HEALTH PSYCHOLOGY BULLETIN

EDITORIAL HISTORY

Factors influencing children's tooth brushing intention: an application of the theory of planned behaviour

Jenny Davison, Marian McLaughlin & Melanie Giles

This document contains the editorial history, organized into three sections. This first section, section 0, provides background information about the paper and the review procedure. Section 1 is organized chronologically and contains the editorial communication and peer review history. Section 2 contains the successive preprints and is organized anti-chronologically.

DOI of article:	10.5334/hpb.8
DOI of this editorial history:	10.5334/hpb.8.pr1
Article submitted:	2017-05-12
Revision 1 submitted:	2018-01-08
Revision 2 submitted:	2018-09-26
Article accepted:	2018-11-01
Editor:	Gjalt-Jorn Peters
Peer reviewer A:	Rik Crutzen
Peer reviewer B:	Gerjo Kok

Cite this document as:

Davison, J., McLaughlin, M., & Giles, M. (authors); Crutzen, R. & Kok, G. (reviewers); Peters, G.-J. Y. (editor) (2017) Editorial history for 'Factors influencing children's tooth brushing intention: an application of the theory of planned behaviour'. *Health Psychology Bulletin*, 3(1). DOI: [10.5334/hpb.8.pr1](https://doi.org/10.5334/hpb.8.pr1)

Paper abstract

Objective: The aim of the present study is to employ the theory of planned behaviour (TPB) to predict and explain intention and motivations to brush teeth among primary school children in Northern Ireland (NI).

Design: Primary schools in NI were sorted by a number of key stratification variables and then randomly sampled. Twenty-seven schools took part in the research, and a questionnaire that incorporated both direct and indirect constructs of the TPB, related to tooth brushing behaviour, was administered to a sample of 867 year six school children.

Results: Multiple regression analyses provided support for TPB; together the TPB constructs predicted 57.1% of the variance in intentions to brush teeth. Self-efficacy significantly affected intention and behaviour, followed by the influence of attitude, subjective norm and perceived control.

Conclusions: The findings obtained in the present study suggest that the TPB is a useful framework on which to investigate children's tooth brushing intention, and provide the foundation for designing an intervention aimed at encouraging tooth brushing behaviour among children.

Background

This peer review history is published under Health Psychology Bulletin's peer review policy. Peer review at Health Psychology Bulletin (HPB) is blind, but upon acceptance of an article, the entire peer review history is made public. This policy has two aims. First, it makes the reviews citable, rewarding reviewers for their reviews, incentivizing thorough, thoughtful reviews, and stimulating constructive, considerate reviews and responses. Second, to yield the best of both worlds in terms of design of the review procedure. The common procedure of shielding authors' and peer reviewers' identities aims to prevent undue harshness or leniency. However, this anonymity also protects reviewers who make unreasonable requests or statements that are inconsistent with the literature, and authors who refuse to respond adequately to reviewers' requests. These risks are ameliorated by unblinding and publishing the peer review procedure upon paper acceptance.

Health Psychology Bulletin

Health Psychology Bulletin (HPB) is an official journal of the European Health Psychology Society (EHPS). It implements a number of innovative practices such as this peer review procedure, a strong full disclosure policy, a two-tiered review procedure, and explicitly welcoming null findings, replications, and reports of lessons learned such as failed manipulations or measurement instruments, as well as regular articles.

Section 2: editorial communication

Round 1: reviewer A

2017-06-07 05:13 PM

Thank you for providing the opportunity to review this manuscript about factors influencing children's tooth brushing intention. In line with Health Psychology Bulletin's Editorial Policies for Reviewers, the comments below are hopefully perceived as constructive and contribute to improving the manuscript at hand. The comments are not divided into major/minor comments, but are mentioned in the order of appearance within the manuscript:

Abstract – “Self efficacy significantly affected... followed by...”; it is not clear on what type of analyses this conclusion was based – bivariate or multivariate?

Introduction – Add a sentence to link the first section to second section by stating that tooth brushing (the topic of the section) contributes to solving many of the issues mentioned in the first section.

Introduction – The second section starts by talking about tooth brushing habits and then moves towards tooth brushing intentions. It is worthwhile to discuss the relationship and difference between the constructs intention and habit.

Introduction – The third section introduces the Theory of Planned Behaviour. It is unclear when the study was conducted (I'd suggest to add this), but perhaps elaborate on whether the Reasoned Action Approach (Fishbein & Ajzen, 2010) was considered and if so, why it was not used. If it was not considered, it might be worthwhile to reflect upon this in the Discussion.

Introduction, section 4: “flossing and dental services”; perhaps rephrase as “flossing and use of dental services.”

Introduction, section 4: “variances ranging from 31% to 46%”; it is unclear whether this refers to variance in intention or behaviour.

Introduction, section 4: “perceived control emerged as the most significant predictor”; it is unclear what this exactly refers to – try to be more specific.

Introduction, section 4: In the aim of the study, both “most influential” and “relative importance” are mentioned; be more specific about what this exactly refers to.

Methods: Recruitment of schools: Explain how many classes within schools participated and perhaps add intraclass correlations regarding school level and class level.

Methods: Questionnaire: It is unclear what “demographic information” was assessed.

Methods: Related to the previous comments, it is warranted to adhere to full disclosure: sharing materials used in this study (e.g., the questionnaire) as well as non-identifiable data, syntax, and output of the analyses. This in order to maximize scrutiny, foster accurate replication, and facilitate future data syntheses (Peters, Abraham, & Crutzen, 2012). To illustrate; it is very good that beliefs are extensively measured in the study at hand, but it is unclear which beliefs are exactly measured. More in general; Health Psychology as a journal has a strong full disclosure policy (Peters, Kok, Crutzen, & Sanderman, 2017).

Table 1: Coefficient alpha is presented even though its use is strongly discouraged and its assumptions are unlikely to be met in the study at hand (McNeish, 2017). Alternatives are readily available, but also for these alternatives, it is warranted to first conduct exploratory factor analyses and then look at the internal structure of a scale (Crutzen & Peters, 2015).

Table 1: See previous comment. The same procedures should not only be applied to higher level determinants (e.g., attitude, subjective norm), but also to the underlying beliefs.

Methods: A detailed analyses section needs to be added to the Methods. This is a crucial aspect for a research paper.

Results: 94% brush their teeth in the morning, 87% before they go to bed – how is it then possible that only 68% adheres to recommendations of twice-daily tooth brushing? This might be related to the lack of insight into the exact questions asked.

Table 2: Add confidence intervals to the correlation coefficients.

Table 3: It is unclear whether R, R square, and R square adj concern the full model? Or whether a stepwise approach is used? This is one of the details that need to be described in a detailed analyses section to be added to the Methods.

Results: Interpretation of regression models: Regression models can be used to look at associations between determinants and an outcome simultaneously. This can be useful to obtain a measure of explained variance in an outcome (e.g., R^2) based on the sub-determinants included in a model. However, neither regression coefficients, nor their standardized counterparts, should be interpreted as indicators of a predictor's relevance (e.g., the relevance of a specific determinant) (Budescu, 1993; Peters, 2014). Instead, regression coefficients can be interpreted as the rate of change in the outcome as a function of change in a predictor while the other predictors are being held constant (Budescu, 1993). This is important to take into account when describing the results of the regression models.

Results: Did the authors investigate multicollinearity between beliefs when they were included in the regression model? If so, how? And what were the results? If not, please add or substantiate why not.

Results: The subheadings "predicting intention" and "explaining intention" are not appropriate; this simply refers to different levels of psychological aggregation (e.g., determinants such as attitude in the first section and their underlying beliefs in the second section).

The dataset used in the current study is very rich. It contains numerous beliefs derived from a belief elicitation procedure. It would be a clear added value to apply a confidence-interval based estimation of relevance (Crutzen & Peters, 2017) to the manuscript. This approach is based on visualization of confidence intervals for the means and correlation coefficients for all determinants simultaneously. This visualization facilitates comparison, which is necessary when making selections – for example – during intervention development.

Discussion: Elaborate on the findings regarding perceived control and self-efficacy.

Discussion, section 1: The percentages regarding variances are different from those mentioned in the Introduction perhaps explain what they exactly refer to avoid possible confusion.

Discussion, section 3: Here it would be worthwhile to elaborate on the different levels of psychological aggregation. The overarching determinants at higher levels of generality (e.g., attitude, self-efficacy) are those needed to select appropriate behaviour change methods. Behaviour change methods have different components, and are not equally effective for all determinants. For example, while stimulating enactive mastery experiences can be used to improve self-efficacy, it is less suitable to foster attitude change (Kok et al., 2016). Sub-determinants formulated at a high level of specificity (e.g., beliefs in the case of TPB) are crucial when studying determinants, because those very specific aspects are what is used in operationalisations and intervention messages.

Discussion, section 4: "to conceptualise 'this coming week' was perhaps too challenging' and could have increased the likelihood of them responding more positively." Explain why this might be? And also provide possible solutions to circumvent this.

Discussion, section 4: "Whilst a measure of past behaviour was employed in the present context, it was not detailed enough to contribute in a meaning way to the statistical analyses." Why could it not contribute? This measure is available, so it is suggested to add this to the regression model (perhaps in a final step) or at least substantiate in more detail why this was not possible.

References

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Round 1: reviewer B

2017-06-12 08:39 AM

This is an interesting paper describing the quantitative part of applying TPB to teeth brushing among children. I would suggest some additions.

1. For some reason the authors ignore the latest version of the TPB, the 2010 Fishbein & Ajzen book describing the Reasoned Action Approach. Ajzen still uses TPB on his website, but he adapted the texts in line with the RAA. Relevant is that self-efficacy is now seen as part of perceived control and that descriptive norm is seen as part of perceived norm next to subjective norm. It is possible that the authors started working on this project before the RAA was presented, but they should at least mention these changes in the Discussion.
2. The Davison et al. 2016 paper is not open access, as far as I can see. This means, that the reader of this paper may need a bit more information on the elicitation procedure and the outcomes thereof.
3. The presentation of the data is somewhat short. For intervention purposes, the underlying beliefs are more relevant than the main variables. I would like to see means and SD's in a table, and moreover the correlation with intention. Fishbein & Ajzen suggest that for changing behavior one needs to change intentions, and for changing intentions one needs to change existing beliefs and/or make new beliefs salient. I would invite the authors to suggest which beliefs need to be changed, which beliefs need to be reinforced and which beliefs need to be introduced.
4. The data on perceived control are not very helpful; something the authors more or less ignore. I would invite the authors to reflect on this. Are perceived control questions useless next to self-efficacy?
5. HPB is in favor of open data. Are the authors prepared to attach the data to this paper?

Round 1: editor decision

2017-06-19 02:53 PM

Dear Dr Jenny Davison,

After review, we have reached a decision regarding your submission to Health Psychology Bulletin, "Factors influencing children's tooth brushing intention: an application of the theory of planned behaviour.". Our decision is to request revisions of the manuscript. These revisions may then undergo further peer review prior to acceptance.

The full review information should be included at the bottom of this email. There may also be a copy of the manuscript file with reviewer comments available once you have accessed the submission account.

I have two additional points.

First, you did not include a Full Disclosure Package as supplementary materials. I scanned your paper for references to an online repository, but could find none.

Health Psychology Bulletin has a strong Full Disclosure policy, which means submissions should be accompanied by a Replication Package (when submitting introduction and methods) and an Analysis Package (when submission results and discussion). The first should contain everything other authors will need to conduct a direct replication of your study, and the second should contain your data (that is, that selection of your data that you report on in the paper), analysis scripts, and output files. We explain this policy and the rationale in the editorial with which the journal was launched (see <http://www.healthpsychologybulletin.com/articles/10.5334/hpb.2/>).

Of course, not all of these may be available any more; or there may be reasons why these cannot be made public. In those situations, we also accept an explanation of the justifications to not Fully Disclose. The Full Disclosure policy is designed to increase the quality of our scientific reports and enable easy replication and close scrutiny, but should not become an obstacle to publishing scientific reports. Therefore, each of the Full Disclosure packages (i.e. the Replication Package and/or the Analysis Package) can also consist of a text document explaining why the materials are not disclosed.

Note that you can always consult the HPB data guidelines at <http://www.healthpsychologybulletin.com/about/data-guidelines/>

Second, a note about reviewers' suggestions regarding improved analyses. As you clearly indicated, you responded to the 'emptying the filedrawer' call for papers. If you no longer have your data or other materials, or if you want to publish these results but will not be able to perform additional analyses, just explain this. The goal of HPB is to publish all research as transparently as possible; our efforts to optimize methodological and statistical quality should not prohibit emptying the file drawers. However, if you are unable to respond to reviewers requests for additional analyses (e.g. due to lack of time, or because you no longer have the original dataset available), don't forget to adjust or weaken your conclusions where necessary.

This pertains especially to reviewer A's suggestion to use CIBER plots. Although I agree that this will aid interpretation of the findings, and it would likely make the manuscript more attractive and useful to readers, I understand if it would require too much rewriting. I can understand if you are unable to do this. Therefore, I want to emphasize that this suggestion is discretionary, especially if you can publish your dataset along with the paper (as others will then be able to produce the CIBER plots if they require).

To access your submission account, follow the below instructions:

- 1) login to the journal webpage with username and password
- 2) click on the submission title
- 3) click 'Review' menu option
- 4) download Reviewed file and make revisions based on review feedback
- 5) upload the edited file
- 6) Click the 'notify editor' icon and email the confirmation of re-submission and any relevant comments to the journal.

Please ensure that your revised files adhere to our author guidelines, and that the files are fully copyedited/proofed prior to upload. Please also ensure that all copyright permissions have been attained. This may be the last opportunity for major editing, therefore please fully check your file prior to re-submission.

If you have any questions or difficulties during this process, please feel free to contact me! This journal has just started, so we are still optimizing our procedures.

Could you please have the revisions submitted by Tuesday the first of August? If you cannot make this deadline, just let us know what alternative you would prefer.

Kind regards,

Dr Gjal't-Jorn Peters

Open University of the Netherlands

gjalt-jorn@behaviorchange.eu

Round 2: cover letter

2017-08-01 01:15 PM

Dear Gjalt-Jorn,

Please find uploaded the requested revisions for the above named manuscript.

Thank-you for giving me the opportunity to address the reviewer comments and resubmit.

I look forward to hearing from you.

With best wishes,

Jenny

Round 2: responses to reviewers

Factors influencing children's tooth brushing intention: an application of the theory of planned behaviour.

Author's response to editor and reviewer comments (emailed 19.06.17).

Comment	Response
<i>Editor Comments</i>	
First, you did not include a Full Disclosure Package as supplementary materials. I scanned your paper for references to an online repository, but could find none.	Full disclosure will now accompany this article.
Second, a note about reviewers' suggestions regarding improved analyses. As you clearly indicated, you responded to the 'emptying the filedrawer' call for papers. If you no longer have your data or other materials, or if you want to publish these results but will not be able to perform additional analyses, just explain this. The goal of HPB is to publish all research as transparently as possible; our efforts to optimize methodological and statistical quality should not prohibit emptying the file drawers. However, if you are unable to respond to reviewers requests for additional analyses (e.g. due to lack of time, or because you no longer have the original dataset available), don't forget to adjust or weaken your conclusions where necessary. This pertains especially to reviewer A's suggestion to use CIBER plots. Although I agree that this will aid interpretation of the findings, and it would likely make the manuscript more attractive and useful to readers, I understand if it would require too much rewriting. I can understand if you are unable to do this. Therefore, I want to emphasize that this suggestion is discretionary, especially if you can publish your dataset along with the paper (as others will then be able to produce the CIBER plots if they require).	Ideally, I would like to publish this research (along with its data) without performing the suggested additional analyses. My reasons are as follows: This article was submitted in response to a call for 'emptying the filedrawer' – which, literally, is what this article-draft is. It has been sitting for a few years now, having been previously rejected from Psychology and Health, who suggested I submit to Health Psychology Bulletin. I also, am no longer working in this area. It has taken me some time to address all of the reviewer comments, and I don't have any further time to run the additional analyses.
<i>Reviewer A Comments</i>	
Abstract – “Self efficacy significantly affected... followed by...”; it is not clear on what type of analyses this conclusion was based – bivariate or multivariate?	Reworded as follows: Multiple regression analyses provided support for TPB; together the TPB constructs predicted 57.1% of the variance in intentions to brush teeth. Correlational analyses confirmed self-efficacy as having the strongest association with intentions, followed by attitude, subjective norm and perceived control.
Introduction – Add a sentence to link the first section	This sentence has now been added.

to second section by stating that tooth brushing (the topic of the section) contributes to solving many of the issues mentioned in the first section.	
Introduction – The second section starts by talking about tooth brushing habits and then moves towards tooth brushing intentions. It is worthwhile to discuss the relationship and difference between the constructs intention and habit.	In line with the third section of the Introduction, tooth brushing intention has been reworded to tooth brushing behaviour (and not habits). This is consistent with the text that follows in the Introduction section.
Introduction – The third section introduces the Theory of Planned Behaviour. It is unclear when the study was conducted (I'd suggest to add this), but perhaps elaborate on whether the Reasoned Action Approach (Fishbein & Ajzen, 2010) was considered and if so, why it was not used. If it was not considered, it might be worthwhile to reflect upon this in the Discussion.	<p>This study commenced in 2009 prior to Fishbein & Ajzen's publication in 2010, hence why the RAA was not considered. This stage of the study, which is reported in this paper was conducted during 2011. A sentence has been added to detail this within the methods section: "The study took place in Northern Ireland during 2011."</p> <p>This has also been acknowledged in the Discussion section.</p>
Introduction, section 4: "flossing and dental services"; perhaps rephrase as "flossing and use of dental services."	This has been changed accordingly, as suggested by reviewer A.
Introduction, section 4: "variances ranging from 31% to 46%"; it is unclear whether this refers to variance in intention or behaviour.	<p>These three studies report variances in intention, I have now made this clear within the Introduction section:</p> <p>"While these studies support the utility of the TPB, where variances ranging from 31% to 46% have been explained <u>for intention</u>, samples have been restricted to 15+ years (Bonetti et al., 2010; Luzzi and Spencer, 2008; Lavin and Groake, 2005)."</p>
Introduction, section 4: "perceived control emerged as the most significant predictor"; it is unclear what this exactly refers to – try to be more specific.	I have elaborated further to say: "Consistently, in both studies, perceived control emerged as the most significant predictor of tooth brushing intention, <u>explaining more of the variance compared to the other TPB variables (attitude and subjective norm).</u> "
Introduction, section 4: In the aim of the study, both "most influential" and "relative importance" are mentioned; be more specific about what this exactly refers to.	I have reworded this as follows: "...the present study aims to explore the attitudes and motivations of young people towards tooth brushing. Specifically, to identify which of the TPB variables and beliefs are most influential in their decisions to brush their teeth, and to assess their association with tooth brushing intentions."
Methods: Recruitment of schools: Explain how many classes within schools participated and perhaps add intraclass correlations regarding school level and class level.	Only one year six class per school participated as the majority of primary schools across Northern Ireland have only one year six class. As such, intraclass correlations regarding school level and

	<p>class level are not relevant for this sample. However, I have added further detail to this sentence (see text underlined) to address this: “The researcher made contact via telephone and email with the 27 consenting schools and arranged suitable dates and times to visit each of them to administer the questionnaire measure <u>with their year six class (one class per each school).</u>”</p>
<p>Methods: Questionnaire: It is unclear what “demographic information” was assessed.</p>	<p>Two items within the questionnaire gathered demographic characteristics, gender and age: ‘Are you a boy or girl?’ and ‘How old are you?’. I have now included detail of this accordingly: “The first section gathered demographic information (gender and age)...”</p>
<p>Methods: Related to the previous comments, it is warranted to adhere to full disclosure: sharing materials used in this study (e.g., the questionnaire) as well as non-identifiable data, syntax, and output of the analyses. This in order to maximize scrutiny, foster accurate replication, and facilitate future data syntheses (Peters, Abraham, & Crutzen, 2012). To illustrate; it is very good that beliefs are extensively measured in the study at hand, but it is unclear which beliefs are exactly measured. More in general; Health Psychology as a journal has a strong full disclosure policy (Peters, Kok, Crutzen, & Sanderman, 2017).</p>	<p>Full disclosure will accompany this article, including the questionnaire and raw data set.</p>
<p>Table 1: Coefficient alpha is presented even though its use is strongly discouraged and its assumptions are unlikely to be met in the study at hand (McNeish, 2017). Alternatives are readily available, but also for these alternatives, it is warranted to first conduct exploratory factor analyses and then look at the internal structure of a scale (Crutzen & Peters, 2015).</p>	<p>I don’t have time to run the additional analyses requested in this reviewer’s comments. However, psychometric analysis (inc. test re-test reliability analysis) of this measure has been previously reported (see Davison et al., 2016). In acknowledging McNeish’s (2017) conclusion that alpha underestimates reliability, this paper under review reports favourable reliability estimates using alpha, and in keeping with typical reporting of TPB studies, reporting alpha enables comparison.</p>
<p>Table 1: See previous comment. The same procedures should not only be applied to higher level determinants (e.g., attitude, subjective norm), but also to the underlying beliefs.</p>	<p>See above comment, however, alpha coefficients have been calculated for the underlying beliefs and added to table 1.</p>
<p>Methods: A detailed analyses section needs to be added to the Methods. This is a crucial aspect for a research paper.</p>	<p>This has now been added.</p>
<p>Results: 94% brush their teeth in the morning, 87% before they go to bed – how is it then possible that only 68% adheres to recommendations of twice-daily tooth brushing? This might be related to the lack of insight into the exact questions asked.</p>	<p>I understand this is reported poorly causing confusion. It has been rewritten as follows:</p> <p>Although 99.8% reported to brush their teeth, two respondents (0.2%) chose the ‘no’ response. Sixty-eight percent adhere to recommendations of twice-daily tooth brushing, while 16.5% brush their</p>

	teeth once-a-day, 13% three times per day and 2% four times per day. For most (94%) tooth brushing is practiced in the morning or before they go to bed (87%), with 14% selecting that they also brush their teeth after eating or at another time (4%).
Table 2: Add confidence intervals to the correlation coefficients.	These have been calculated using program within R (www.r-project.org) and added to Table 1 (formerly Table 2).
Table 3: It is unclear whether R, R square, and R square adj concern the full model? Or whether a stepwise approach is used? This is one of the details that need to be described in a detailed analyses section to be added to the Methods.	R square concerns the full model. A detailed analysis section has been added to the Methods section.
Results: Interpretation of regression models: Regression models can be used to look at associations between determinants and an outcome simultaneously. This can be useful to obtain a measure of explained variance in an outcome (e.g., R ²) based on the sub-determinants included in a model. However, neither regression coefficients, nor their standardized counterparts, should be interpreted as indicators of a predictor's relevance (e.g., the relevance of a specific determinant) (Budescu, 1993; Peters, 2014). Instead, regression coefficients can be interpreted as the rate of change in the outcome as a function of change in a predictor while the other predictors are being held constant (Budescu, 1993). This is important to take into account when describing the results of the regression models.	Adhering to this, I have reworded the results section which describes the regression analysis.
Results: Did the authors investigate multicollinearity between beliefs when they were included in the regression model? If so, how? And what were the results? If not, please add or substantiate why not.	This was not investigated as it wasn't required considering the beliefs were derived from an elicitation study and included in a pilot study. I'm unsure as to why this would need to be conducted.
Results: The subheadings "predicting intention" and "explaining intention" are not appropriate; this simply refers to different levels of psychological aggregation (e.g., determinants such as attitude in the first section and their underlying beliefs in the second section).	I have changed the result sections to: Tooth brushing behaviour, Predicting behaviour and Explaining behaviour. Using the terms 'predicting' and 'explaining' are consistent with the reporting of TPB results.
The dataset used in the current study is very rich. It contains numerous beliefs derived from a belief elicitation procedure. It would be a clear added value to apply a confidence-interval based estimation of relevance (Crutzen & Peters, 2017) to the manuscript. This approach is based on visualization of confidence intervals for the means and correlation coefficients for all determinants simultaneously. This visualization facilitates comparison, which is	I have had a look at your paper (Crutzen & Peters, 2017) and have downloaded the R-programme. While I also agree including the CIBER approach would improve interpretation of findings (visually) – I do not have the knowledge (or the time to gain the knowledge) to run this suggested analysis. However, as the dataset will be published alongside this article, perhaps this will provide for opportunity for others who are experienced using

necessary when making selections - for example - during intervention development.	CIBER to run such analysis, if interested.
Discussion: Elaborate on the findings regarding perceived control and self-efficacy.	Self-efficacy has been elaborated on. Commenting on the lack of the power of perceived control within the study would involve further analysis and rewriting.
Discussion, section 1: The percentages regarding variances are different from those mentioned in the Introduction – perhaps explain what they exactly refer to avoid possible confusion.	This has been reworded to avoid confusion.
Discussion, section 4: “to conceptualise ‘this coming week’ was perhaps too challenging’ and could have increased the likelihood of them responding more positively.” Explain why this might be? And also provide possible solutions to circumvent this.	<p>This has been reworded, as follows:</p> <p>Second, the way in which the behaviour was operationalised using the TACT principle may have been problematic. Children were asked how likely it is that you will brush your teeth every morning and every evening this coming week. With hindsight, requiring children who typically live <u>day-by-day</u> to conceptualise ‘this coming week’ was perhaps challenging, <u>requiring them to reflect on the week ahead</u>, and may have increased the likelihood of them responding more positively. In <u>future, it might therefore be advisable to define the behaviour in line with Martin et al. (2009) and refer with immediate time, i.e. today.</u></p>
<p>Discussion, section 4: “Whilst a measure of past behaviour was employed in the present context, it was not detailed enough to contribute in a meaning way to the statistical analyses.” Why could it not contribute?</p> <p>This measure is available, so it is suggested to add this to the regression model (perhaps in a final step) or at least substantiate in more detail why this was not possible.</p>	<p>Firstly, apologies for the typo that has caused this confusion, but a measure of past behaviour was not included in the questionnaire, hence why it was not added to the regression model. This is recognised as a limitation of the study.</p>
<i>Reviewer B Comments</i>	
<p>For some reason the authors ignore the latest version of the TPB, the 2010 Fishbein & Ajzen book describing the Reasoned Action Approach. Ajzen still uses TPB on his website, but he adapted the texts in line with the RAA. Relevant is that self-efficacy is now seen as part of perceived control and that descriptive norm is seen as part of perceived norm next to subjective norm. It is possible that the authors started working on this project before the RAA was presented, but they should at least mention these changes in the Discussion.</p>	<p>This study commenced in 2009 prior to Fishbein & Ajzen’s publication in 2010, hence why the RAA was not considered.</p> <p>This change has now been mentioned in the Discussion (see Limitation section):</p> <p>Finally, since this study has been conducted the TPB has come under scrutiny, with a revised model of Reasoned Action Approach (Fishbein & Ajzen, 2010) formulated. Unlike the TPB, the RAA suggests that self-efficacy is part of perceived behavioural control, which would have important</p>

	implications for the findings of this study.
The Davison et al. 2016 paper is not open access, as far as I can see. This means, that the reader of this paper may need a bit more information on the elicitation procedure and the outcomes thereof.	For those unable to access the paper, a copy of this can be requested through Ulster Institutional Repository (http://uir.ulster.ac.uk/36810/) or via the corresponding author on Research Gate.
The presentation of the data is somewhat short. For intervention purposes, the underlying beliefs are more relevant than the main variables. I would like to see means and SD's in a table, and moreover the correlation with intention. Fishbein & Ajzen suggest that for changing behavior one needs to change intentions, and for changing intentions one needs to change existing beliefs and/ or make new beliefs salient. I would invite the authors to suggest which beliefs need to be changed, which beliefs need to be reinforced and which beliefs need to be introduced.	Table 3 has been changed accordingly. Means (SDs) have been added to Table 3. This has been outlined within the results section.
The data on perceived control are not very helpful; something the authors more or less ignore. I would invite the authors to reflect on this. Are perceived control questions useless next to self-efficacy?	See above comment from reviewer 1 concerning perceived control.
HPB is in favor of open data. Are the authors prepared to attach the data to this paper?	Full disclosure will accompany this article, including the raw data set.

Round 2: reviewer A

2017-08-15

Thank you for providing the opportunity to review the revised version of this manuscript. The authors explained in an adequate way how they dealt with the comments provided by two reviewers and the editor. Some suggested further analyses were not conducted, but this is acceptable as the ‘emptying of the filedrawer’ provides sufficient reason that warrant publication/this study being made available to a wider audience. Additional comments for further improvement of the manuscript:

It is laudable that the authors adhered to full disclosure and provided the data. It would be nice if the syntax and questionnaire would also be made available.

It would be good (e.g., for future data syntheses) to add the N per item in Table 3. If all respondents completed all items (i.e., no missing data for beliefs), then add the N in the title.

Coefficient alpha is reported to keep with (using the words of the authors) “typical reporting of TPB studies, reporting alpha enables comparison.” However, alpha relies on the essentially tau-equivalent model, which assumes unidimensionality and equal variances of and covariances between items. So, I think it is even better to report no coefficient at all, then a coefficient whose assumptions are not met/checked. However, I also understand that the authors want to provide something to the reader. Hence, I offer to run these analyses myself, if the authors are willing to include them in the manuscript.

A detailed analyses section is still lacking. It is unclear, for example, how the regression models were constructed. Please describe in more detail (and note that adding the syntax, as suggested in comment 1, would be helpful to give the reader more insight into how the analyses were conducted).

Two typos in Table 2: (1) Correlation between Attitude and Intention; upper bound of confidence interval should be 0.60 (not 0.6). (2) Correlation between Self-efficacy and Subjective norm; = between lower and upper bound of confidence interval should be -.

See comment on previous version of manuscript about interpretation of regression models.

In the Results section, there are still some wordings as “the most important referent.” However, neither regression coefficients, nor their standardized counterparts, should be interpreted as indicators of a predictor’s importance (e.g., the relevance of a specific determinant) (Budescu, 1993; Peters, 2014). Instead, regression coefficients can be interpreted as the rate of change in the outcome as a function of change in a predictor *while the other predictors are being held constant* (Budescu, 1993). This is important to take into account when describing the results of the regression models.

The authors’ reply states that “Commenting on the lack of the power of perceived control within the study would involve further analysis and rewriting.” While additional analyses are not what is expected for this ‘emptying of the filedrawer,’ it is recommended to at least explain it in more detail in the manuscript.

Round 2: reviewer B

2017-08-13 08:20 AM

The authors responded effectively to my earlier comments.

Round 2: editorial decision

2017-09-20 03:51 PM

Dear Dr Jenny Davison,

After review, we have reached a decision regarding your submission to Health Psychology Bulletin, "Factors influencing children's tooth brushing intention: an application of the theory of planned behaviour.". Our decision is to request revisions of the manuscript prior to acceptance for publication.

Specifically, one reviewer is happy with the manuscript in its current form. The other reviewer has a number of constructive suggestions for improvement. I agree that these improvements would make the manuscript more informative and valuable as part of the literature, and therefore hereby give you the opportunity to consider and implement these improvements. This reviewer also offers to run some more advanced analysis themselves, if you would like to follow their suggestion but are unable to conduct these analyses yourselves. You can email me with your response to this offer, and I can relay it to the reviewer, so that you we won't need another round of revisions. I will ask this reviewer to also send me the analysis script they use, either separately or as a part of their reviewer response, so that this script is easily available to you or readers of the manuscript for future reference.

For those suggestions of reviewer 1 that you will not implement, please briefly explain your reasons. And as a reminder: note that the peer review procedure will be unblinded, and the editorial history will become public and citable upon acceptance of your paper (see <https://www.healthpsychologybulletin.com/articles/10.5334/hpb.3/> for an example). This means that where you disagree with one of the suggestions, you need not necessarily explain this in the manuscript: instead explaining it in your response to reviewers will also make the response accessible to readers.

The comments of the reviewer are available once you logged in to the journal management system (see below). If you run into any problems, please let me know!

To access your submission account, follow the below instructions:

- 1) login to the journal webpage with username and password
- 2) click on the submission title
- 3) click 'Review' menu option
- 4) download Reviewed file and make revisions based on review feedback
- 5) upload the edited file
- 6) Click the 'notify editor' icon and email the confirmation of re-submission and any relevant comments to the journal.

Please ensure that your revised files adhere to our author guidelines, and that the files are fully copyedited/proofed prior to upload. Please also ensure that all copyright permissions have been attained. This is the last opportunity for major editing, therefore please fully check your file prior to re-submission.

If you have any questions or difficulties during this process, please do contact us.

Kind regards,

Dr Gjal't-Jorn Peters
Open University of the Netherlands
gjal't-jorn@behaviorchange.eu

Round 3: cover letter

2017-09-28 11:21 AM

Dear Gjalt-Jorn,

Many thanks for the opportunity of revising this manuscript prior to acceptance for publication in Health Psychology Bulletin. I have also attached a copy of the questionnaire, as requested, for full disclosure.

I look forward to hearing from you.

With Thanks,
Jenny

Round 3: responses to reviewers

Factors influencing children's tooth brushing intention: an application of the theory of planned behaviour.

Author's response to reviewer comments (emailed 20.09.17).

Comment	Response
<i>Reviewer Comments</i>	
It is laudable that the authors adhered to full disclosure and provided the data. It would be nice if the syntax and questionnaire would also be made available.	I am happy to make the questionnaire available. However there is no accompanying syntax. The data was not analysed using syntax.
It would be good (e.g., for future data syntheses) to add the N per item in Table 3. If all respondents completed all items (i.e., no missing data for beliefs), then add the N in the title.	N per item has been added to Table 3.
Coefficient alpha is reported to keep with (using the words of the authors) "typical reporting of TPB studies, reporting alpha enables comparison." However, alpha relies on the essentially tau-equivalent model, which assumes unidimensionality and equal variances of and covariances between items. So, I think it is even better to report no coefficient at all, then a coefficient whose assumptions are not met/checked. However, I also understand that the authors want to provide something to the reader. Hence, I offer to run these analyses myself, if the authors are willing to include them in the manuscript.	Many thanks to the reviewer for running the additional analyses using psych R package. We have now reported Omega, GLB and Coefficient H in Table 1, in place of Alpha.
A detailed analyses section is still lacking. It is unclear, for example, how the regression models were constructed. Please describe in more detail (and note that adding the syntax, as suggested in comment 1, would be helpful to give the reader more insight into how the analyses were conducted).	More detail has been added to the data analysis section, including information on how the regression models were constructed. See page 6-7. To note, the data was not analysed using syntax. However, the analysis outputs are available if required.
Two typos in Table 2: (1) Correlation between Attitude and Intention; upper bound of confidence interval should be 0.60 (not 0.6). (2) Correlation between Self-efficacy and Subjective norm; = between lower and upper bound of confidence interval should be -.	Thank-you for highlighting these typos. They have been amended accordingly.
See comment on previous version of manuscript about interpretation of regression models. In the Results section, there are still some wordings as "the most important referent." However, neither	We are simply stating which beliefs (for example: people) are most influential, as rated on a 5-point likert scale, when children decide if they are going to brush their teeth. In addressing your comment,

<p>regression coefficients, nor their standardized counterparts, should be interpreted as indicators of a predictor's importance (e.g., the relevance of a specific determinant) (Budescu, 1993; Peters, 2014). Instead, regression coefficients can be interpreted as the rate of change in the outcome as a function of change in a predictor <i>while the other predictors are being held constant</i> (Budescu, 1993). This is important to take into account when describing the results of the regression models.</p>	<p>which as the author I don't 100% agree with - as it very much depends on ones own interpretation of ones writing style, I have reworded these to read: 'most strongly associated with'; 'emerged as the most popular' and 'most significantly related to'. The beliefs that are included in this questionnaire are based on an elicitation study of a sample the same age as those who were surveyed.</p>
<p>The authors' reply states that "Commenting on the lack of the power of perceived control within the study would involve further analysis and rewriting." While additional analyses are not what is expected for this 'emptying of the filedrawer,' it is recommended to at least explain it in more detail in the manuscript.</p>	<p>See page 10, Discussion:</p> <p>This finding also has theoretical implications given that there is continuing speculation surrounding the distinction between the concepts of perceived control and self-efficacy. While Ajzen (2006b) asserts that they are interconnected, others suggest that a distinction should be made between them (Tavousi et al., 2009; Armitage and Connor, 1999; Terry and O'Leary, 1995). This finding not only provides additional support for the differential roles played by self-efficacy and perceived control, but highlights the importance of self-efficacy within the TPB. In contrast, the evidence also suggests that in the case of tooth brushing, perceived control does not directly determine intentions. Possible explanations for this finding could be related to the age of the sample and the likelihood that the individuals concerned do not perceive 'brushing their teeth' as being entirely of their own free will.</p>

Round 3: reviewer A

2018-01-08 08:56 PM

Thank you for carefully addressing all comments. It is mentioned that analysis outputs are available if required. It would be good to actually make them available.

Round 3: editor decision

2018-05-10 09:49 AM

Dear Dr Jenny Davison,

All reviewers and I now agree that your manuscript in its current form would be an excellent addition to the literature. I have one remaining request, more of a question.

You mention that analysis outputs are available if required. Could you perhaps submit them as supplementary materials, or (even better) make them available through the Open Science Framework? There have been a number of studies into the success of requesting data, stimuli, analysis scripts, and output from researchers years after the study was published, and success rates are generally very low. By making them public with the publication of the article, you both facilitate access for other researchers, make sure a version is always securely stored and will remain accessible even if your computer burns down (or a flood happens - that was a response I once received when contacting an author in New Orleans when I did a meta-analysis...), and you save yourself time in the future as you won't have to correspond with interested researchers and won't have to look for the files any more.

If this is not possible, that is of course fine - there can be any number of reasons why this is not possible. In that case, could you explain that in the manuscript, so that the manuscript adheres to the full disclosure principles (i.e. make everything open or explain why it's not possible or desirable)?

Once you uploaded the files as supplements, or uploaded them to a public Open Science Framework project and added the link to the manuscript, or added an explanation as to why publishing the output is not possible/desirable, I can move the manuscript into the typesetting stage.

Thank you very much, kind regards,

Dr Gjal't-Jorn Peters
Open University of the Netherlands
gjal't-jorn@behaviorchange.eu

Round 4: cover letter

2018-09-26 08:10 PM

Dr Gjalte-Jorn Peters,

Apologies for the delay in responding to your one remaining request (emailed 10.05.18) but I have been on maternity leave since March 2018. I have now uploaded my analysis outputs as supplementary materials. There are 5 outputs in total. I hope that this is everything that is required and I look forward to the article progressing to the typesetting stage.

With best wishes,

Jenny

Section 3: manuscript iterations

Round 3: revised manuscript

Abstract:

Objective: The aim of the present study was to employ the theory of planned behaviour (TPB) to predict and explain intentions and motivations to brush teeth among primary school children in Northern Ireland (NI). Design: Primary schools in NI were sorted by a number of key stratification variables and then randomly sampled. Twenty-seven schools took part in the research, and a questionnaire that incorporated both direct and indirect constructs of the TPB, related to tooth brushing behaviour, was administered to a sample of 867 year six school children. Results: Multiple regression analyses provided support for the TPB; together the TPB constructs predicted 57.1% of the variance in intentions to brush teeth. Correlational analyses confirmed self-efficacy as having the strongest association with intentions, followed by attitude, subjective norm and perceived control. Conclusion: The findings obtained in the present study suggest that the TPB is a useful framework for investigating children's tooth brushing intentions, and provides the foundation for designing an intervention aimed at encouraging tooth brushing behaviour among children.

Introduction

Poor oral health can negatively affect physical and psychological health and wellbeing (Sheiham, 2006). As a result, those with poor oral health are more likely to have reduced quality of life (Watt, 2005; WHO, 2003; Low, Tan and Schwartz, 1999), experience pain and suffering (Nuttall et al., 2006), feel embarrassment and have low self-esteem (Agou et al., 2008), encounter problems with eating, chewing and smiling (Steele et al., 1998), and have sleepless nights (Petersen et al., 2005; WHO, 2003). For children, those with poor oral health are often subject to peer bullying (Seehra, Newton and Dibiase, 2011) and their education can be adversely affected as they are 12 times more likely to miss days at school (Gift, Reisine and Larach, 1992). Northern Ireland (NI) has the poorest levels of oral health in the United Kingdom (UK) (HSCIC, 2015) with its children suffering the highest levels of dental caries in Europe (DHSSPS, 2007). Over half of 8 and 12 year olds (56% and 57%) have obvious decay experience in their primary/permanent teeth compared to the UK average (46% and 34% respectively) (HSCIC, 2015).

Tooth brushing contributes to solving many of the issues aforementioned. There is evidence to suggest that tooth brushing habits are most effectively sustained when they have been established at an early age. Not only does this result in a healthier mouth (Perinnetti, Caputi and Varvara, 2005) but, because good oral hygiene methods commenced early in life are more likely to be regularly continued throughout adolescence and into adulthood (Astrom, 2004; Kuusela et al., 1996). Adopting adequate tooth brushing habits during early childhood is therefore essential, especially as this is a crucial stage of child development when health-related behaviours that are practised routinely are more likely to be habitual (Almet et al., 2008; WHO, 1996). Evidence also indicates that children who adopt daily tooth brushing will reduce their risk of developing dental caries in their permanent and primary teeth by almost 13%, compared to those who have irregular tooth brushing habits (Twetman, 2009; Donaldson, 2008; Whelton et al., 2008; Parnell et al., 2007; Sheiham, 2001). Given these detrimental effects of poor oral health, there is a call for identifying the determinants of childrens tooth brushing behaviour in order to provide evidence for developing effective interventions designed to encourage good oral practices.

Psychological research evidence shows that intervention strategies aimed at changing attitudes and, ultimately, behaviour, are more successful if they are guided by empirically validated theory (Abraham and Michie, 2008; Michie and Abraham, 2004). A theoretical

framework deemed particularly effective in the context of behaviour change is the Theory of Planned Behaviour (TPB). The TPB suggests that individuals consider the implications of their actions before they decide to engage or not to engage in a given behaviour (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). According to the theory behaviour is determined by intentions, which in turn are the result of a combination of: attitude; subjective norm; and perceived control (Ajzen, 1991; Ajzen 1985). Indeed, the TPB has been endorsed by the National Institute for Health and Care Excellence (NICE) as an evidence based way of predicting health behaviour (Taylor et al., 2006), and has emerged as one of the most effective models for understanding, predicting and evaluating health-related behaviours (Ogden, 2012).

The majority of oral health related research underpinned by the TPB that has been conducted, tends to focus on the application of fissure sealants, flossing and use of dental services. While these studies support the utility of the TPB, where variances ranging from 31% to 46% have been explained for intention, samples have been restricted to 15+ years (Bonetti et al., 2010; Luzzi and Spencer, 2008; Lavin and Groake, 2005). To date, only a small number of studies have identified the factors that influence tooth brushing behaviour where the theory has predicted variances of 32% (Buunk-Werkhoven, Dijkstra and van der Schans, 2011) and 76.9% (Pakpour and Sniehotta, 2012). Consistently, in both studies, perceived control emerged as the most significant predictor of tooth brushing intention, explaining more of the variance compared to the other TPB variables (attitude and subjective norm). Furthermore, research driven by the TPB has tended to focus on adolescent and adult populations, with none aimed specifically at assessing and improving the health behaviour of children. In fact, as far as the authors are aware, there have been no published research studies applying the TPB among a sample of primary school children (under 12 years) and in the area of oral hygiene, i.e. tooth brushing. This is surprising given the popularity and success of the theory, and the growing importance of providing children with the skills to improve knowledge, attitude and behaviour to enable them to make appropriate decisions with the goal of establishing healthy lifetime habits (Kwan et al., 2005; WHO, 2003). Accordingly, given the limited work in this area, the present study aims to explore the attitudes and motivations of young people towards tooth brushing. Specifically, to identify which of the TPB variables are influential in their decisions to brush their teeth, and to assess their association with tooth brushing intentions.

Methods

A cross-sectional design was employed whereby, in line with TPB research protocols, a self-completed questionnaire survey was utilised to collect data. Ethical approval was granted by the Ulster University Research Ethical Committee. The study took place in Northern Ireland (NI) during 2011.

To achieve the target sample a list of all primary schools in NI was obtained from the Department of Education for NI (DENI). The sample sought to be representative of each of the five Education Authority (EA) areas in NI, and of children from different socio-economic groups based on the extent of receipt of free school meals. The DENI uses free school meal (FSM) entitlement as a social indicator of deprivation, a state that is based on an aggregate level measure of relative poverty, low income and social disadvantage. Therefore, those schools receiving higher numbers of free school meals are reckoned to have a greater number of children from correspondingly deprived backgrounds.

The list of schools was stratified by both EA and socio-economic group, and a stratified random sampling technique was employed to select schools to contact. Assuming a response rate in the region of 50% for research of this nature (Francis et al., 2004), contact was initially made with 50 primary schools, comprising ten from each EA area, care being taken to ensure that, within each EA area, a range of FSM percentages were selected. A letter detailing the aims, objectives and procedures of the study, along with an invitation to participate, was posted to each of the selected schools. Of the 50 schools contacted, 27 agreed to participate in the study. The researcher made contact via telephone and email with the 27 consenting schools and arranged suitable dates and times to visit each of them to administer the questionnaire measure with their year six class (one class per each school). Completed questionnaires were received from 867 pupils: 442 male and 425 female, aged 9-10 years (mean age 9.74 years).

The questionnaire

The findings from an elicitation study were used to construct the questionnaire (the questionnaire development process is reported in Davison, McLaughlin and Giles, 2016), which was subsequently divided into three sections. The first section gathered demographic information (gender, age and school attended) and section two assessed respondent's

behavioural characteristics relating to tooth brushing. Specifically, tooth brushing behaviour was assessed by self-report, measured by asking respondents: Do you brush your teeth? (yes or no); How many times per day do you brush your teeth? (0-4 times per day); When do you brush your teeth? (in the morning, after eating, before bed, or at another time); and Do you enjoy brushing your teeth? (yes, it is Ok or no). The final section of the questionnaire incorporated all key constructs contained within the TPB and, as such, was operationalised using both direct and belief-based measures.

Direct Measures

[Insert Table 1 here]

In line with Francis et al.'s (2004) recommendations, a generalised model of intention, attitude, subjective norm, perceived control and self-efficacy was adopted in this research study. Three items assessed each of the variables in line with the TACT principle of 'brushing teeth every morning and every evening this coming week'. Behavioural intention was assessed using the following three items, each rated on a five-point likert scale ranging from strongly agree to strongly disagree: I am going (have decided/will try) to brush my teeth; I have decided to brush my teeth; and I will try to brush my teeth. Attitude was measured using three evaluative semantic differential scales (good-bad, happy-sad, pleased-displeased) in response to the item: 'Brushing my teeth makes me feel...'. Subjective norm was derived using the following three items, each rated on five-point agree-disagree scales: People who care about me would like me to brush my teeth; People who care about me would want me to brush my teeth; and, People who care about me think I should brush my teeth. Perceived behavioural control was assessed from responses to three items, using a five-point agree-disagree scale: It is mostly up to me whether or not I brush my teeth; I can generally decide whether or not I brush my teeth; and, It is mainly my decision whether or not I brush my teeth. In addition to perceived behaviour control, three items were included to assess self-efficacy: I think I will find it easy to brush my teeth; I am sure I will be able to brush my teeth; and, I am confident that I can brush my teeth, each using a five-point scale ranging from strongly agree to strongly disagree. Reliability estimates of the direct measures are presented in Table 1.

Attitude

The indirect measure of attitude was based on 11 outcome evaluations and the corresponding behavioural beliefs. Respondents were first required to evaluate each outcome, for example, 'having toothache' on a good/bad dimension. They were then required to indicate the likelihood that each of these outcomes would occur if they were to brush their teeth, for example 'If I brush my teeth I won't have toothache'. Outcome evaluations were then multiplied by the corresponding behavioural beliefs and the summed product served as the belief-based measure of attitude.

Subjective Norm

The belief-based measure of subjective norm was derived from the expectations of six referents: mummy, daddy, other members of my family, dentist, friends and teacher/principal. Respondents were first required to indicate the extent to which each of their significant others would endorse their intention to brush their teeth. This was followed by a request to indicate the extent to which they were motivated to comply with the wishes of their significant others, across a five-point Likert scale (strongly agree to strongly disagree). Each normative belief was multiplied by the corresponding motivation to comply, and the summed product served as an indirect measure of subjective norm.

Perceived Control

The indirect measure of perceived control was grounded on the seven beliefs elicited from the focus group discussions. Given the age of the sample, it was decided to base this measure on single items (Ajzen & Madden, 1986) because they are generally easier to operationalise. As such, respondents were required to indicate the extent to which each of the beliefs would encourage them to, or prevent them from, brushing their teeth, for example, 'If I am tired I won't brush my teeth' (very true to very untrue).

Data Analysis

Data were analysed using SPSS Statistics version 23. Following descriptive analysis of tooth brushing behaviour, the data was analysed in two steps. Initially, multiple linear regression analysis was conducted to examine the relationship between tooth brushing intention and the direct TPB items. Summed scores of direct attitude, subjective norm, perceived control and self-efficacy were entered into the regression model as predictor variables, along with the

summed score of tooth brushing intention (i.e. Int1+Int2+Int3) as the dependent variable. Next, to examine the utility of the indirect TPB items, analysis consisted of Pearson correlations and multiple linear regression analysis exploring the relationship between indirect TPB constructs and the prediction of intention. Separately, behavioural, normative and control beliefs, each with summed tooth brushing intention were entered into the correlational analysis. Then, summed scores of indirect attitude and subjective norm were calculated to form the belief-based measures, and these along with the indirect control beliefs were entered separately into the regression model, along with the summed score of intention as the dependent variable.

Results

Tooth Brushing Behaviour

Although 99.8% reported to brush their teeth, two respondents (0.2%) chose the ‘no’ response. Sixty-eight percent adhere to recommendations of twice-daily tooth brushing, while 16.5% brush their teeth once-a-day, 13% three times per day and 2% four times per day. For most (94%), tooth brushing is practiced in the morning or before they go to bed (87%), with 14% selecting that they also brush their teeth after eating or at another time (4%). Only 3% of the sample reported that they do not go to the dentist, compared to 97% who do. Of those that visited the dentist, 60% go every six months and 8% once a year (30% are unsure of how often they visit the dentist).

Predicting Behaviour

To identify the factors influencing school children’s motivations to brush their teeth and to assess their strength, correlation and regression analysis were conducted on the main TPB constructs.

[Insert Table 2 here]

All of the direct TPB constructs were significantly correlated with tooth brushing intention ($p < .01$) with correlation values ranging from 0.103 to 0.711 (Table 2). The strongest

association with intention was self-efficacy, followed in descending order, by attitude, subjective norm and perceived control.

In terms of identifying the most important predictors of brushing teeth, the model was able to account for 57.1% of the variance, $F(4,862) = 287.23$, $p < 0.01$, in explaining tooth brushing intention. Of particular interest was the finding that self-efficacy was the strongest predictor ($\beta = 0.55$, $p < 0.01$) and that attitudes to brushing teeth ($\beta = 0.26$, $p < 0.01$), subjective norm ($\beta = 0.1$, $p < 0.01$) and perceived control ($\beta = 0.01$, $p < 0.05$) were positively and significantly, albeit to certain extents, related to intentions.

Explaining Behaviour

Correlational analyses (Table 3) further revealed which beliefs played an important role in influencing one's intention to brush their teeth. The beliefs underlying attitude that were most strongly connected to intentions ($p < 0.01$) were with 'removing food from being stuck in my teeth' ($r = 0.27$) and 'having clean teeth' ($r = 0.26$). In addition outcomes such as: 'will stop teeth from rotting or falling out'; 'will have a nice smile'; 'won't have a build-up of plaque'; 'won't have bad breath'; 'won't get sore gums'; and will have strong teeth' were also among the beliefs to have a higher correlation with tooth brushing intentions. Respondent's perceptions of the opinions and support of their parent/s (daddy and mummy), family, and friend/s were highly correlated with their intention to tooth brush. In fact, daddy ($r = 0.36$) had the strongest association with intention. Barriers such as: 'being tired' ($r = 0.38$); 'in a rush' ($r = 0.36$); 'at the weekend if I am staying at home' ($r = 0.32$); and 'forgetting' ($r = 0.29$) showed the strongest associations with intentions among the sample. The belief about bullying: 'I brush my teeth so I won't get bullied'; had a significant negative correlation with intentions, indicating that there was a tendency for respondents who saw this factor as a facilitator to have a weaker tendency not to intend to brush their teeth.

[Insert Table 3 here]

The behavioural beliefs explained 18% of the variance in intention to brush teeth, $F(11, 855) = 11.40$ $p < 0.05$. Removing food from being stuck in teeth ($\beta = 0.19$), having clean teeth ($\beta = 0.17$) and having a nice smile ($\beta = 0.11$) were the beliefs most strongly associated with intention. However, brushing teeth to stop them from rotting or falling out ($\beta = 0.09$) and to remove plaque ($\beta = 0.03$) also uniquely contributed to the variance in intention ($p < 0.05$).

Similarly, 17% of the variance in intention to brush teeth was accounted for by the normative beliefs, $F(6, 857) = 30.12, p < 0.01$. Although one's father ($\beta = .25, p < .01$) emerged as the most popular referent, one's mother ($\beta = .20, p < .01$) and close friends ($\beta = .17, p < .01$) were also influential. The control beliefs accounted for 22% of the variance in intention, $F(7, 858) = 35.30, p < 0.01$. Being tired ($\beta = .21, p < 0.01$) most significantly related to reducing intention, but being in rush ($\beta = .15, p < 0.01$), weekends ($\beta = .15, p < 0.01$) and forgetting ($\beta = .12, p < 0.01$) were also associated.

Discussion

This study demonstrates that the TPB can usefully be employed to predict tooth brushing intention of Northern Ireland's school children. Analyses revealed that all of the TPB constructs contributed significantly (albeit to varying extents) to the prediction of intention, explaining 57.1% of the variance. In fact, the unique contribution of the models components to the prediction of intention is marginally higher than that reported in previous TPB-based studies with school children and physical activity (Martin et al., 2009; Foley et al., 2008; Trost et al., 2002), where variances of between 10% - 56% have been explained. In respect of oral health research, 44% and 46% of the variance in intention to dental floss has been explained with adolescents (Rise et al., 1998) and university students (Lavin and Groarke, 2005), and 76.9% of the variance in tooth brushing behaviour has been found with adolescents (Pakpour and Sniehotta, 2012). The results of the study provide support for the utility of the TPB in that attitude, subjective norm, perceived control and self-efficacy predicted intention to brush teeth. Furthermore, the present findings serve to identify which beliefs to target when designing an intervention. Investigation of the indirect measures identified removing food, having clean teeth, to stop teeth from rotting or falling out; to remove plaque and to have a nice smile, as the main motivators for children to brush their teeth. Further, being tired, in a rush, when staying at home at the weekends, and forgetting emerged as significant barriers to children's tooth brushing habits. Such results are similar to the findings of Pakpour and Siehotta (2012) which suggests that an intervention simultaneously targeting PBC and action planning might prove to be effective when promoting tooth brushing amongst school children.

In line with previous research self-efficacy contributed most significantly to the prediction of tooth brushing intentions amongst this target group. These results confirm the importance of self-efficacy perceptions in oral self-care care behaviour with similar findings reported in the context of dental flossing and the uptake of public dental services (Luzzi and Spencer, 2008; Tedesco et al., 1993). In relation to tooth brushing behaviour it does not appear to be physical difficulties which act as barriers, but rather the regular daily performance of such behaviours which prove to be difficult for some children (Zhou, Sun, Knoll, Hamilton and Schwarzer, 2015). These findings clearly have practical implications and suggest the need for behaviour-change interventions to target self-regulatory tasks such as self-monitoring (Michie, Atkins & West, 2014), which have been found to improve dental self-efficacy, dental planning and action control in Chinese young adults (Zhou et al, 2015).

This finding also has theoretical implications given that there is continuing speculation surrounding the distinction between the concepts of perceived control and self-efficacy. While Ajzen (2006) asserts that they are interconnected, others suggest that a distinction should be made between them (Tavousi et al., 2009; Armitage and Connor, 1999; Terry and O'Leary, 1995). This finding not only provides additional support for the differential roles played by self-efficacy and perceived control, but highlights the importance of self-efficacy within the TPB. In contrast, the evidence also suggests that in the case of tooth brushing, perceived control does not directly determine intentions. Possible explanations for this finding could be related to the age of the sample and the likelihood that the individuals concerned do not perceive 'brushing their teeth' as being entirely of their own free will.

In keeping with previous research with children, subjective norm was one of the weakest predictors of tooth brushing intentions. In relation to subjective norm, this finding is perhaps not surprising given that most parents equip children with tooth brushing knowledge and endeavour to generally reinforce tooth brushing routines in order to establish consistent lifetime habits. Parents usually supervise children's tooth brushing until at least six years, with some continuing to do so until 10 years (Sandstrom et al., 2011). Such evidence may imply that children aged 9-10 years face difficulties in adopting responsibility for their individual tooth brushing regimes, reaffirming previous research that children are reliant on their parents for reminding them of, and reinforcing engagement in, daily tooth brushing practice (Davison et al., 2016).

The present study has recognisable limitations which elicits direction for future research. First, as is often the case with TPB-based research, there was no measure of actual behaviour; tooth brushing behaviour was ascertained by self-report. Given the relatively low correlations often reported between intention and behaviour (Armitage and Conner, 2001), it is feasible that our measure of intention/motivation did not represent what happens in reality, or indeed, may have been inflated due to social desirability. Second, the way in which the behaviour was operationalised using the TACT principle may have been problematic. Children were asked how likely it was that they would brush their teeth every morning and every evening 'this coming week'. With hindsight, requiring children who typically live day-by-day to conceptualise 'this coming week' was perhaps challenging, requiring them to reflect on the week ahead, and may have increased the likelihood of them responding more positively. In future, it might therefore be advisable to define the behaviour in line with Martin et al. (2009) and refer to immediate time, i.e. today. Third, it might also be argued that tooth brushing is a habitual behaviour (Sandstrom et al., 2011) and therefore best explained by past behaviour. Certainly, this is often a criticism levied at the TPB and has caused many to add a measure of past behaviour to the variables contained within the model. According to Armitage and Conner (2001), in some cases, past behaviour may account for an additional 18% of the variance in intentions. Finally, since this study has been conducted the literature has advanced in terms of theory and as a result the TPB has come under scrutiny. While the TPB plays an important role in predicting, understanding and changing behaviour, it has been postulated that providing functionality of these variables (intention, attitude, subjective norm and perceived control) will only result from a broader theoretical approach (Sniehotta, Preece & Araujo-Soares, 2014). The Reasoned Action Approach (Fishbein & Ajzen, 2010) is one such model as it seeks to extend the TPB by splitting attitudes, subjective norm and PBC into two sub-components in order to offer additional insights into the determinants of health behaviour.

Despite these criticisms the current study provides support for the theoretical model of the TPB and has highlighted the importance of key theoretical constructs in predicting intentions to brush teeth among school children. It has also served to elucidate the relative importance of the factors influential in affecting children's motivations and decisions to brush their teeth. It is hoped that the findings reported here will serve to identify those variables that might provide the foundation for designing an intervention aimed at encouraging tooth brushing behaviour among a particularly at-risk group.

Acknowledgements

The authors would like to acknowledge the schools and their pupils, who gave of their time to participate in this research.

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Table 1: Details of the direct measures contained within the questionnaire and reliability estimates.					
Theory of planned behaviour construct	n items	Sample Items	Omega	GLB	Coefficient <i>H</i>
Intention	3	I am going (have decided/will try) to brush my teeth: agree/disagree	0.85	0.85	0.85
Attitude	3	Brushing my teeth makes me feel: good/bad; happy/sad; pleased/displeased	0.85	0.84	0.85
Perceived control	3	It is mostly up to me whether or not I brush my teeth (I can generally decide/it is mainly my decision): agree/disagree.	0.71	0.72	0.72
Subjective norm	3	People who care about me would like me to (want me to/think I should) brush my teeth: agree/disagree.	0.69	0.72	0.73
Self-efficacy	3	I think I will find it easy to (I am sure I will be able to/I am confident that I can) brush my teeth: agree/disagree.	0.78	0.79	0.80

Note: GLB=Greatest lower bound. Omega, GLB and Coefficient H calculated using psych R package.

Table 2: Predicting behavioural intention: correlation (and 95% CI) and multiple regression analysis of the direct measures.								
Variable	Mean	SD	1	2	3	4	R^2	Beta
1. Intention	4.55	0.62	-					
2. Attitude	4.47	0.64	.561** (0.51-0.60)	-			0.571	.258**
3. Subjective Norm	4.66	0.54	.361** (0.3-0.42)	.278** (0.22-0.34)	-			.103**
4. Perceived Control	3.83	1.02	.180** (0.11-0.24)	.157** (0.09-0.22)	.223** (0.16-0.29)	-		.007*
5. Self-efficacy	4.35	0.70	.711** (0.68-0.74)	.500** (0.45-0.55)	.340** (0.28-0.4)	.103** (0.04-0.17)		.546**

Note: ** $P < 0.01$; * $P < 0.05$; R^2 =squared multiple correlation; Beta=standardised regression coefficients.

Table 3: Correlation and multiple regression analysis of the indirect measures.						
	N	Mean	SD	<i>r</i>	Beta	<i>R</i> ²
Attitude						
Won't have toothache	867	20.40	5.57	0.12**	-.01	0.18
Will have strong teeth	867	23.45	3.39	0.15**	-.00	
Won't have bad breath	867	21.30	4.84	0.16**	-.02	
Will remove food from being stuck in my teeth	867	19.87	5.14	0.27**	.19**	
Will have clean teeth	867	23.89	2.84	0.26**	.17**	
Will stop teeth from rotting or falling out	866	22.99	4.01	0.19**	.09*	
Will have a nice smile	867	21.05	5.31	0.19**	.11**	
Won't have funny coloured teeth	867	22.95	4.18	0.12**	-.00	
Won't have to visit the dentist	867	18.43	6.99	0.09**	-.09	
Won't get sore gums	867	19.91	5.68	0.15**	-.01	
Won't have a build up of plaque	867	22.26	4.48	0.17**	.03*	
Subjective Norm						
My mummy thinks I should brush my teeth	867	21.31	5.12	0.27**	.20**	0.17
My daddy thinks I should brush my teeth	867	20.74	5.60	0.36**	.25**	
Other members of my family think I should brush my teeth	867	18.73	6.34	0.28**	.09*	
My dentist thinks I should brush my teeth	864	21.67	5.00	0.22**	.08*	
My friends thinks I should brush my teeth	867	13.96	6.89	0.25**	.17**	
My teacher/principal think I should brush my teeth	867	15.19	7.23	0.14**	-.10*	
Perceived Behavioural Control						
If I am tired I won't brush my teeth	867	3.85	1.21	0.38**	0.21**	0.22
If I had nicer toothpaste I would brush my teeth more often	867	2.70	1.51	-0.16**	-0.03	
Sometimes I can forget to brush my teeth	867	2.93	1.42	0.29**	0.12**	
If I got a treat for brushing my teeth I would brush my teeth more often	867	3.23	1.54	-0.14**	-0.02	
I brush my teeth so I won't get bullied	866	1.97	1.34	-0.03	0.04	
If I am in a rush I won't brush my teeth	867	3.90	1.21	0.36**	0.15**	
At the weekend, if I am staying at home I don't brush my teeth	867	4.35	1.03	0.32**	0.15**	

Note: * $P < 0.05$; ** $P < 0.01$; r =Pearson product moment correlation coefficient; R^2 =squared multiple correlation; Beta=standardised regression coefficients.

Round 2: revised manuscript

Abstract:

Objective: The aim of the present study was to employ the theory of planned behaviour (TPB) to predict and explain intentions and motivations to brush teeth among primary school children in Northern Ireland (NI). **Design:** Primary schools in NI were sorted by a number of key stratification variables and then randomly sampled. Twenty-seven schools took part in the research, and a questionnaire that incorporated both direct and indirect constructs of the TPB, related to tooth brushing behaviour, was administered to a sample of 867 year six school children. **Results:** Multiple regression analyses provided support for the TPB; together the TPB constructs predicted 57.1% of the variance in intentions to brush teeth. Correlational analyses confirmed self-efficacy as having the strongest association with intentions, followed by attitude, subjective norm and perceived control. **Conclusion:** The findings obtained in the present study suggest that the TPB is a useful framework for investigating children's tooth brushing intentions, and provides the foundation for designing an intervention aimed at encouraging tooth brushing behaviour among children.

Introduction

Poor oral health can negatively affect physical and psychological health and wellbeing (Sheiham, 2006). As a result, those with poor oral health are more likely to have reduced quality of life (Watt, 2005; WHO, 2003; Low, Tan and Schwartz, 1999), experience pain and suffering (Nuttall et al., 2006), feel embarrassment and have low self-esteem (Agou et al., 2008), encounter problems with eating, chewing and smiling (Steele et al., 1998), and have sleepless nights (Petersen et al., 2005; WHO, 2003). For children, those with poor oral health are often subject to peer bullying (Seehra, Newton and Dibiase, 2011) and their education can be adversely affected as they are 12 times more likely to miss days at school (Gift, Reisine and Larach, 1992). Northern Ireland (NI) has the poorest levels of oral health in the United Kingdom (UK) (HSCIC, 2015) with its children suffering the highest levels of dental caries in Europe (DHSSPS, 2007). Over half of 8 and 12 year olds (56% and 57%) have obvious decay experience in their primary/permanent teeth compared to the UK average (46% and 34% respectively) (HSCIC, 2015).

Tooth brushing contributes to solving many of the issues aforementioned. There is evidence to suggest that tooth brushing habits are most effectively sustained when they have been established at an early age. Not only does this result in a healthier mouth (Perinnetti, Caputi and Varvara, 2005) but, because good oral hygiene methods commenced early in life are more likely to be regularly continued throughout adolescence and into adulthood (Astrom, 2004; Kuusela et al., 1996). Adopting adequate tooth brushing habits during early childhood is therefore essential, especially as this is a crucial stage of child development when health-related behaviours that are practised routinely are more likely to be habitual (Almet et al., 2008; WHO, 1996). Evidence also indicates that children who adopt daily tooth brushing will reduce their risk of developing dental caries in their permanent and primary teeth by almost 13%, compared to those who have irregular tooth brushing habits (Twetman, 2009; Donaldson, 2008; Parnell et al., 2007; Whelton et al., 2006; Sheiham, 2001). Given these detrimental effects of poor oral health, there is a call for identifying the determinants of childrens tooth brushing behaviour in order to provide evidence for developing effective interventions designed to encourage good oral practices.

Psychological research evidence shows that intervention strategies aimed at changing attitudes and, ultimately, behaviour, are more successful if they are guided by empirically validated theory (Abraham and Michie, 2008; Michie and Abraham, 2004). A theoretical framework

deemed particularly effective in the context of behaviour change is the Theory of Planned Behaviour (TPB). The TPB suggests that individuals consider the implications of their actions before they decide to engage or not to engage in a given behaviour (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). According to the theory behaviour is determined by intentions, which in turn are the result of a combination of: attitude; subjective norm; and perceived control (Ajzen, 1991; Ajzen 1985). Indeed, the TPB has been endorsed by the National Institute for Health and Care Excellence (NICE) as an evidence based way of predicting health behaviour (Taylor et al., 2006), and has emerged as one of the most effective models for understanding, predicting and evaluating health-related behaviours (Ogden, 2012).

The majority of oral health related research underpinned by the TPB that has been conducted, tends to focus on the application of fissure sealants, flossing and use of dental services. While these studies support the utility of the TPB, where variances ranging from 31% to 46% have been explained for intention, samples have been restricted to 15+ years (Bonetti et al., 2010; Luzzi and Spencer, 2008; Lavin and Groake, 2005). To date, only a small number of studies have identified the factors that influence tooth brushing behaviour where the theory has predicted variances of 32% (Buunk-Werkhoven, Dijkstra and van der Schans, 2011) and 76.9% (Pakpour and Sniehotta, 2012). Consistently, in both studies, perceived control emerged as the most significant predictor of tooth brushing intention, explaining more of the variance compared to the other TPB variables (attitude and subjective norm). Furthermore, research driven by the TPB has tended to focus on adolescent and adult populations, with none aimed specifically at assessing and improving the health behaviour of children. In fact, as far as the authors are aware, there have been no published research studies applying the TPB among a sample of primary school children (under 12 years) and in the area of oral hygiene, i.e. tooth brushing. This is surprising given the popularity and success of the theory, and the growing importance of providing children with the skills to improve knowledge, attitude and behaviour to enable them to make appropriate decisions with the goal of establishing healthy lifetime habits (Kwan et al., 2005; WHO, 2003). Accordingly, given the limited work in this area, the present study aims to explore the attitudes and motivations of young people towards tooth brushing. Specifically, to identify which of the TPB variables are influential in their decisions to brush their teeth, and to assess their association with tooth brushing intentions.

Methods

A cross-sectional design was employed whereby, in line with TPB research protocols, a self-completed questionnaire survey was utilised to collect data. Ethical approval was granted by the Ulster University Research Ethical Committee. The study took place in Northern Ireland (NI) during 2011.

To achieve the target sample a list of all primary schools in NI was obtained from the Department of Education for NI (DENI). The sample sought to be representative of each of the five Education Authority (EA) areas in NI, and of children from different socio-economic groups based on the extent of receipt of free school meals. The DENI uses free school meal (FSM) entitlement as a social indicator of deprivation, a state that is based on an aggregate level measure of relative poverty, low income and social disadvantage. Therefore, those schools receiving higher numbers of free school meals are reckoned to have a greater number of children from correspondingly deprived backgrounds.

The list of schools was stratified by both EA and socio-economic group, and a stratified random sampling technique was employed to select schools to contact. Assuming a response rate in the region of 50% for research of this nature (Francis et al., 2004), contact was initially made with 50 primary schools, comprising ten from each EA area, care being taken to ensure that, within each EA area, a range of FSM percentages were selected. A letter detailing the aims, objectives and procedures of the study, along with an invitation to participate, was posted to each of the selected schools. Of the 50 schools contacted, 27 agreed to participate in the study. The researcher made contact via telephone and email with the 27 consenting schools and arranged suitable dates and times to visit each of them to administer the questionnaire measure with their year six class (one class per each school). Completed questionnaires were received from 867 pupils: 442 male and 425 female, aged 9-10 years (mean age 9.74 years).

The questionnaire

The findings from an elicitation study were used to construct the questionnaire (the questionnaire development process is reported in Davison, McLaughlin and Giles, 2016), which was subsequently divided into three sections. The first section gathered demographic information (gender, age and school attended) and section two assessed respondent's behavioural characteristics relating to tooth brushing. Specifically, tooth brushing behaviour was assessed by self-report, measured by asking respondents: Do you brush your teeth? (yes or no); How many times per day do you brush your teeth? (0-4 times per day); When do you

brush your teeth? (in the morning, after eating, before bed, or at another time); and Do you enjoy brushing your teeth? (yes, it is Ok or no). The final section of the questionnaire incorporated all key constructs contained within the TPB and, as such, was operationalised using both direct and belief-based measures.

Direct Measures

[Insert Table 1 here]

In line with Francis et al.'s (2004) recommendations, a generalised model of intention, attitude, subjective norm, perceived control and self-efficacy was adopted in this research study. Three items assessed each of the variables in line with the TACT principle of 'brushing teeth every morning and every evening this coming week'. Behavioural intention was assessed using the following three items, each rated on a five-point likert scale ranging from strongly agree to strongly disagree: I am going (have decided/will try) to brush my teeth; I have decided to brush my teeth; and I will try to brush my teeth. Attitude was measured using three evaluative semantic differential scales (good-bad, happy-sad, pleased-displeased) in response to the item: 'Brushing my teeth makes me feel...'. Subjective norm was derived using the following three items, each rated on five-point agree-disagree scales: People who care about me would like me to brush my teeth; People who care about me would want me to brush my teeth; and, People who care about me think I should brush my teeth. Perceived behavioural control was assessed from responses to three items, using a five-point agree-disagree scale: It is mostly up to me whether or not I brush my teeth; I can generally decide whether or not I brush my teeth; and, It is mainly my decision whether or not I brush my teeth. In addition to perceived behaviour control, three items were included to assess self-efficacy: I think I will find it easy to brush my teeth; I am sure I will be able to brush my teeth; and, I am confident that I can brush my teeth, each using a five-point scale ranging from strongly agree to strongly disagree.

Attitude

The indirect measure of attitude was based on 11 outcome evaluations and the corresponding behavioural beliefs. Respondents were first required to evaluate each outcome, for example, 'having toothache' on a good/bad dimension. They were then required to indicate the likelihood that each of these outcomes would occur if they were to brush their teeth, for example 'If I brush my teeth I won't have toothache'. Outcome evaluations were then

multiplied by the corresponding behavioural beliefs and the summed product served as the belief-based measure of attitude.

Subjective Norm

The belief-based measure of subjective norm was derived from the expectations of six referents: mummy, daddy, other members of my family, dentist, friends and teacher/principal. Respondents were first required to indicate the extent to which each of their significant others would endorse their intention to brush their teeth. This was followed by a request to indicate the extent to which they were motivated to comply with the wishes of their significant others, across a five-point Likert scale (strongly agree to strongly disagree). Each normative belief was multiplied by the corresponding motivation to comply, and the summed product served as an indirect measure of subjective norm.

Perceived Control

The indirect measure of perceived control was grounded on the seven beliefs elicited from the focus group discussions. Given the age of the sample, it was decided to base this measure on single items (Ajzen & Madden, 1986) because they are generally easier to operationalise. As such, respondents were required to indicate the extent to which each of the beliefs would encourage them to, or prevent them from, brushing their teeth, for example, 'If I am tired I won't brush my teeth' (very true to very untrue).

Data Analysis

Data were analysed using SPSS Statistics version 23. Following descriptive analysis of tooth brushing behaviour, correlation and multiple linear regression analyses were conducted to examine the relationship between tooth brushing intentions and the direct and indirect TPB constructs.

Results

Tooth Brushing Behaviour

Although 99.8% reported to brush their teeth, two respondents (0.2%) chose the 'no' response. Sixty-eight percent adhere to recommendations of twice-daily tooth brushing, while 16.5% brush their teeth once-a-day, 13% three times per day and 2% four times per day. For most

(94%), tooth brushing is practiced in the morning or before they go to bed (87%), with 14% selecting that they also brush their teeth after eating or at another time (4%). Only 3% of the sample reported that they do not go to the dentist, compared to 97% who do. Of those that visited the dentist, 60% go every six months and 8% once a year (30% are unsure of how often they visit the dentist).

Predicting Behaviour

To identify the factors influencing school children's motivations to brush their teeth and to assess their strength, correlation and regression analysis were conducted on the main TPB constructs.

[Insert Table 2 here]

All of the direct TPB constructs were significantly correlated with tooth brushing intention ($p < .01$) with correlation values ranging from 0.103 to 0.711 (Table 2). The strongest association with intention was self-efficacy, followed in descending order, by attitude, subjective norm and perceived control.

In terms of identifying the most important predictors of brushing teeth, the model was able to account for 57.1% of the variance, $F(4,862) = 287.23$, $p < 0.01$, in explaining tooth brushing intention. Of particular interest was the finding that self-efficacy was the strongest predictor ($\beta = 0.55$, $p < 0.01$) and that attitudes to brushing teeth ($\beta = 0.26$, $p < 0.01$), subjective norm ($\beta = 0.1$, $p < 0.01$) and perceived control ($\beta = 0.01$, $p < 0.05$) were positively and significantly, albeit to certain extents, related to intentions.

Explaining Behaviour

Correlational analyses (Table 3) further revealed which beliefs played an important role in influencing one's intention to brush their teeth. The beliefs underlying attitude that were most strongly connected to intentions ($p < 0.01$) were with 'removing food from being stuck in my teeth' ($r = 0.27$) and 'having clean teeth' ($r = 0.26$). In addition outcomes such as: 'will stop teeth from rotting or falling out'; 'will have a nice smile'; 'won't have a build-up of plaque'; 'won't have bad breath'; 'won't get sore gums'; and will have strong teeth' were also among the beliefs to have a higher correlation with tooth brushing intentions. Respondent's perceptions of the opinions and support of their parent/s (daddy and mummy), family, and

friend/s were highly correlated with their intention to tooth brush. In fact, daddy ($r = 0.36$) had the strongest association with intention. Barriers such as: 'being tired' ($r = 0.38$); 'in a rush' ($r = 0.36$); 'at the weekend if I am staying at home' ($r = 0.32$); and 'forgetting' ($r = 0.29$) showed the strongest associations with intentions among the sample. The belief about bullying: 'I brush my teeth so I won't get bullied'; had a significant negative correlation with intentions, indicating that there was a tendency for respondents who saw this factor as a facilitator to have a weaker tendency not to intend to brush their teeth.

[Insert Table 3 here]

The behavioural beliefs explained 18% of the variance in intention to brush teeth, $F(11, 855) = 11.40$, $p < 0.05$. Removing food from being stuck in teeth ($\beta = 0.19$), having clean teeth ($\beta = 0.17$) and having a nice smile ($\beta = 0.11$) were the most significant predictors. However, brushing teeth to stop them from rotting or falling out ($\beta = 0.09$) and to remove plaque ($\beta = 0.03$) also uniquely contributed to the variance in intention ($p < 0.05$). Similarly, 17% of the variance in intention to brush teeth was accounted for by the normative beliefs, $F(6, 857) = 30.12$, $p < 0.01$. Although one's father ($\beta = .25$, $p < .01$) was reported to be the most important referent, one's mother ($\beta = .20$, $p < .01$) and close friends ($\beta = .17$, $p < .01$) were also influential. The control beliefs accounted for 22% of the variance in intention, $F(7, 858) = 35.30$, $p < 0.01$. Being tired ($\beta = .21$, $p < 0.01$) was the most significant predictor in reducing intention, but being in rush ($\beta = .15$, $p < 0.01$), weekends ($\beta = .15$, $p < 0.01$) and forgetting ($\beta = .12$, $p < 0.01$) were also important.

Discussion

This study demonstrates that the TPB can usefully be employed to predict tooth brushing intention of Northern Ireland's school children. Analyses revealed that all of the TPB constructs contributed significantly to the prediction of intention, explaining 57.1% of the variance. In fact, the unique contribution of the models components to the prediction of intention is marginally higher than that reported in previous TPB-based studies with school children and physical activity (Martin et al., 2009; Foley et al., 2008; Trost et al., 2002), where variances of between 10% - 56% have been explained. In respect of oral health research, 44% and 46% of the variance in intention to dental floss has been explained with adolescents (Rise

et al., 1998) and university students (Lavin and Groarke, 2005), and 76.9% of the variance in tooth brushing behaviour has been found with adolescents (Pakpour and Sniehotta, 2012). The results of the study provide support for the utility of the TPB in that attitude, subjective norm, perceived control and self-efficacy predicted intention to brush teeth. Furthermore, the present findings serve to identify which beliefs to target when designing an intervention. Investigation of the indirect measures identified removing food, having clean teeth, to stop teeth from rotting or falling out; to remove plaque and to have a nice smile, as the main motivators for children to brush their teeth. Further, being tired, in a rush, when staying at home at the weekends, and forgetting emerged as significant barriers to children's tooth brushing habits. Such results are similar to the findings of Pakpour and Siehotta (2012) which suggests that an intervention simultaneously targeting PBC and action planning might prove to be effective when promoting tooth brushing amongst school children.

In line with previous research self-efficacy contributed most significantly to the prediction of tooth brushing intentions amongst this target group. These results confirm the importance of self-efficacy perceptions in oral self-care care behaviour with similar findings reported in the context of dental flossing and the uptake of public dental services (Luzzi and Spencer, 2008; Tedesco et al., 1993). In relation to tooth brushing behaviour it does not appear to be physical difficulties which act as barriers, but rather the regular daily performance of such behaviours which prove to be difficult for some children (Zhou, Sun, Knoll, Hamilton and Schwarzer, 2015). These findings clearly have practical implications and suggest the need for behaviour-change interventions to target self-regulatory tasks such as self-monitoring (Michie, Atkins & West, 2014), which have been found to improve dental self-efficacy, dental planning and action control in Chinese young adults (Zhou et al, 2015).

In keeping with previous research with children, subjective norm was one of the weakest predictors of tooth brushing intentions. This finding is perhaps not surprising given that most parents equip children with tooth brushing knowledge and endeavour to generally reinforce tooth brushing routines in order to establish consistent lifetime habits. Parents usually supervise children's tooth brushing until at least six years, with some continuing to do so until 10 years (Sandstrom et al., 2011). Such evidence may imply that children aged 9-10 years face difficulties in adopting responsibility for their individual tooth brushing regimes, reaffirming previous research that children are reliant on their parents for reminding them of, and reinforcing engagement in, daily tooth brushing practice (Davison et al., 2016).

The present study has recognisable limitations which elicits direction for future research. First, as is often the case with TPB-based research, there was no measure of actual behaviour; tooth brushing behaviour was ascertained by self-report. Given the relatively low correlations often reported between intention and behaviour (Armitage and Conner, 2001), it is feasible that our measure of intention/motivation did not represent what happens in reality, or indeed, may have been inflated due to social desirability. Second, the way in which the behaviour was operationalised using the TACT principle may have been problematic. Children were asked how likely it was that they would brush their teeth every morning and every evening ‘this coming week’. With hindsight, requiring children who typically live day-by-day to conceptualise ‘this coming week’ was perhaps challenging, requiring them to reflect on the week ahead, and may have increased the likelihood of them responding more positively. In future, it might therefore be advisable to define the behaviour in line with Martin et al. (2009) and refer to immediate time, i.e. today. Third, it might also be argued that tooth brushing is a habitual behaviour (Sandstrom et al., 2011) and therefore best explained by past behaviour. Certainly, this is often a criticism levied at the TPB and has caused many to add a measure of past behaviour to the variables contained within the model. According to Armitage and Conner (2001), in some cases, past behaviour may account for an additional 18% of the variance in intentions. Finally, since this study has been conducted the literature has advanced in terms of theory and as a result the TPB has come under scrutiny. While the TPB plays an important role in predicting, understanding and changing behaviour, it has been postulated that providing functionality of these variables (intention, attitude, subjective norm and perceived control) will only result from a broader theoretical approach (Sniehotta, Pesseau & Araujo-Soares, 2014). The Reasoned Action Approach (Fishbein & Ajzen, 2010) is one such model as it seeks to extend the TPB by splitting attitudes, subjective norm and PBC into two sub-components in order to offer additional insights into the determinants of health behaviour.

Despite these criticisms the current study provides support for the theoretical model of the TPB and has highlighted the importance of key theoretical constructs in predicting intentions to brush teeth among school children. It has also served to elucidate the relative importance of the factors influential in affecting children’s motivations and decisions to brush their teeth. It is hoped that the findings reported here will serve to identify those variables that might provide the foundation for designing an intervention aimed at encouraging tooth brushing behaviour among a particularly at-risk group.

Acknowledgements

The authors would like to acknowledge the schools and their pupils, who gave of their time to participate in this research.

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Table 1: Details of the direct measures contained within the questionnaire.

Theory of planned behaviour construct	n items	Sample Items	Alpha Coefficient
Intention	3	I am going (have decided/will try) to brush my teeth: agree/disagree	0.84
Attitude	3	Brushing my teeth makes me feel: good/bad; happy/sad; pleased/displeased	0.85
Perceived control	3	It is mostly up to me whether or not I brush my teeth (I can generally decide/it is mainly my decision): agree/disagree.	0.70
Subjective norm	3	People who care about me would like me to (want me to/think I should) brush my teeth: agree/disagree.	0.68
Self-efficacy	3	I think I will find it easy to (I am sure I will be able to/I am confident that I can) brush my teeth: agree/disagree.	0.78

Table 2: Predicting behavioural intention: correlation (and 95% CI) and multiple regression analysis of the direct measures.								
Variable	Mean	SD	1	2	3	4	R^2	Beta
1. Intention	4.55	0.62	-					
2. Attitude	4.47	0.64	.561** (0.51-0.6)	-			0.571	.258**
3. Subjective Norm	4.66	0.54	.361** (0.3-0.42)	.278** (0.22-0.34)	-			.103**
4. Perceived Control	3.83	1.02	.180** (0.11-0.24)	.157** (0.09-0.22)	.223** (0.16-0.29)	-		.007*
5. Self-efficacy	4.35	0.70	.711** (0.68-0.74)	.500** (0.45-0.55)	.340** (0.28-0.4)	.103** (0.04-0.17)		.546**

Note: ** $P < 0.01$; * $P < 0.05$; R^2 =squared multiple correlation; Beta=standardised regression coefficients.

Table 3: Correlation and multiple regression analysis of the indirect measures.					
	Mean	SD	<i>r</i>	Beta	<i>R</i> ²
Attitude					
Won't have toothache	20.40	5.57	0.12**	-.01	0.18
Will have strong teeth	23.45	3.39	0.15**	-.00	
Won't have bad breath	21.30	4.84	0.16**	-.02	
Will remove food from being stuck in my teeth	19.87	5.14	0.27**	.19**	
Will have clean teeth	23.89	2.84	0.26**	.17**	
Will stop teeth from rotting or falling out	22.99	4.01	0.19**	.09*	
Will have a nice smile	21.05	5.31	0.19**	.11**	
Won't have funny coloured teeth	22.95	4.18	0.12**	-.00	
Won't have to visit the dentist	18.43	6.99	0.09**	-.09	
Won't get sore gums	19.91	5.68	0.15**	-.01	
Won't have a build up of plaque	22.26	4.48	0.17**	.03*	
Subjective Norm					
My mummy thinks I should brush my teeth	21.31	5.12	0.27**	.20**	0.17
My daddy thinks I should brush my teeth	20.74	5.60	0.36**	.25**	
Other members of my family think I should brush my teeth	18.73	6.34	0.28**	.09*	
My dentist thinks I should brush my teeth	21.67	5.00	0.22**	.08*	
My friends thinks I should brush my teeth	13.96	6.89	0.25**	.17**	
My teacher/principal think I should brush my teeth	15.19	7.23	0.14**	-.10*	
Perceived Behavioural Control					
If I am tired I won't brush my teeth	3.85	1.21	0.38**	0.21**	0.22
If I had nicer toothpaste I would brush my teeth more often	2.70	1.51	-0.16**	-0.03	
Sometimes I can forget to brush my teeth	2.93	1.42	0.29**	0.12**	
If I got a treat for brushing my teeth I would brush my teeth more often	3.23	1.54	-0.14**	-0.02	
I brush my teeth so I won't get bullied	1.97	1.34	-0.03	0.04	
If I am in a rush I won't brush my teeth	3.90	1.21	0.36**	0.15**	
At the weekend, if I am staying at home I don't brush my teeth	4.35	1.03	0.32**	0.15**	

Note: * $P < 0.05$; ** $P < 0.01$; r =Pearson product moment correlation coefficient; R^2 =squared multiple correlation; Beta=standardised regression coefficients.

Round 1: submitted manuscript

Abstract:

Objective: The aim of the present study is to employ the theory of planned behaviour (TPB) to predict and explain intention and motivations to brush teeth among primary school children in Northern Ireland (NI). Design: Primary schools in NI were sorted by a number of key stratification variables and then randomly sampled. Twenty-seven schools took part in the research, and a questionnaire that incorporated both direct and indirect constructs of the TPB, related to tooth brushing behaviour, was administered to a sample of 867 year six school children. Results: Multiple regression analyses provided support for TPB; together the TPB constructs predicted 57.1% of the variance in intentions to brush teeth. Self-efficacy significantly affected intention and behaviour, followed by the influence of attitude, subjective norm and perceived control. Conclusion: The findings obtained in the present study suggest that the TPB is a useful framework on which to investigate children's tooth brushing intention, and provide the foundation for designing an intervention aimed at encouraging tooth brushing behaviour among children.

Introduction:

Poor oral health can negatively affect physical and psychological health and wellbeing (Sheiham, 2006). As a result, those with poor oral health are more likely to have reduced quality of life (Watt, 2005; WHO, 2003; Low, Tan and Schwartz, 1999), experience pain and suffering (Nuttall et al., 2006), feel embarrassment and have low self-esteem (Agou et al., 2008), encounter problems with eating, chewing and smiling (Steele et al., 1998), and have sleepless nights (Petersen et al., 2005; WHO, 2003). For children, those with poor oral health are often subject to peer bullying (Seehra, Newton and Dibiase, 2011) and their education can be adversely affected as they are 12 times more likely to miss days at school (Gift, Reisine and Larach, 1992). Northern Ireland (NI) has the poorest levels of oral health in the United Kingdom (UK) (HSCIC, 2015) with its children suffering the highest levels of dental caries in Europe (DHSSPS, 2007). Over half of 8 and 12 year olds (56% and 57%) have obvious decay experience in their primary/permanent teeth compared to the UK average (46% and 34% respectively) (HSCIC, 2015).

There is evidence to suggest that tooth brushing habits are most effectively sustained when they have been established at an early age. Not only does this result in a healthier mouth (Perinnetti, Caputi and Varvara, 2005) but, because good oral hygiene methods commenced early in life are more likely to be regularly continued throughout adolescence and into adulthood (Astrom, 2004; Kuusela et al., 1996). Adopting adequate tooth brushing habits during early childhood is therefore essential, especially as this is a crucial stage of child development when health-related behaviours that are practised routinely are more likely to be habitual (Almet et al., 2008; WHO, 1996). Evidence also indicates that children who adopt daily tooth brushing will reduce their risk of developing dental caries in their permanent and primary teeth by almost 13%, compared to those who have irregular tooth brushing habits (Twetman, 2009; Donaldson, 2008; Parnell et al., 2007; Whelton et al., 2006; Sheiham, 2001). Given these detrimental effects of poor oral health, there is a call for identifying the determinants of childrens tooth brushing intention in order to provide evidence for developing effective interventions designed to encourage good oral practices.

Psychological research evidence shows that intervention strategies aimed at changing attitudes and, ultimately, behaviour, are more successful if they are guided by empirically validated theory (Abraham and Michie, 2008; Michie and Abraham, 2004). A theoretical framework deemed particularly effective in the context of behaviour change is the Theory of

Planned Behaviour (TPB). The TPB suggests that individuals consider the implications of their actions before they decide to engage or not to engage in a given behaviour (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). According to the theory behaviour is determined by intentions, which in turn are the result of a combination of: attitude; subjective norm; and perceived control (Ajzen, 1991; Ajzen 1985). Indeed, the TPB has been endorsed by the National Institute for Health and Care Excellence (NICE) as an evidence based way of predicting health behaviour (Taylor et al., 2006), and has emerged as one of the most effective models for understanding, predicting and evaluating health-related behaviours (Ogden, 2012).

The majority of oral health related research underpinned by the TPB that has been conducted, tends to focus on the application of fissure sealants, flossing and dental services. While these studies support the utility of the TPB, where variances ranging from 31% to 46% have been explained, samples have been restricted to 15+ years (Bonetti et al., 2010; Luzzi and Spencer, 2008; Lavin and Groake, 2005). To date, only a small number of studies have identified the factors that influence tooth brushing behaviour where the theory has predicted variances of 32% (Buunk-Werkhoven, Dijkstra and van der Schans, 2011) and 76.9% (Pakpour and Sniehotta, 2012). Consistently, in both studies, perceived control emerged as the most significant predictor of tooth brushing intention. Furthermore, research driven by the TPB has tended to focus on adolescent and adult populations, with none aimed specifically at assessing and improving the health behaviour of children. In fact, as far as the authors are aware, there have been no published research studies applying the TPB among a sample of primary school children (under 12 years) and in the area of oral hygiene, i.e. tooth brushing. This is surprising given the popularity and success of the theory, and the growing importance of providing children with the skills to improve knowledge, attitude and behaviour to enable them to make appropriate decisions with the goal of establishing healthy lifetime habits (Kwan et al., 2005; WHO, 2003). Accordingly, given the limited work in this area, the present study aims to explore the attitudes and motivations of young people towards tooth brushing, to identify which factors are most influential in their decisions to brush their teeth, and to assess their relative importance.

Methods:

A cross-sectional design was employed whereby, in line with TPB research protocols, a self-completed questionnaire survey was utilised to collect data.

To achieve the target sample a list of all primary schools in Northern Ireland (NI) was obtained from the Department of Education for NI (DENI). The sample sought to be representative of each of the five Education and Library Boards (ELB) in NI, and of children from different socio-economic groups based on the extent of receipt of free school meals. The DENI uses free school meal (FSM) entitlement as a social indicator of deprivation, a state that is based on an aggregate level measure of relative poverty, low income and social disadvantage. Therefore, those schools receiving higher numbers of free school meals are reckoned to have a greater number of children from correspondingly deprived backgrounds.

The list of schools was stratified by both ELB and socio-economic group, and a stratified random sampling technique was employed to select schools to contact. Assuming a response rate in the region of 50% for research of this nature (Francis et al., 2004), contact was initially made with 50 primary schools, comprising ten from each ELB, care being taken to ensure that, within each ELB, a range of FSM percentages were selected. A letter detailing the aims, objectives and procedures of the study, along with an invitation to participate, was posted to each of the selected schools. Of the 50 schools contacted, 27 agreed to participate in the study. The researcher made contact via telephone and email with the 27 consenting schools and arranged suitable dates and times to visit each of them to administer the questionnaire measure. Completed questionnaires were received from 867 pupils: 442 male and 425 female.

The questionnaire

The findings from an elicitation study were used to construct the questionnaire (the questionnaire development process is reported in Davison, McLaughlin and Giles, 2016), which was subsequently divided into three sections. The first section gathered demographic information and section two assessed respondent's behavioural characteristics relating to tooth brushing. Specifically, tooth brushing behaviour was assessed by self-report, measured by asking respondents: Do you brush your teeth? (yes or no); and How many times per day do you brush your teeth? (0-4 times per day). The final section of the questionnaire incorporated all key constructs contained within the TPB and, as such, was operationalised using both direct and belief-based measures.

In line with Francis et al.'s (2004) recommendations, a generalised model of intention, attitude, subjective norm, perceived control and self-efficacy was adopted in this research

study (Table 1). Three items assessed each of the variables in line with the TACT principle of 'brushing teeth every morning and every evening this coming week'. Responses were recorded on a five-point Likert scale from 'strongly agree to strongly disagree'.

[Insert Table 1]

The indirect measure of attitude was based on 11 outcome evaluations and the corresponding behavioural beliefs. Respondents were first required to evaluate each outcome, for example, 'having toothache' on a good/bad dimension. They were then required to indicate the likelihood that each of these outcomes would occur if they were to brush their teeth, for example 'If I brush my teeth I won't have toothache'. Outcome evaluations were then multiplied by the corresponding behavioural beliefs and the summed product served as the belief-based measure of attitude.

The belief-based measure of subjective norm was derived from the expectations of six referents: mummy, daddy, other members of my family, dentist, friends and teacher/principal. Respondents were first required to indicate the extent to which each of their significant others would endorse their intention to brush their teeth. This was followed by a request to indicate the extent to which they were motivated to comply with the wishes of their significant others, across a five-point Likert scale (strongly agree to strongly disagree). Each normative belief was multiplied by the corresponding motivation to comply, and the summed product served as an indirect measure of subjective norm.

The indirect measure of perceived control was grounded on the seven beliefs elicited from the focus group discussions. Given the age of the sample, it was decided to base this measure on single items (Ajzen & Madden, 1986) because they are generally easier to operationalise. As such, respondents were required to indicate the extent to which each of the beliefs would encourage them to, or prevent them from, brushing their teeth, for example, 'If I am tired I won't brush my teeth' (very true to very untrue).

Results

Although 99.8% reported to brush their teeth, two respondents (0.2%) chose the 'no' response. For most, 94% brush their teeth in the morning and 87% before they go to bed, with 68% adhering to recommendations of twice-daily tooth brushing. Only 3% of the sample

reported that they do not go to the dentist, compared to 97% who do. Of those that visited the dentist, 60% go every six months and 8% once a year.

Predicting Intention

To identify the factors influencing school children's motivations to brush their teeth and to assess their relative importance, correlation and regression analysis were conducted on the main TPB constructs.

All of the direct TPB constructs were significantly correlated with tooth brushing intention ($p < .01$) with correlation ranging from 0.103 to 0.711 (Table 2). The strongest association with intention was self-efficacy, followed in descending order, by attitude, subjective norm and perceived control.

In terms of prediction, the model was able to account for 57.1% of the variance, $F(4,862) = 287.23, p < 0.01$, for tooth brushing intention. Of particular interest was the finding that self-efficacy was the strongest predictor ($\beta = 0.55, p < 0.01$) and that attitudes to brushing teeth ($\beta = 0.26, p < 0.01$), subjective norm ($\beta = 0.1, p < 0.01$) and perceived control ($\beta = 0.01, p < 0.05$) were positively and significantly, albeit to certain extents, related to intentions.

[Insert Table 2 and 3 here]

Explaining Intention

In order to enhance understanding of the reasons why some children were more likely to brush their teeth than others, the indirect measures were correlated with, and regressed onto, tooth brushing intention.

All of the behavioural beliefs correlated significantly ($p < 0.01$) with intention, with removing food from being stuck in my teeth ($r = 0.27$) and having clean teeth ($r = 0.26$) showing strongest associations. Likewise, all of the normative beliefs significantly correlated where daddy ($r = 0.36$) had the strongest relationship with intention. Meanwhile, six of the seven perceived control beliefs correlated, where being tired ($r = 0.38$) or in a rush ($r = 0.36$) showed the strongest link with intention among the sample.

The behavioural beliefs explained 18% of the variance in intention to brush teeth, $F(11, 855) = 11.40$, $p < 0.05$. Removing food from being stuck in teeth ($\beta = 0.19$), having clean teeth ($\beta = 0.17$) and having a nice smile ($\beta = 0.11$) were the most significant predictors. However, brushing teeth to stop them from rotting or falling out ($\beta = 0.09$) and to remove plaque ($\beta = 0.03$) also uniquely contributed to the variance in intention ($p < 0.05$). Similarly, 17% of the variance in intention to brush teeth was accounted for by the normative beliefs, $F(6, 857) = 30.12$, $p < 0.01$. Although one's father ($\beta = .25$, $p < .01$) was reported to be the most important referent, one's mother ($\beta = .20$, $p < .01$) and close friends ($\beta = .17$, $p < .01$) were also influential. The control beliefs accounted for 22% of the variance in intention, $F(7, 858) = 35.30$, $p < 0.01$. Being tired ($\beta = .21$, $p < 0.01$) was the most significant predictor in reducing intention, but being in rush ($\beta = .15$, $p < 0.01$), weekends ($\beta = .15$, $p < 0.01$) and forgetting ($\beta = .12$, $p < 0.01$) were also important.

Discussion

This study demonstrates that the TPB can usefully be employed to predict and explain tooth brushing intention of Northern Ireland's school children. All of the TPB constructs contributed significantly to the prediction of intention, explaining 57.1% of the variance. In fact, the unique contribution of the models components to the prediction of intention is marginally higher than that reported in previous studies with children (Martin et al., 2009; Foley et al., 2008; Trost et al., 2002), where variances of between 10% - 56% have been explained. In respect of oral health research, between 12% - 42% of the variance in intention to dental floss has been explained with adolescents (Rise et al., 1998) and university students (Lavin and Groarke, 2005), and 32% - 76.9% of the variance in tooth brushing behaviour has been found with adolescents (Pakpour and Sniehotta, 2012) and adults (Buunk-Werkhoven et al., 2011). Investigation of the indirect measures identified removing food, having clean teeth, and nice smile, as the main motivators for children to brush their teeth. Further, being tired, in a rush, weekends, and forgetting emerged as significant barriers to children's tooth brushing habits. Therefore, the results of the study provide support for the utility of the TPB in that attitude, subjective norm, perceived control and self-efficacy predicted intention to brush teeth. Furthermore, these present findings serve to identify which variables to target when designing an intervention.

In line with previous research, it was found that self-efficacy contributed most significantly to the prediction of intention thus indicating that self-efficacy perceptions are most influential in

the prediction of tooth brushing intention. Similar findings have been reported in the context of dental flossing and uptake of public dental services (Luzzi and Spencer, 2008; Tedesco et al., 1993). Applications of the theory in other contexts, e.g. physical activity, has found self-efficacy to generally increase the variance. In particular, Trost et al. (2002) report that self-efficacy significantly enhanced the prediction of intention accounting for an additional 15 - 22% of the variance over and above the other TPB variables. Thus, these findings clearly have practical implications and highlight the need for behaviour-change interventions to encourage tooth brushing behaviour, by targeting self-efficacy for the purpose of strengthening children's confidence in their ability to brush their teeth.

Consistent with previous research, attitude was also a significant predictor of tooth brushing intention (Luzzi and Spencer, 2008; Lavin and Groarke, 2005; Syrjala et al., 2002; Rise et al., 1998), with five of the 11 underlying beliefs correlating significantly with tooth brushing intention. These findings are favourable, reflecting respondents' recognition of the importance of tooth brushing: to remove food from being stuck in teeth; to have clean teeth and a nice smile; to stop teeth from rotting or falling out; and to remove plaque. In keeping with previous research with children, subjective norm was found to be one of the weaker predictors of tooth brushing intention. This finding is perhaps not surprising given that most parents equip children with tooth brushing knowledge and endeavour to generally reinforce tooth brushing routines in order to establish consistent lifetime habits. Parents usually supervise children's tooth brushing until at least six years, with some continuing to do so until 10 years (Sandstrom et al., 2011). Such evidence may imply that children aged 9-10 years face difficulties in adopting responsibility for their individual tooth brushing regimes, reaffirming previous research that children are reliant on their parents for reminding them of, and reinforcing engagement in, daily tooth brushing practice (Davison et al., 2016).

The present study has recognisable limitations which elicits direction for future research. First, as is often the case with TPB-based research, there was no measure of actual behaviour, tooth brushing behaviour was ascertained by self-report. Given the relatively low correlations often reported between intention and behaviour (Armitage and Conner, 2001), it is feasible that our measure of intention/motivation did not represent what happens in reality, or indeed, may have been inflated due to social desirability. Second, the way in which the behaviour was operationalised using the TACT principle may have been problematic. Children were asked how likely it is that you will brush your teeth every morning and every

evening this coming week. With hindsight, requiring children who typically live in the here and now to conceptualise 'this coming week' was perhaps too challenging and could have increased the likelihood of them responding more positively. Moreover, the introductory statements within the questionnaire were based on the assumption that respondents were going to brush their teeth every morning and evening. In future, it might therefore be advisable to define the behaviour in line with Martin et al. (2009) and refer with immediate time, i.e. every day. Finally, it might also be argued that tooth brushing is a habitual behaviour (Sandstrom et al., 2011) and therefore best explained by past behaviour. Certainly, this is often a criticism levied at the TPB and has caused many to add a measure of past behaviour to the variables contained within the model. According to Armitage and Conner (2001), in some cases, past behaviour may account for an additional 18% of the variance in intentions. Whilst a measure of past behaviour was employed in the present context, it was not detailed enough to contribute in any meaningful way to the statistical analyses. A more precise assessment of past behaviour might have helped to better explain behaviour in the present context and have enhanced our understanding of the role of habitual processes within the context of planned behaviour.

The current study provides support for the theoretical model of the TPB and has highlighted the importance of key theoretical constructs in predicting intentions to brush teeth among school children. It has also served to elucidate the relative importance of the factors influential in affecting children's motivations and decisions to brush their teeth. It is hoped that the findings reported here will serve to identify those variables that might provide the foundation for designing an intervention aimed at encouraging tooth brushing behaviour among a particularly at-risk group.

Acknowledgements

The authors would like to acknowledge the schools and their pupils, who gave of their time to participate in this research.

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Table 1: Details of the direct measures contained within the questionnaire.			
Theory of planned behaviour construct	n items	Sample Items	Alpha Coefficient
Intention	3	I am going (have decided/will try) to brush my teeth: agree/disagree	0.84
Attitude	3	Brushing my teeth makes me feel: good/bad; happy/sad; pleased/displeased	0.85
Perceived control	3	It is mostly up to me whether or not I brush my teeth (I can generally decide/it is mainly my decision): agree/disagree.	0.70
Subjective norm	3	People who care about me would like me to (want me to/think I should) brush my teeth: agree/disagree.	0.68
Self-efficacy	3	I think I will find it easy to (I am sure I will be able to/I am confident that I can) brush my teeth: agree/disagree.	0.78

Table 2: Inter-correlations data for the TPB constructs and tooth brushing behaviour (N=867).				
Variable	Intention	Attitude	Subjective Norm	Perceived Control
Intention	-			
Attitude	.561**	-		
Subjective Norm	.361**	.278**	-	
Perceived Control	.180**	.157**	.223**	-
Self-efficacy	.711**	.500**	.340**	.103**

Note: ** $P < 0.01$

Table 3: Multiple regression analysis predicting intention.				
<i>Variables</i>	<i>R</i>	<i>R²</i>	<i>R² adj</i>	<i>Beta</i>
Attitude				.258**
Subjective Norm	0.756	0.571	0.569	.103**
Perceived Control				.007*
Self-efficacy				.546**

Note: * $P < 0.05$; ** $P < 0.01$