated by attitudes and subjective norm. **Conclusions:** Current results indicate that parents' sun-protective behaviors toward their children are a function of motivational (autonomous motivation, intentions), volitional (action planning), and implicit (habit) factors. The findings from the current study provide formative data to inform the development of behavior change interventions to increase parents' participation in sun-protective behaviors for their children.

Key words: sun safety; children; parents; integrated behavior change model; autonomous motivation; theoretical integration; self-determination theory; theory of planned behavior

1 One in every three cancers diagnosed is a skin cancer (WHO, 2015), with Australia reported
2 as having the world's highest age-standardized incidence rate of skin melanoma (AIHW, 2012).
3 Skin cancers predominately develop as a result of a lifetime of excessive exposure to ultraviolet
4 (UV) radiation in sunlight (WHO, 2015). An estimated 50% of total UV exposure to age 60 occurs
5 before the age of 20 years, and silicone casts of the skin of teenagers aged 13–15 years in four cities
6 in eastern Australia showed 40% to 70% already had signs of UV-induced skin damage (Green,
7 Wallingford, & McBride, 2011). Childhood sun exposure and multiple sunburns are associated with
8 increased lifetime risk of skin cancer (Cancer Council Australia, 2016; Green et al., 2011). This is a
9 concern given that most children (69%) report having been sunburnt one or more times (Green et
10 al., 2011). Sun-protective behaviors such as the consistent use of sunscreen during childhood has
11 been estimated to reduce lifetime skin cancer risk by up to 80% (Stern, Weinstein, & Baker, 1986).
12 Reducing exposure to harmful levels of UV radiation in childhood is therefore vital in decreasing
13 skin cancer risk in later life (Hornung, 2000). As young children have limited capacities for self-
14 regulating their sun-protective behaviors, parental guidance is needed (Hamilton, Cleary, White, &
15 Hawkes, 2016; Hamilton, Kirkpatrick, Rebar, White, & Hagger, 2017). However, even if parents
16 are motivated to ensure their child engages in appropriate sun protection, corresponding behaviors
17 may not ensue (Hamilton et al., 2016).

18 It is well known that people who are motivated to act often do not behave according to their
19 intentions (Gollwitzer & Sheeran, 2006) and instead act 'mindlessly' or impulsively, paying little
20 attention to the reasoning behind their behavior or its consequences (Strack & Deutsch, 2004). The
21 reasons for these failures to act may be because individuals are faced with multiple impediments
22 (such as distractions and competing parenting demands, Hamilton, Spinks, White, Kavanagh, &
23 Walsh, 2016; Hamilton & White, 2010; Spinks & Hamilton, 2016) that tend to derail attempts to
24 engage in intended behaviors. If individuals are not equipped with means to meet these obstacles or
25 their cognitive capacity is low, then motivation alone will be insufficient to ensure they act on their

1 intentions. To overcome this limitation, volitional and implicit processes are thought to operate in
2 concert with and independent of motivational processes.

3 **Theoretical Bases of Behavior Change**

4 For decades, social psychologists and behavioral scientists have attempted to develop
5 comprehensive, parsimonious theoretical models that are effective in predicting people's intentions
6 and behavior. Human behavior, however, is complex with multiple processes guiding decision
7 making. Motivational models and theories such as theory of planned behavior (Ajzen, 1991) and
8 self-determination theory (Deci & Ryan, 1985); volitional, dual-process models such as health
9 action process approach (Schwarzer, 2008); and implicit, automatic theories such as reflective
10 impulsive model (Strack & Deutsch, 2004) have been attempts aimed at better understanding
11 human behavior. Researchers have also attempted to integrate and extend these models to further
12 understanding of the processes that impact health behavior engagement and maintenance (e.g.,
13 Allom, Mullan, Cowie, Hamilton, 2016; Arnautovska, Fleig, O'Callaghan, & Hamilton, 2017;
14 Hagger, Chan, Protogerou, & Chatzisarantis, 2016a; Hagger & Chatzisarantis, 2014; Hagger, Trost,
15 Keech, Chan, & Hamilton, 2017; Hamilton, Cox, & White, 2012; Reyes Fernández, Knoll,
16 Hamilton, & Schwarzer, 2016).

17 For example, Hagger and Chatzisarantis (2014) recently proposed an integrated behavior
18 change (IBC) model. The model integrates processes from key motivational theories that have been
19 previously employed to predict participation in health-related behaviors. The model outlines the
20 factors that relate to intention formation (Ajzen, 1991; Deci & Ryan, 1985), the self-regulatory and
21 volitional processes that lead to the enactment of intentions (Gollwitzer & Sheeran, 2006;
22 Schwarzer, 2008), and the non-conscious, implicit processes that lead to behavioral engagement
23 beyond an individual's awareness (Hagger, 2016; Strack & Deutsch, 2004). The integrated model
24 addresses the limitations of traditional social cognitive and motivational models that do not account
25 for volitional and implicit processes (for a complete overview of the model see Hagger &
26 Chatzisarantis, 2014). Three processes in the integrated model - motivational, volitional, and

1 implicit – are proposed to guide behavior change. The relative contribution of each process is
2 important when identifying the pathways to action and should be considered when designing
3 interventions to change behavior. To date, little research has examined how these three processes
4 operate together to explain behavior, and no attempt has been made to formally test these three
5 processes in the area of sun safety. Further, given that parents are likely to express positive attitudes
6 and intentions regarding their children’s health behaviors but fail to act consistent with their beliefs,
7 the model may shed light on the processes for these failures and point to possible strategies to
8 intervene.

9 **The Current Study and Hypotheses**

10 The aim of the current study was to test the predictions of an IBC model in the context of
11 parents’ behavior to sun protect their young children. The approach is unique as it is the first to
12 simultaneously account for three sets of processes likely to impact on behavior derived from
13 theories of motivation, social cognition, and volition: motivation, volitional, and implicit. The
14 motivational pathways are represented by the effects of motivational and social cognitive constructs
15 from the integration of self-determination theory and theory of planned behavior, respectively. The
16 volitional pathways are represented by the effects of action planning on the intention-behavior
17 relationship. The implicit pathways are represented by participants’ self-reported habit. All of these
18 processes are stated formally in a series of a priori hypotheses listed in Appendix A (supplemental
19 materials). We outline the hypotheses in the next section. The hypotheses are illustrated in Figure 1,
20 which can be used as a reference guide alongside the hypotheses listed in Appendix A to clarify
21 model predictions.

22 Turning first to the motivational effects in the proposed model, autonomous forms of
23 motivation from self-determination theory (Deci & Ryan, 1985) are hypothesized to serve as distal
24 predictors of the social cognitive antecedents of behavior from the theory of planned behavior,
25 attitudes (H₁), subjective norm (H₂), and perceived behavioral control (H₃). These effects are based
26 on previous integration of these theories consistent with the premise that autonomous forms of

1 motivation lead to adaptive outcomes because they are self-endorsed and satisfy psychological
2 needs. Attitudes, subjective norm, and perceived behavioral control are proposed to mediate
3 autonomous motivation effects on intentions and behavior because individuals are proposed to align
4 their beliefs with their motives. These effects have been supported empirically in multiple studies
5 (e.g., Hagger & Chatzisarantis, 2016; Hagger et al., 2017, 2016a,b). In contrast, controlled forms of
6 motivation are hypothesized to predict subjective norm only (H₅) and have null effects on attitudes
7 (H₄) and perceived behavioral control (H₆). Non-self determined beliefs reflect externally-
8 referenced motives, are not need satisfying and, therefore, tend not be congruent with attitudes and
9 perceived behavioral control. Conversely, as subjective norm reflects social pressure for engaging
10 in the future action, these beliefs tend to be aligned with subjective norm. Consistent with the theory
11 of planned behavior (Ajzen, 1991) and meta-analytic studies in health behavior (McEachan,
12 Conner, Taylor, & Lawton, 2012; Rich, Brandes, Mullan, & Hagger, 2016), attitudes (H₇),
13 subjective norm (H₈), and perceived behavioral control (H₉) are proposed to predict intentions; and
14 intentions (H₁₀) and perceived behavioral control (H₁₁) are proposed as predictors of behavior. The
15 model also accounts for the predictions of self-determination theory which proposes direct relations
16 of autonomous (H₁₅) and controlled (H₁₆) motivation on behavior, with support found for these
17 effects in studies in health contexts (Hagger & Chatzisarantis, 2015).

18 Consistent with theories and models that propose a volitional process that operates in a post-
19 decisional manner to facilitate the enactment of goal intentions, it is proposed that intentions would
20 predict action planning (H₁₂) and action planning would predict behavior (H₁₃). These predictions
21 are consistent with the health action process approach (Schwarzer, 2008) and previous studies
22 adopting the model across various health behaviors (e.g., Reyes Fernández et al., 2016; Zhou, Miao,
23 Hamilton, Knoll, Schwarzer, 2015). It is further proposed that action planning would moderate the
24 intention-behavior relationship consistent with the model of action phases (Gollwitzer & Sheeran,
25 2006) (H₁₇). This is based on the premise that individuals adopting planning strategies are more
26 likely to convert their good intentions into action behavior, and has been empirically supported in a

1 number of studies (Gollwitzer & Sheeran, 2006). The IBC model also predicts that individuals with
2 considerable experience with the behavior and likely to have developed a routine to engage in the
3 behavior, will have a more automatic, non-intentional pathway to behavior. These effects have been
4 predicted in studies using dual process approaches to health behavior (Hagger, 2016; Rebar et al.,
5 2016; Strack & Deutsch, 2004) and is represented by the direct effect of habit on behavior (H₁₄).
6 Finally, the effects in the model are expected to be independent of past behavior in that proposed
7 effects will hold even while controlling for past behavior. This is an important consideration given
8 the pervasive effects of past behavior on behavior in tests of psychological theories in health
9 contexts (Hagger et al., 2016a). Accordingly, past behavior is essential to evaluate whether a model
10 has efficacy in accounting for unique variance in the behavioral outcome. If past behavior
11 attenuates all model effects to trivial values, then the model would be considered redundant. In the
12 current study, it is proposed that significant effects of past behavior on all constructs in the model
13 will emerge (H₁₈).

14 A set of indirect effects consistent with the premises of the IBC model are also specified.
15 Consistent with Ajzen's (1991) exposition of the theory of planned behavior and previous research
16 (Hagger et al., 2016a), it is proposed that indirect effects of attitudes (H₁₉), subjective norm (H₂₀),
17 and perceived behavioral control (H₂₁) on behavior through intentions will emerge. Consistent with
18 the integration of the theory of planned behavior and self-determination theory, it is proposed that
19 autonomous motivation will predict intentions (H₂₂) through attitudes, subjective norm, and
20 perceived behavioral control, and predict behavior through these variables and intentions (H₂₄).
21 Empirical research has supported these indirect effects in health contexts (Hagger & Chatzisarantis,
22 2016). Similarly, the same pattern of effects for controlled motivation on intentions (H₂₃) and
23 behavior (H₂₅) is expected, but mediated by subjective norm and subjective norm and intentions,
24 respectively. This is, again, congruent with the premise that subjective norm reflects perceived
25 pressures from significant others and controlled motives reflect externally-referenced reasons for
26 action. Finally, consistent with hypotheses from the health action process approach (Schwarzer,

2008), action planning is proposed to mediate the effect of intentions on behavior (H_{26}). These effects are, however, conditional on the multiple direct effects that make up the mediation effects.

Method

Participants

Participants ($N = 373$) were residents of Queensland, Australia and comprised parents who had at least one child aged between 2 and 5 years who usually resided in the same household as the parent. Parents were independent, with only one partner from each couple completing the questionnaire. Two weeks later, 273 (73% of the baseline sample) of the parents completed the follow-up survey. Lack of time and going on school holidays were the main reasons for attrition. Participants were recruited via online advertising (e.g., online parenting forums such as “BubHub” and “Raising Children Network”, social media such as “Facebook”), face-to-face (e.g., dance schools, shopping centres), and through schools and childcare facilities. As an incentive to participate in the study, participants were offered the opportunity to enter a prize draw to win one of three double movie passes. Sample demographic characteristics are presented in Table 1.

Design and Procedure

The study was conducted at two major universities in Queensland, Australia – Griffith University and Central Queensland University. The University Human Research Ethics Committee of both universities approved the study. Data were collected between October 2014 and August 2015, with recorded UV index values during the data collection months ranging between 4-13, indicative of a UV exposure category of “moderate” to “extreme” (ARPNSA, 2017). Sun protection is highly recommended for UV index values of 3 or higher (Cancer Council Australia, 2016). The study used a correlational design with a two week behavioral follow-up. At Time 1 (T1), participants completed a questionnaire either face-to-face or on-line assessing motivational processes (autonomous and control motivation, attitudes, subjective norm, perceived behavioral control, intentions, and past behavior), volitional processes (action planning), and automatic processes (habit). Demographic variables were also collected. At Time 2 (T2), a follow-up

1 telephone call was conducted to measure the decisions parents had made regarding their children's
2 sun-protective behaviors during the previous two weeks. Consent was gained through the
3 completion of the T1 questionnaire, and consent to contact participants for the T2 follow-up was
4 given through the provision of contact details. Data across each of the time points were able to be
5 de-identified and matched using a unique code identifier created by the participant.

6 **Measures**

7 Psychological constructs were measured on multi-item psychometric instruments developed
8 using standardized guidelines and validated in previous studies and adapted for use with the target
9 behavior in the current study (Hamilton et al., 2016; Thomson, White, & Hamilton, 2012; White
10 Starfelt, Young, Hawkes, Leske, & Hamilton, 2015). Brief details of the measures are provided
11 below and a full set of items are available in Appendix B (supplemental materials). Items from each
12 instrument were used as indicators of latent variables representing each model construct in a
13 structural equation model.

14 **Sun-protective behavior.** The target behavior was *sun-protective behaviors* based on the
15 guidelines of sun protection outlined by Cancer Council Australia (2016): (a) applying SPF 30+
16 sunscreen; (b) wearing sun-protective clothing such as a hat, long-sleeved shirt, and sunglasses; and
17 (c) seeking shade between 10am and 3pm. The target behavior was to be adopted every time their
18 child was outdoors in direct sunlight for more than 10 minutes. Parents were asked to think of the
19 sun-protective behaviors they engaged in for their youngest child aged 2 to 5 years. Given that
20 adequate sun protection does not require performing of all sun-safety behaviors simultaneously
21 (e.g., if a person wears a hat, seeks shade, and applies sunscreen, long-sleeved clothing may not be
22 necessary), separate measures of individual sun-protective behaviors are not essential to reflect
23 adequate protection (Hamilton et al., 2016; White et al., 2015). Examples of sun-protective
24 measures were provided to parents and they then decided whether the measures they had undertaken
25 for their child provided sufficient sun protection.

1 At T1 and T2, sun-protective behaviors performed by the parent for their child in the
2 previous two weeks was measured using four items (e.g., “Think about the past 2 weeks. In general,
3 how often did you perform sun-protective behaviors for your child”) with responses given on 7-
4 point Likert scales ranging from *never* (1) to *always* (7). Similar measures have been used in studies
5 on sun safety (White et al., 2015).

6 **Intention.** Parent intention to perform sun-protective behaviors for their child was measured
7 using four items (e.g., “I intend to perform sun-protective behaviors for my child every time they go
8 in the sun for more than 10 minutes in the next 2 weeks”, scored (1) *strongly disagree* to (7)
9 *strongly agree*).

10 **Attitude.** Parent attitude to perform sun-protective behaviors for their child was assessed
11 using five semantic differential items (e.g., “Performing sun-protective behaviors for my child
12 every time they go in the sun for more than 10 minutes during the next 2 weeks would be... *bad* –
13 *good*”, scored (1) to (7).

14 **Subjective norm.** Subjective norm was measured using five items assessing how likely
15 parents’ believe important others in their life would want them to perform sun-protective behaviors
16 for their child (e.g., “Those people who are important to me would want me to perform sun-
17 protective behaviors for my child every time they go in the sun for more than 10 minutes in the next
18 2 weeks”, scored (1) *strongly disagree* to (7) *strongly agree*).

19 **Perceived behavioral control.** Perceived behavioral control was assessed using four items
20 measuring parents’ level of self-efficacy and control over performing sun-protective behaviors for
21 their child (e.g., “I have complete control over whether my child’s sun-protective behaviors are
22 performed every time they go in the sun for more than 10 minutes in the next 2 weeks”, scored (1)
23 *strongly disagree* to (7) *strongly agree*).

24 **Autonomous and controlled motivation.** An adapted version of Ryan and Connell’s (1989)
25 measure of perceived locus of causality was used to measure parents’ autonomous and controlled
26 motivation to perform sun-protective behaviors for their child. Participants were presented with

1 initial instructions: “The following questions relate to the reasons why you would perform sun-
2 protective behaviors for your child every time they go in the sun for more than 10 minutes.
3 Different people have different reasons for doing that, and we want to know how true each of the
4 following reasons is for you”. They were next presented with a common stem: “The reason I would
5 perform sun-protective behaviors for my child every time they go in the sun for more than 10
6 minutes is:...” followed by four reasons for autonomous motivation (e.g., “...because it is very
7 important for my child being as healthy as possible”) and four reasons for controlled motivation
8 (e.g., “...because others would be upset with me if I did not”). Responses were measured on seven-
9 point scales ranging from (1) *not at all true* to (7) *very true*.

10 **Action planning.** Action planning was measured by four items developed by Sniehotta,
11 Schwarzer, Scholz, and Schuz (2005) and assessed the extent to which parents had made a plan in
12 relation to performing sun-protective behaviors for their child every time they go in the sun for
13 more than 10 minutes during the next 2 weeks. Participants were required to respond to the stem: “I
14 have made a plan regarding...” followed by the four items of the scale (e.g., “...when to perform
15 sun-protective behaviors for my child”) on Likert scales ranging from *not at all true* (1) to *exactly*
16 *true* (7).

17 **Habit.** The 12-item Self-Report Habit Index (Verplanken & Orbell, 2003) was used to
18 measure the extent to which child sun-protective behaviors were performed habitually by parents.
19 Participants were required to respond to the stem: “Performing sun-protective behaviors on my
20 child is something...” followed by the 12 items of the scale (e.g., “...I do frequently”) on Likert
21 scales ranging from *strongly agree* (1) to *strongly disagree* (7).

22 **Demographic variables.** Participants self-reported their gender, age in years, number of
23 children, highest education level (junior school, senior school, TAFE/high school diploma,
24 university undergraduate degree, university postgraduate degree), ethnicity (Caucasian,
25 Indigenous/Torres Strait Islander, Asian, Pacific Islander, African, other), employment status
26 (currently unemployed/full-time caregiver, currently employed full-time, part-time/casual

1 employed, full-time/part-time student), and family income (zero-\$18,000, \$18201-\$37,000, \$37001-
2 \$80,000, \$80,001-\$180,000, \$180,000+). For subsequent analyses, these variables were represented
3 as dichotomous dummy-coded variables for highest education level (1 = university undergraduate
4 degree, university postgraduate degree; 0 = primary school or secondary school or TAFE/high
5 school diploma), ethnicity (1 = Caucasian; 0 = non-Caucasian), employment status (1 = currently
6 employed full-time; 0 = currently unemployed/full-time caregiver or employed part-time/casual
7 employed or full-time/part-time student), and family income (1 = zero-\$18,000; 0 = \$18201-
8 \$37,000 or \$37001-\$80,000 or \$80,001-\$180,000 or \$180,000+).

9 **Data Analysis**

10 We used variance-based structural equation modeling (VB-SEM) to test our hypothesized
11 model. VB-SEM is similar to covariance-based SEM in that it explicitly models measurement error
12 using latent factors. However, VB-SEM is based on ranked data and is, therefore, distribution-free
13 and less affected by model complexity, sample size, or non-normality. This makes it optimal for use
14 in the current analysis given the complexity of the model and the greater statistical power offered by
15 the VB-SEM method. Models were estimated using the Warp PLS v5.0 software (Kock, 2015).
16 Missing data were treated using stochastic hierarchical regression imputation which has been shown
17 to minimize standard errors in simulations with the amount of data replaced ranging from 0.37% to
18 1.10% across all variables (Kock, 2015). Items from the measures of the psychological and
19 behavioral constructs were set as indicators of latent variables. All paths among constructs of the
20 proposed model detailed in Figure 1 and Appendix A (supplemental material) were specified as free
21 parameters in the model. In addition, paths were included from the demographic variables to each
22 of the psychological and behavioral variables in the model to statistically control for these variables.

23 Validity of the proposed measures was assessed by observing the parameters of the
24 measurement aspects of the SEM. The loading of each indicator on its respective latent factor was
25 expected to exceed .700. Composite reliability coefficients (ρ) and average variance extracted
26 (AVE) statistics, which test the sufficiency of scale items as indicators the latent variables and

1 whether the items account for sufficient variance in the factor, both indicators of construct validity,
2 were expected to exceed .700 and .500, respectively. Discriminant validity of latent variables was
3 confirmed if the square-root of the AVE of the variable was larger than its correlation with the other
4 variables in the model.

5 Overall goodness of fit of the proposed model was evaluated using multiple criteria: the
6 goodness-of-fit (GoF) index with values of .100, .250, and .360 corresponding to small, medium,
7 and large effect sizes, respectively (Tenenhaus, Vinzi, Chatelin, & Lauro, 2005), the average path
8 coefficient (APC) and the average R^2 (ARS), both of which should be significantly different from
9 zero for an adequate model, and the average variance inflation factor for model parameters (AVIF)
10 statistic, with values less than 5.000 indicating a well-fitting model (Kock, 2015). Hypothesized
11 mediation effects were tested by calculating indirect effects using a bootstrap resampling method
12 with 100 replications.

13 Results

14 Participants

15 Demographic characteristics of the sample at the two time points are presented in Table 1.
16 Data were missing from 100 participants due to absences at either time point, resulting in a final
17 sample of 273 participants (females = 238; males = 35, M age = 34.80, SD = 5.21). Attrition
18 analyses indicated that there were no significant differences in number of children ($t(371) = 0.495$,
19 $p = .062$, $d = 0.051$), age ($t(371) = 1.73$, $p = .084$, $d = 0.179$), highest education level ($\chi^2(1) = 0.567$,
20 $p = .452$, $d = 0.077$), or psychological and behavioral variables (attitudes, subjective norm,
21 perceived behavioral control, intentions, autonomous motivation, controlled motivation, action
22 planning, habit, and past behavior) measured at the first time point (Wilks' Lambda = .966,
23 $F(9,352) = 1.379$, $p = .196$, $d = 0.122$) between participants that dropped out of the study and those
24 who completed the T2 assessment. There were, however, differences in gender distribution ($\chi^2(1) =$
25 6.87 , $p = .009$, $d = 0.274$), ethnic distribution ($\chi^2(1) = 9.11$, $p = .003$, $d = 0.315$), employment status
26 ($\chi^2(1) = 19.25$, $p < .001$, $d = 0.465$), and family income ($\chi^2(1) = 4.34$, $p = .009$, $d = 0.217$). There

1 was a greater proportion of females, non-Caucasians, full-time employees, and high income earners
2 among participants that dropped out relative to those that remained in the study.

3 **Preliminary Analyses**

4 Measurement model statistics from the VB-SEM confirmed that the latent variables met
5 criteria for construct and discriminant validity. Factor loadings for each latent factor are presented
6 in Appendix C (supplemental materials). All loadings exceeded the .700 criterion supporting the
7 validity of the factors. The only exception was one item for the SRHI, but given this factor was
8 indicated by 12 items, the errant loading was not considered a threat to validity. Composite
9 reliability coefficients, AVE, and intercorrelations for model variables are presented in Table 2.
10 Reliability coefficients exceeded the .700 criterion and AVE values exceeded the recommended
11 .500 criterion for all factors. Factor correlations among the latent variables also indicated no
12 problems with discriminant validity. Goodness of fit statistics revealed acceptable overall fit of the
13 model with the data according to the multiple indices adopted (GoF Index = .527; APC = .111, $p =$
14 .016, ARS = .337, $p < .001$; AVIF = 1.195).

15 **Model Effects**

16 Standardized parameter estimates for tests of hypothesized structural relations among the IBC
17 model factors identified in Figure 1 and Appendix A (supplemental materials) are presented in
18 Figure 2. A full breakdown of estimates including direct, indirect, and total effects are presented in
19 the table in Appendix D (supplemental materials). In addition, effects of control variables in the
20 model are available in a separate table in Appendix E (supplemental materials). Autonomous
21 motivation had statistically significant direct effects on attitudes (H_1), subjective norm (H_2), and
22 perceived behavioral control (H_3), as predicted. Controlled motivation had a statistically significant
23 effect on subjective norm (H_5), and no effect on attitudes (H_4) and perceived behavioral control (H_6)
24 consistent with hypotheses. This suggests that parents who endorsed more self-determined reasons
25 for acting were more likely to hold positive attitudes, perceived control, and normative beliefs for
26 engaging in sun-protective behaviors for their children. As predicted, attitudes (H_7), subjective

1 norm (H₈), and perceived behavioral control (H₉) were all statistically significant positive predictors
2 of intentions. These results suggest that parents' attitudes, perceptions of control, and beliefs about
3 norms with respect to sun-protective behaviors for their children directly impacted their self-
4 reported intentions to engage in such behaviors. There were also statistically significant positive
5 effects of intentions on behavior (H₁₀) and action planning (H₁₂), and of action planning on behavior
6 (H₁₃), as hypothesized. It seems that parents who form intentions and action plans for sun-protective
7 behaviors for their children are more likely to report having engaged in those behaviors. In addition,
8 perceived behavioral control (H₁₁) and habit (H₁₄) were significant predictors on behavior, as
9 hypothesized. Autonomous motivation was also a significant direct predictor of behavior (H₁₅),
10 consistent with our hypothesis. There was no statistically significant direct effect of controlled (H₁₆)
11 motivation on behavior, so this hypothesis was rejected. Also, contrary to hypotheses (H₁₇), action
12 planning did not moderate the intention-behavior relationship. Past behavior statistically
13 significantly predicted all variables in the model as hypothesized (H₁₈).

14 Turning to the hypothesized indirect effects, there were no statistically significant indirect
15 effects of attitudes (H₁₉), subjective norm (H₂₀), and perceived behavioral control (H₂₁) on behavior,
16 leading to a rejection of these hypotheses. There was, however, a significant total indirect effect of
17 autonomous motivation on intentions mediated by attitudes, subjective norm, and perceived
18 behavioral control consistent with our hypothesis (H₂₂, $\beta = .180$, $p = .001$). Parents who hold
19 autonomous motives to engage in sun-safety behaviors are more likely to form intentions to engage
20 in those behaviors because their beliefs are aligned with their motives and intentions accordingly.
21 There was, however, no total indirect effect of controlled motivation on intentions through
22 subjective norm, so this hypothesis was rejected (H₂₃, $\beta = .039$, $p = .260$). There was no significant
23 total indirect effect of autonomous motivation on behavior through attitudes, subjective norm,
24 perceived behavioral control, and intentions, leading to a rejection of our hypothesis (H₂₄, $\beta = .044$,
25 $p = .231$). Similarly, controlled motivation did not significantly predict behavior through subjective

1 norm and intentions (H_{25} , $\beta = .007$, $p = .426$). Finally, there was no indirect effect of intentions on
2 behavior through action planning, so this hypothesis was also rejected (H_{26} , $\beta = .023$, $p = .296$).

3 **Discussion**

4 The aim of the current study was to test the predictions of an IBC model (Hagger &
5 Chatzisarantis, 2014) with respect to parents' sun-protective behaviors for their children. The model
6 identified key processes derived from multiple theoretical models of motivation, social cognition,
7 and volition and adopted hypotheses from self-determination theory, theory of planned behavior,
8 the health action process approach and action-control theory, and dual process models of action.
9 Results indicated significant effects of motivational, volitional, and implicit factors on parents'
10 intentions and behavior to engage in sun-protective behaviors for their children. Intentions,
11 perceived behavioral control, and autonomous motivation had small but significant direct effects on
12 behavior. Action planning and habit were also direct predictors of behavior, also with small effect
13 sizes, supporting the effects of volitional strategies and implicit processes. The relative contribution
14 of intentions, action planning, and habit on behavior were similar, indicating that each process
15 appears to have independent effects on behavior. Importantly, the effects were independent of past
16 behavior, so these psychological factors account for unique variance in behavior, regardless of
17 previous experience.

18 A key contribution of the current research is the confirmation of multiple pathways by which
19 parents' psychological constructs affect sun-protective behaviors toward their children. Consistent
20 with the social cognitive and motivational theoretical components that comprise the
21 deliberative/reasoned component of the IBC model, belief-based (e.g., attitudes) and motivational
22 (autonomous motivation) factors predicted the sun safety behavior of parents for their children.
23 However, we also found that volitional and implicit processes accounted for significant variance in
24 behavior, independent of the deliberative component. Specifically, it seems that both action
25 planning and habit are important unique predictors of behavior. It is interesting, however, that

1 planning did not account for the intention-behavior effect, as predicted by the health action process
2 approach (Schwarzer, 2008), but predicted behaviour directly.

3 A number of potential interpretations of this pattern of effects exist. It is possible, for
4 example, that all of these effects are present simultaneously for all participants, such that the
5 behavior is controlled, in part, by all three processes at once. A more likely interpretation, however,
6 is that the different processes impact behavior for specific groups of people with certain
7 characteristics with sufficient strength to present as non-trivial effects at the group level. In other
8 words, some participants' behavior may be more controlled by deliberative effects while others may
9 be more influenced by volitional or implicit factors. This trade-off between deliberative and
10 volitional or implicit factors likely occurs between people as well as within people, shifting across
11 time as behaviors become more habitual. The critical question arising from this interpretation is
12 what conditions determine the processes that control the behavior. In other words, what moderator
13 or set of moderators will determine whether the deliberative and intentional, volitional, or implicit
14 processes predominate in determining parents' sun-protective behavior toward young children?

15 In the current research, such moderators were unmeasured. Future studies, therefore, would
16 need to systematically identify candidate moderators of these processes and test their impact within
17 an analysis of the validity of the nomological network (Hagger et al., 2016). For example,
18 individual difference factors such as capacity of self-regulation or conscientiousness may moderate
19 the impact of the intentional pathways on behavior. Self-control or affective states may moderate
20 the within-person links between intentions and behavior. The inclusion of such moderators, which
21 have yet to be specified in the IBC model but have been explored in other tests of the component
22 theories (Rhodes, Courneya, & Jones, 2002), may further elucidate the factors that magnify or
23 diminish the proposed processes on behavior according to the model.

24 The current research also has ramifications for improving sun protection behavior. Based on
25 the findings that motivational, volitional, and implicit factors are all key processes in sun-protection
26 behavior of parents toward their children, future interventions and campaigns should target all three

1 processes to increase sun-protective intentions and behavior of parents for their young children,
2 ideally using a multifaceted approach. Ongoing Australian community-based campaigns (e.g.,
3 “SunSmart”) are aimed at improving the awareness and knowledge about UV exposure and
4 messages have, to a large extent, taken the form of education and risk awareness (e.g., “UV. It all
5 adds up” - a recent campaign aimed at increasing people’s awareness of the risk of developing skin
6 cancer through incidental exposure to UV radiation) and reminders to be sun safe (e.g., “Slip [on
7 sun-protective clothing]! Slop [on SPF 30+ sunscreen]! Slap [on a broad brimmed hat]! Seek
8 [shade]! Slide [on sunglasses]!”). Community and nation-wide programs have established an
9 improvement in attitudes and behavior over time which corresponds with the public campaigning of
10 these sun-safe messages (e.g., Volkov et al., 2013), and some programs for parents have been
11 shown to increase sun protection for their children (Dadlani & Orlow, 2008). However, reviews on
12 health behavior interventions suggest that the evidence relates more to short-term effects rather than
13 sustained, longer-term impact (Jepson, Harris, Platt, & Tannahill, 2010). Further, it is suggested that
14 multi-component programs achieve greater success in changing behavior (Chase, 2015; Dadlani &
15 Orlow, 2008). Given that current interventions more commonly employ motivational as opposed to
16 structural or environmental strategies to change behavior, the findings of the current study suggest
17 that future interventions should complement techniques targeting motivation and planning with
18 structural and environmental strategies (e.g., prompts or cues to activate implicit constructs for
19 desired behaviors or structuring the environment so as to make unwanted behaviors difficult), which
20 would either activate implicit factors that lead to sun-protective habits or prevent individuals acting
21 ‘mindlessly’. By identifying key theory-based constructs, the findings of the current study can be
22 translated into practice by linking key predictors identified with relevant behavior change
23 techniques (see Kok et al., 2016), to develop effective empirical- and theory-based interventions to
24 facilitate parents provision of sun-protection for their young children.

25 Based on the findings of the current study there are some specific strategies to consider when
26 understanding parental sun protection decisions for young children. First, parents should be

1 provided with choices for performing such behaviors to instil a sense of internal value and interest
2 toward sun protecting their children, thus improving parents' ratings of their beliefs toward
3 behavioral performance. This strategy is particularly important given that self-determined
4 motivation drives parents' intentions via their social-cognitions. Second, strategies to increase
5 parents' attitudes (e.g., information giving), perceptions of social norms (e.g., social support
6 provisions), and perceptions of control (e.g., behavioral modelling) should be considered to promote
7 intentions as a direct predictor of behavior. Third, given volitional and implicit processes also
8 emerged as direct predictors of behavior, these processes are also important to consider. Engaging
9 parents in formulating plans for sun-safety, monitoring their behavior, and providing cues to action
10 may facilitate greater participation in sun protection behaviors by parents for their children.

11 **Strengths and Limitations**

12 To date, there is a dearth of research that has investigated how motivational, volitional, and
13 implicit processes operate to explain behavior or that attempted to integrate these multiple processes
14 into a testable model. The current study was the first to apply a comprehensive IBC model to the
15 area of sun safety. However, as is the case with most correlational research designs, we recognize
16 that our results do not permit the inference of causality on the basis of the data, only theory. Future
17 research that attempts to manipulate theoretical constructs and measures their influence on behavior
18 change is essential in supporting the tenets of the IBC model for this behavior. The current research
19 does, however, highlight important potential routes to behavioral engagement, which can be used as
20 a basis for interventions that may be efficacious in eliciting behavior change. Moreover, the current
21 study focused on a key target group, parents of young children, whose decisions play an important
22 role in the enforcement and adoption of their children's sun-protective behaviors (Hamilton et al.,
23 2016; Thomson et al., 2012). In addition, a large community-based sample of parents from a region
24 with a high risk of skin cancer was obtained. These findings and future strategies could be used for
25 not only other high risk populations but for various risk populations as well.

1 Despite these strengths, the results should be considered in light of some limitations.

2 Although various sampling methods were used, the sample predominately comprised married

3 Caucasian mothers and the attrition rate was 27%, with a greater proportion of females, non-

4 Caucasians, full-time employees, and high income earners remaining in the study. Although other

5 studies have found attrition to be higher among parent samples and involving multiple follow-ups

6 (Hamilton, Daniels, Murray, White, & Walsh, 2012; Thomson et al., 2012; Walsh, Hamilton,

7 White, & Hyde, 2015), current results may not generalize across other family structures and cultural

8 groups and reflect predominately the decision making processes of mothers. Measurement

9 limitations also need to be taken into account when interpreting the findings. The study used self-

10 report measures of sun-protective behavior, which may be susceptible to social desirability and

11 recall bias. This was evident by the high means of both intentions and follow-up behavior observed

12 in the current study, contrasting to empirical research which suggests fewer than 50% of parents

13 reported providing regular sun protection for their children (Johnson, Davy, Boyett, Weathers, &

14 Roetzheim, 2001). Further, reporting behavior via a telephone follow-up may have induced demand

15 characteristics, inflating estimates of sun-protective behavior. Although there is no gold standard for

16 measuring sun protection behavior (Dadlani & Orlow, 2008), self-report, prospective diaries, and

17 observation techniques show small positive correlations (Buller & Borland, 1999). In addition,

18 previous research demonstrates an acceptable overlap between self-report and objective measures of

19 sun exposure as well as sun-protective behaviors (Hillhouse, Turrisi, Jaccard, & Robinson, 2012).

20 Also, the item stems of the TPB measures were devised specifically for the target behaviour (albeit

21 adapted from established TPB guidelines and similar TPB studies). Ideally, some preliminary pilot

22 testing of these measures would have ensured that the scales were valid and reliable prior to their

23 use in the current investigation. Finally, in the current study all the sun-protective behaviors were

24 combined in an overall measure of sun protection. This decision was made based on previous

25 research suggesting that adequate sun protection does not require performing of all sun-protective

26 behaviors simultaneously and, thus, separate measures of individual sun-protective behaviors are

1 not essential to reflect adequate protection (Hamilton et al., 2016; White et al., 2015). Nevertheless,
2 given sunscreen is reported as the most common method of sun protection that parents use for their
3 children (Johnson et al., 2001), it may be advantageous for future research to identify parents'
4 specific intentions and behaviors by examining individual sun-protective behaviors.

5 **Conclusion**

6 The current study tested an IBC model in a sun safety context. Overall, we found support for
7 the majority of the core proposed effects among the motivational, volitional, and implicit factors in
8 the model, as well as their effects on parents' behavior for their children's sun protection. The
9 current study fills a significant knowledge gap in the literature on the multiple processes that guide
10 health behavior and suggests that the IBC model may have utility in explaining health behavior.
11 Future research should investigate possible moderators to establish which of the motivational,
12 volitional, or implicit processes predominate in determining action. Despite the correlational design
13 of the current study, findings suggest multiple potential routes to behavioral performance that can
14 serve as a basis for the development of future sun safety interventions that are efficacious in
15 eliciting behavior change. Future interventions aimed at improving sun-protective practices of
16 parents for their children should therefore consider the application of an IBC model and the
17 multiple-processes it advocates as necessary for motivated action.

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Table 1
Child Sun Safety: Demographic Data and Descriptive Statistics for Study Variables Across Time Points

Variable	Time 1	Time 2
Participants	373	273
Age, <i>M</i> years (SD)	35.09 (5.39)	34.80 (5.21)
Parent gender (<i>n</i> female, <i>n</i> male)	314, 59	238, 35
Child gender of youngest child aged 2 to 5 years (<i>n</i> female, <i>n</i> male)	192, 181	138, 135
Employment status		
currently unemployed/full-time caregiver	78	65
currently employed full-time	141	85
part-time/casual employed	126	100
full-time/part-time student	28	23
Ethnicity		
Caucasian	335	253
Indigenous/Torres Strait Islander	8	5
Asian	10	2
Pacific Islander	5	3
African	8	7
Other	7	3
Income ^a		
zero-\$18,000	8	6
\$18201-\$37,000	21	20
\$37001-\$80,000	72	49
\$80,001-\$180,000	215	165
\$180,000+	54	32
Education level ^b		
Junior school	9	8
Senior school	41	27
TAFE/diploma	104	75
University undergraduate degree	132	100
University postgraduate degree	85	62
Psychological variables, <i>M</i> (SD)		
Attitude	5.82 (1.04)	5.90 (1.10)
Subjective norm	5.91 (0.93)	6.23 (0.69)
Perceived behavioral control	5.73 (1.13)	5.89(0.96)
Intention	6.24 (0.91)	6.43 (0.69)
Autonomous motivation	6.25 (0.97)	6.41 (0.68)
Controlled motivation	4.04 (1.52)	4.41 (1.24)
Action planning	4.94 (1.51)	5.18 (1.46)
Habit	4.78 (1.22)	5.01 (1.28)
Past behavior	5.41 (1.49)	5.70 (1.31)
Behavior	–	5.64 (1.34)

Note. ^aThree participants did not report their income; ^bTwo participants did not report their education level.

Table 2

Child Sun Safety: Measurement Model Statistics and Factor Intercorrelations for Integrated Behavior Change Model Latent Variables

Variable	AVE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Attitude	.680***	.914														
2. Sub. norm.	.591***	.314***	.876													
3. PBC	.580***	.361***	.330***	.847												
4. Intention	.840***	.521***	.473***	.463***	.955											
5. Past behavior	.844***	.388***	.375***	.296***	.461***	.956										
6. Behavior	.825***	.336***	.321***	.298***	.442***	.667***	.950									
7. Aut. mot.	.696***	.423***	.440***	.297***	.607***	.540***	.373***	.901								
8. Con. mot.	.561***	.166**	.191**	.220***	.300***	.331***	.180**	.347***	.836							
9. Act. Plan.	.840***	.194**	.182**	.172**	.325***	.399***	.354***	.331***	.242***	.955						
10. Habit	.665***	.424***	.342***	.273***	.466***	.644***	.522***	.527***	.320***	.398***	.960					
11. No. of children	—	.051	-.076	-.030	-.074	-.173**	-.020	-.107	-.032	.033	-.048	—				
12. Age	—	-.075	.007	-.169**	-.102	.043	.066	-.000	-.069	-.017	-.004	.155*	—			
13. Gender	—	.003	.074	-.089	-.030	-.035	-.011	-.025	-.023	.026	-.000	-.076	.251***	—		
14. Emp. status	—	.041	-.002	-.148*	.012	-.009	-.007	-.003	-.055	.011	-.027	-.079	.073	.503***	—	
15. Income	—	-.067	-.108	-.203***	-.115	-.076	-.057	-.077	-.077	-.093	-.153**	.007	.223***	.173**	.148**	—
16. Ethnicity	—	.035	.026	.040	.003	.048	-.032	.115	.144*	.045	-.015	.007	-.009	.053	-.007	.238***
17. Education	—	.073	.016	-.048	.033	.044	.112	.026	-.020	.076	.004	.050	.123*	-.008	-.056	.112

Note. Composite reliability coefficients shown on principal diagonal; AVE = Average variance extracted; Sub. norm = Subjective norm; PBC = Perceived behavioral control; Aut. motivation = Autonomous motivation; Con. motivation = Controlled motivation; Act. plan. = Action planning; Emp. status = Employment status.

*** p < .001 ** p < .01 * p < .05.

Figure 1. Child sun safety: Hypothesized relations among integrated behavior change model constructs.

Note. Broken lines between constructs indicate effects tested in the model but hypothesized to be null. The following covariates were set to predict all model variables but omitted from the diagram for clarity: Parents' past sun safety behavior for their children, age, gender, employment status, income, ethnicity, education, and number of children were included as control variables. All hypothesized effects were proposed to be positive in direction, with the exception of H₄ and H₆, which were hypothesized to be non-significant.

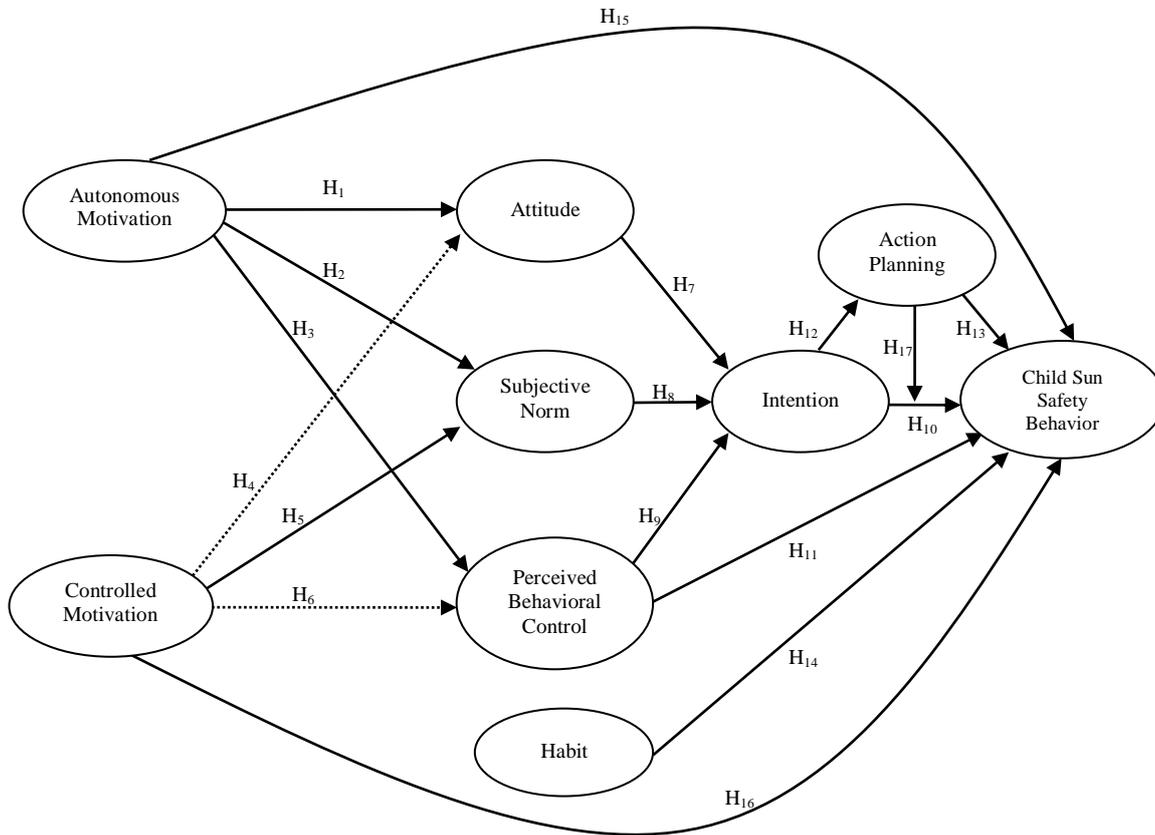


Figure 2. Child sun safety: Standardized path coefficients for structural equation model of relations among integrated behavior change model constructs including past behavior.

Note. Broken lines between constructs indicate effects tested in the model but hypothesized to be null.

