

# The use of a mobile app to motivate evidence-based oral hygiene behaviour

B. Underwood,<sup>\*1</sup> J. Birdsall<sup>2</sup> and E. Kay<sup>3</sup>

## IN BRIEF

- Reviews the latest developments in mobile devices, mobile apps and health apps.
- Raises awareness of the potential of a mobile app to motivate and inform patients.
- Highlights the use of music to motivate toothbrushing for longer.
- Innovative tool to raise awareness of Delivering Better Oral Health toolkit information to the public.

**Introduction** Mobile apps are software programmes that run on smartphones and other mobile devices. Mobile health apps can help people manage their own health and wellness, promote healthy living and gain access to useful information when and where they need it. The Brush DJ oral health app was developed to use the opportunity mobile apps offer to motivate an evidence-based oral hygiene routine. A literature review has found no research investigating the use of a mobile app to motivate evidence-based oral hygiene behaviour. **Objective** The objective of this preliminary investigation was to assess user perception of an oral health app to give a basis for future research and development of app technology in relation to oral health. **Method** A cross-sectional qualitative user perception questionnaire. **Results** One hundred and eighty-nine people responded to the questionnaire. Seventy percent (n = 113) of respondents reported that their teeth felt cleaner since using the app. Eighty-eight percent (n = 133) reported the app motivated them to brush their teeth for longer and 92.3% (n = 144) would recommend the app to their friends and family. Four broad themes relating to how the app helped toothbrushing were reported. These themes were motivation, education, compliance and perceived benefits. **Conclusion** A mobile app is a promising tool to motivate an evidence-based oral hygiene routine.

## INTRODUCTION

### Mobile applications (apps)

Mobile apps are software programmes that run on smartphones and other mobile devices.<sup>1</sup> Over 75 billion apps have been downloaded from the Apple App Store<sup>2</sup> since its launch in 2008,<sup>3</sup> with over 50 billion apps downloaded from Google Play.<sup>4</sup> These apps have been downloaded onto just under 1 billion Apple iOS devices<sup>5</sup> and over 1 billion Android devices<sup>6</sup> around the world. As the number of these devices has increased, the price has reduced making them an affordable alternative to traditional mobile phones, with a £26 smartphone being available to UK consumers.<sup>7</sup> Global smartphone subscriptions have been predicted to grow to 5.6 billion by 2019.<sup>8</sup>

It is not just adults who own a device capable of running mobile apps, with a reported 81% of 13–18-year-old phone

owners in the UK owning a smartphone<sup>9</sup> and 88% of 16–24-year-olds.<sup>10</sup> The age of those able to use these devices is decreasing with OfCom reporting that six-year-olds understand digital technology better than adults.<sup>11</sup> As well as being used on smartphones, mobile apps can be used on tablet computers. In 2014 62% of children in the UK used a tablet computer at home, compared to 42% in 2013.<sup>12</sup>

### Health apps

The US Food and Drug Administration states:

‘The widespread adoption and use of mobile technologies is opening new and innovative ways to improve health and healthcare delivery. Apps can help people manage their own health and wellness, promote healthy living and gain access to useful information when and where they need it.’<sup>1</sup>

It is estimated that in 2015 half-a-billion people will be using healthcare mobile apps, with this figure increasing to 50% of the estimated 3.4 billion smartphone and tablet users by 2018.<sup>13</sup>

A survey carried out among patients in 2012 found 59% of respondents indicated that mobile health apps would change the way health information is sought and 50% felt that these apps will radically change the way they manage their chronic disease.<sup>14</sup>

Mobile devices are a useful means to deliver health interventions because of their widespread adoption, powerful technical capabilities, portability – people tend to have their mobile phones on them at most times and form strong emotional attachments to them.<sup>15</sup>

‘Sick or well, we have come to love our mobile devices. They are a source of immediate gratification: a powerful link to those we love, access to pictures, sports scores, movies and gossip about friends. That little device is so positive, so beloved. It connects us to the world.’<sup>16</sup>

This positive emotional attachment may benefit health promotion via a mobile device being accepted more readily than traditional means, especially among those who have grown up with the technology. People spend more time with their mobile phones than with their partners or at work, meaning health intervention can be delivered anytime and anywhere.

Health apps have been developed to manage various common medical conditions such as diabetes,<sup>17</sup> asthma,<sup>18</sup> pain<sup>19</sup> and dermatological conditions.<sup>20</sup> This latter example highlights the need for careful selection and regulation of apps, as an analysis of apps claiming to be able to assess melanoma risk found three out of four of the apps incorrectly classified 30% or more of melanomas as ‘unconcerning’.

<sup>1</sup>General Dental Practitioner and NHS Innovation Accelerator fellow, York; <sup>2</sup>Consultant Orthodontist, The Rotherham NHS Foundation Trust, Moorgate Road, Rotherham, S60 2UD; <sup>3</sup>Foundation Dean, Peninsula Dental School, Plymouth, Devon, PL4 8AA  
Correspondence to: Ben Underwood  
Email: bfuunderwood@btopenworld.com

**Oral health**

Poor oral health can affect someone’s ability to eat, speak, smile and socialise normally, due to pain or social embarrassment.<sup>21</sup>

Caries has been reported as the most common reason for children aged between five and nine being admitted to a hospital in England. The same report found that 70,000 children from birth to 16 years of age were admitted to hospital in England as a result of dental decay in 2012/13.<sup>22</sup> Hospital treatment has a significant financial cost to the NHS and therefore taxpayer. It is also a traumatic experience for the child, parent/carer and all those healthcare professionals involved. Surveys have reported periodontitis affects almost half of all adults in the UK.<sup>23</sup>

Evidence of the daily oral hygiene tasks adults and children need to carry out to prevent caries and periodontal disease is known.<sup>24</sup> Evidence is also available that a significant percentage of the population do not accomplish these daily tasks, with 33% of men brushing less than twice a day<sup>25</sup> and 59% of women regularly skipping brushing at bedtime.<sup>26</sup>

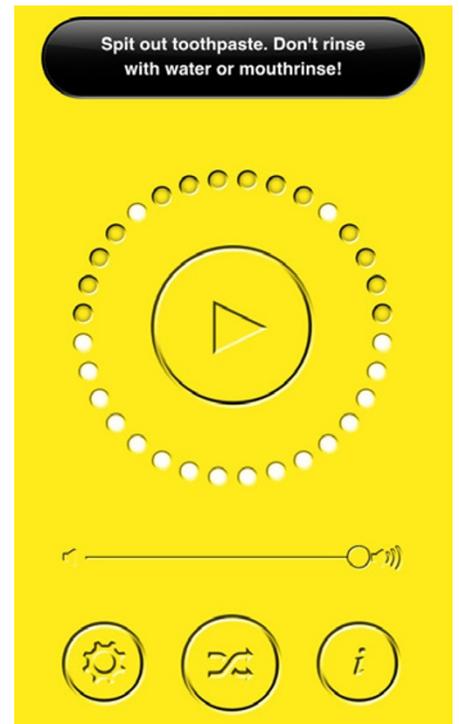
**Oral health app**

The Brush DJ app was developed to use the opportunity mobile apps offer to motivate an evidence-based oral hygiene routine. The app aims to motivate users to brush for two minutes by playing music, taken either from a playlist, or randomly, from the music stored

on the user’s device and cloud. The idea of using music to motivate brushing for longer is not new, with Clemens and Taylor reporting in 1980 the development of an audiotape combining music and instruction.<sup>27</sup> Listening to music in the bathroom has become more practical with the development of mobile devices with built in speakers.

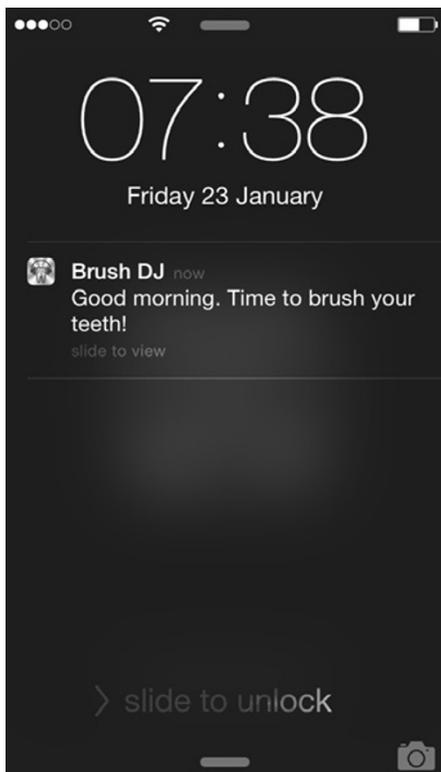
As well as playing two minutes of music, the app reminds users to spit out after brushing and not rinse, to maintain fluoride concentrations (Fig. 1). The app allows users to set reminders to brush twice a day, use a mouthwash at a different time of the day to toothbrushing (Figs 2–4), when their next dentist/hygienist/therapist appointment is (Figs 5,6) and to change their toothbrush every three months. By July 2014 over 1 million reminders had been sent to users of the app. It also contains the information for patients on how to prevent dental caries and periodontal disease given in the Public Health England document Delivering Better Oral Health: an evidence-based toolkit for prevention<sup>24</sup> (Figs 7–10). The app has links to the NHS Smokefree website,<sup>28</sup> NHS Choices Healthy Eating<sup>29</sup> and Alcohol websites.<sup>30</sup> The app also links to animated videos published on YouTube showing how to effectively use a manual toothbrush, floss and interdental brushes.<sup>31</sup>

The Brush DJ app was launched on the Apple App Store<sup>32</sup> in November 2011 and the Android Market<sup>33</sup> (now called Google Play) in March 2012. In 2013 the app was accepted into the NHS Choices Health Apps Library,<sup>34</sup>

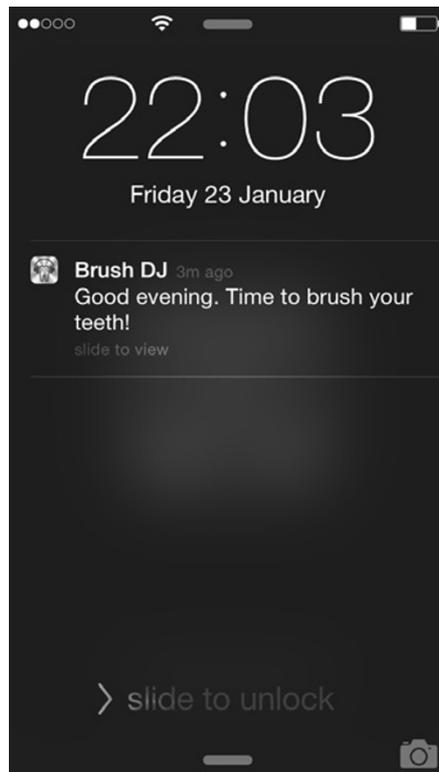


**Fig. 1** Screen shot from Brush DJ app showing reminder to spit out and not rinse after toothbrushing

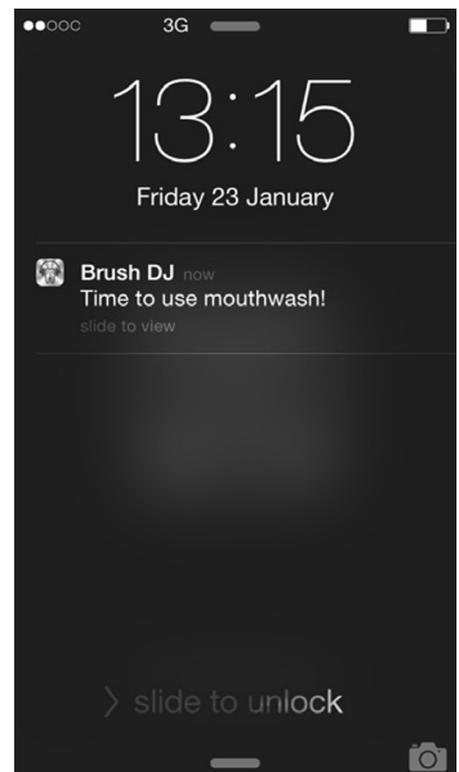
which aims to make it simple for people to find safe and trusted apps to help manage their health. All apps submitted to the library are reviewed to make sure that they are clinically safe, relevant to people living in England, comply with data protection laws



**Fig. 2** Screen shot showing reminder to brush in the morning



**Fig. 3** Screen shot showing reminder to brush in the evening



**Fig. 4** Screen shot showing reminder to use a mouthwash

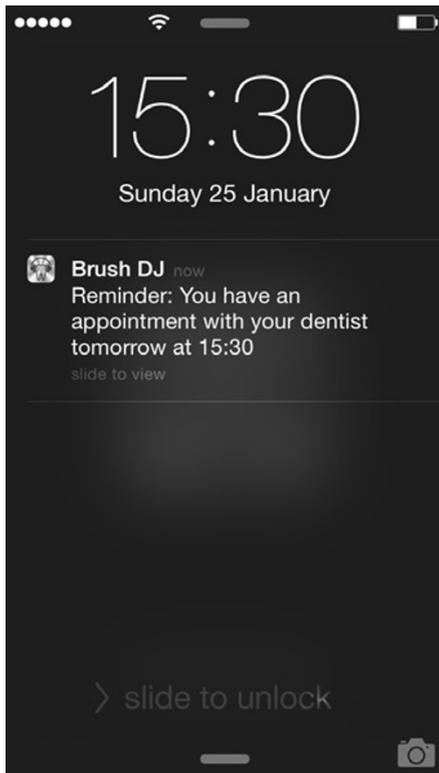


Fig. 5 Screen shot showing dentist appointment reminder – sent 24 hours before scheduled appointment

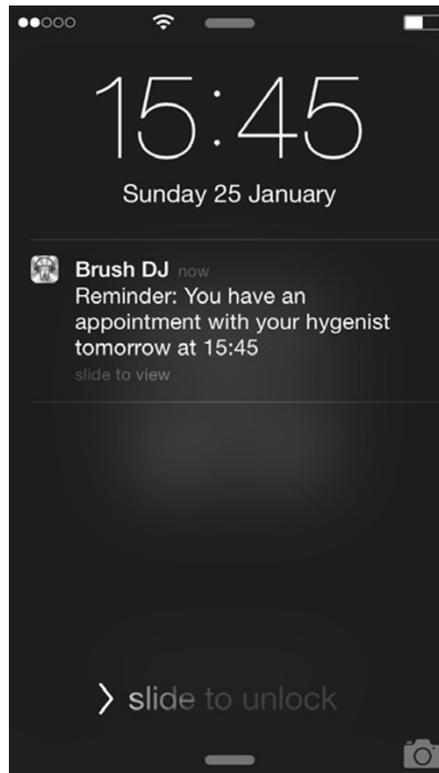


Fig. 6 Screen shot showing hygienist appointment reminder – sent 24 hours before scheduled appointment

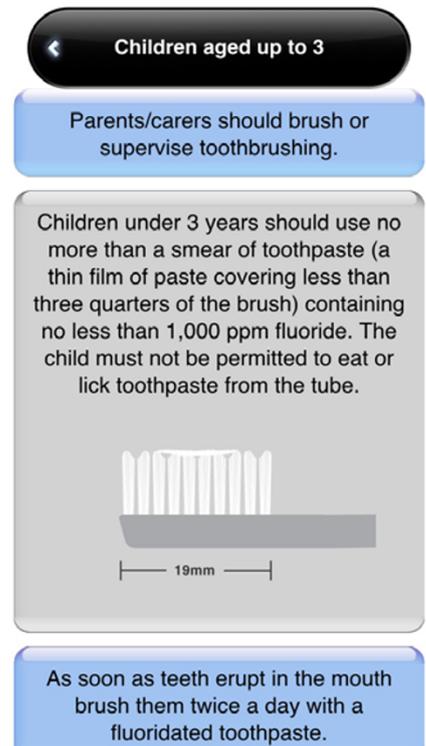


Fig. 7 Screen shot from Brush DJ app showing fluoride toothpaste information for children aged up for 3 years of age

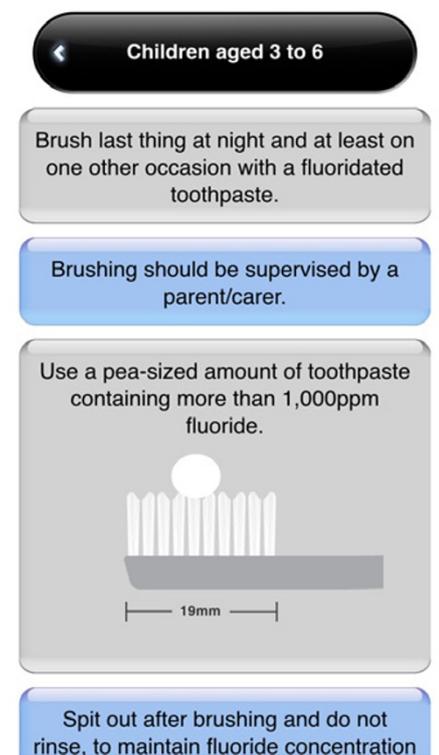


Fig. 8 Screen shot from Brush DJ app showing fluoride toothpaste information for children aged 3 to 6 years of age

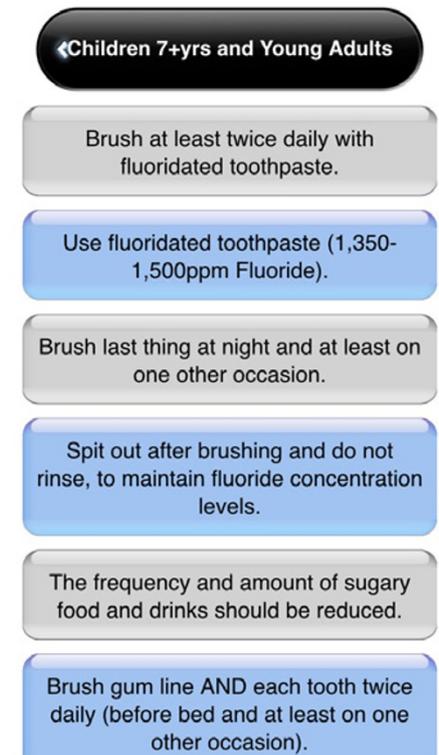


Fig. 9 Screen shot from Brush DJ app showing fluoride toothpaste information for children over 7 years old and young adults

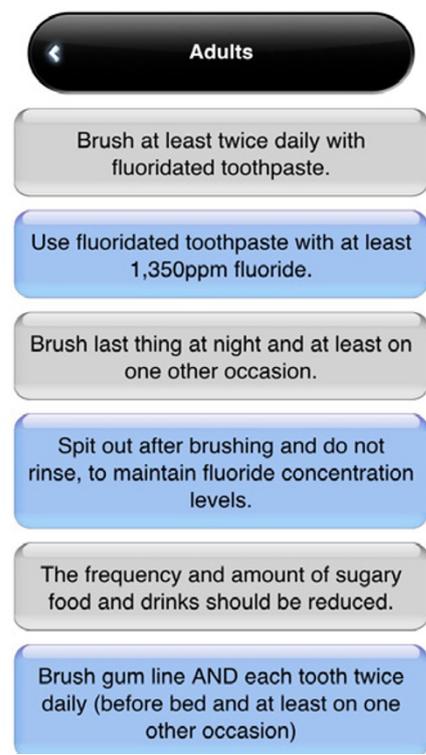


Fig. 10 Screen shot from Brush DJ app showing fluoride toothpaste information for adults

and comply with trusted sources of information. Once an app has met these minimum requirements it is checked to see whether it could potentially cause harm to a person's health or condition.<sup>35</sup>

By February 2015 the Brush DJ app had been downloaded on to over 155,000 devices in 182 countries. The app is free, with no adverts or in-app-purchases and it can be used with any type of toothbrush.

Before oral health apps can be recommended to patients and as a public health measure; the question of their effectiveness and cost effectiveness in comparison to existing methods of motivating an

evidence-based oral health routine need to be considered. A literature review found that no research currently exists investigating the use of a mobile app to motivate evidence-based oral hygiene behaviour.

## OBJECTIVE

The objective of this preliminary investigation was to assess user perception of an oral health app to give a basis for future research.

## METHOD

A cross-sectional qualitative user perception questionnaire to examine experiences and beliefs of people using the Brush DJ app was created using SurveyMonkey.<sup>36</sup> This was piloted, then updated from the feedback and piloted again before final distribution (contact the corresponding author for a link to the questionnaire).

The final questionnaire consisted of nine multiple choice questions, with space to give further details if none of the options was suitable and one open-ended question. The invitation to respond was via a pop-up notification, which appeared when the app was opened three times. The invitation gave the option to not take part in the survey, to be invited again to respond at a later date (this would result in the pop-up invitation appearing again after another three times opening the app) or to take part, which took the user to the questionnaire website page.

No incentives were offered to complete the questionnaire, which was designed to be completed on a smartphone or tablet and kept short to reduce respondent fatigue. Respondents could skip questions, if they preferred to. Ethical approval was not required as the participant in the survey were not randomised to different groups, the study did not demand changing treatment/patient care from accepted standards for any of the participants involved and the findings cannot be generalised.<sup>37</sup>

The updated version of the app, with the pop-up invitation to respond to the questionnaire was released on the 24 October 2014 to all iOS users of the app worldwide and on the 16 December 2014 to all Android users. This paper reports on responses up to the 29 January 2015.

## RESULTS

Due to the nature of reporting by the App Store and Google Play, it is not possible to know how many people saw the invitation to respond to the questionnaire. The possible sample consisted of anyone who opened the app on at least three occasions on a mobile device running iOS or Android software in any of 182 countries the app has been downloaded.

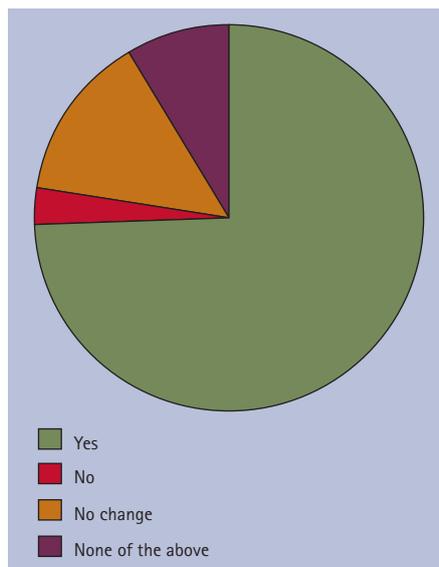


Fig. 11 Response to the question 'Since using the app, do your teeth feel cleaner?'

One hundred and eighty-nine people responded to the questionnaire. Of these 183 gave their gender, with the majority at 71.6% (n = 131) being female. The greatest number of respondents were from the 7–12 age group at 37.1% (n = 69) with 4.8% (n = 9) being under the age of seven (Table 1). Sixty-five percent (n = 120) of respondents had used the app for under one week and 6% (n = 11) had used the app for a year or longer.

In response to the question 'How many times in an average day do you brush your teeth?' 77.4% (n = 128) of respondents brushed at least twice a day and 20.6% (n = 34) reported brushing once a day. At 44.8% (n = 56) the majority of respondents used the Brush DJ app twice a day when brushing with 30.3% (n = 50) using it once a day and 11.5% (n = 19) using it more than twice a day.

Seventy percent (n = 113) of respondents reported that their teeth felt cleaner since using the app (Fig. 11) and 39.3% (n = 57) reported their gums bleed less, with 39.3% (n = 57) reporting no change in bleeding. Eighty-eight percent (n = 133) of respondents reported the app motivated them to brush their teeth for longer and 92.3% (n = 144) would recommend the Brush DJ app to their friends and family.

The final question asked of respondents was 'could you explain to me why the Brush DJ app helps your toothbrushing?' One hundred and thirty-one people responded to this question. These qualitative responses were examined using thematic analysis from which four broad themes relating to attitudes towards and responses to use of the app were given. These themes were motivation, education, compliance and perceived benefits.

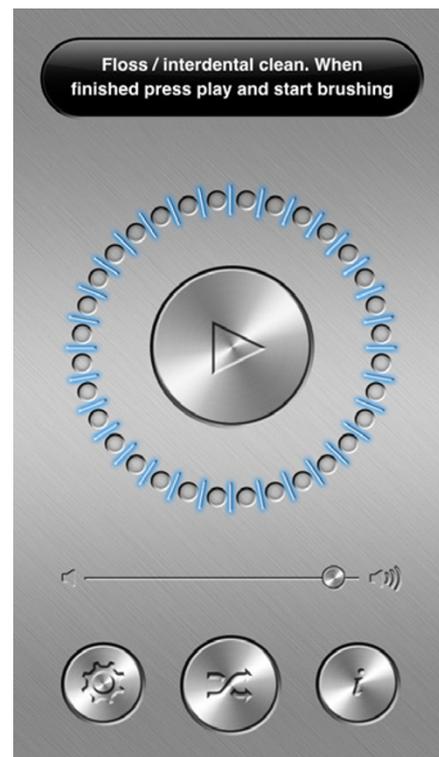


Fig. 12 Screen shot from Brush DJ app reminding users to interdental clean before brushing

## Motivation

The most frequently reported theme was that the app motivated various aspects of the user's oral hygiene routine. Respondents reported that the app motivated them to brush their teeth, to brush for longer, that they no longer found the process boring and in fact looked forward to brushing as they found it fun and enjoyed the music.

*'This app is very useful as brushing can be very boring, but who knew brushing could be so fun with a little bit of music. I've just recently started using this app as I never brushed my teeth very often, but with this app it motivates me! It makes that two minutes of brushing fun! Excellent app. Would recommend this to anyone who tends not to brush their teeth as it can be extremely boring!'* Female aged 13–17 years old.

*'Somehow two minutes seems to fly by for my son – a two minute egg timer dragged for him. He lives to get the applause at the end which is motivational.'* Male aged under 7 years old.

*'It makes brushing fun for my children. My youngest used to battle with me and now he loves brush time.'* Female aged 35–44 years old.

*'It helps me because I hated brushing my teeth and I would be too lazy to do it but now it motivates me to brush my teeth and it makes it fun.'* Female aged 7–12 years old.

**Table 1** Age of respondents to Brush DJ app user perception questionnaire

What is your age?		
Answer options	Response percent	Response count
under 7	4.8%	9
7 to 12	37.1%	69
13 to 17	11.3%	21
18 to 24	11.8%	22
25 to 34	12.9%	24
35 to 44	13.4%	25
45 to 54	7.0%	13
55 to 64	1.1%	2
65 to 74	0.5%	1
75 or older	0.0%	0
Answered question		186
Skipped question		3

## Education

After motivation, the next most common theme was education. Respondents reported that the app helped them carry out oral hygiene tasks in the correct order, that using the timer interface showed them to brush all of their teeth not just the front ones and that they found the videos helpful.

*'Before I usually only brushed for about 30 seconds because I never knew how long you should brush your teeth. The video was also really helpful.'* Female aged 18–24 years old.

*'It makes me do things in the right order and stops me from rinsing after brushing.'* Female aged 25–34 years old.

*'It helps keep me on track to brush for the right amount of time and I spend a lot more time on all the areas of my mouth (especially my molars) as opposed to just the front where it's easiest to brush.'* Female aged 25–34 years old.

*'I use the flashing spots to help me brush each part of my mouth.'* Male aged 7–12 years old.

## Compliance

The degree to which users followed the self-care advice given by the app was reported by a small number of users.

*'It reminds me that I need to brush at least twice a day and everyday! It times me too.'* Female aged 13–17 years old.

*'Keeps me on task. I also am a wanderer while I brush. So it keeps me in the bathroom focused on what I am doing.'* Female aged 35–44 years old.

*'Because I normally brush for 30 seconds to a minute and Brush DJ forces me to brush for two minutes. It's also fun because I can*

*listen to my playlist.'* Female aged 7–12 years old.

## Perceived benefits

Respondents reported a number of perceived benefits to their own or their children's oral health as a result of using the app.

*'I needed a timer to help know when I've brushed my two-year-old son's teeth long enough and this a fun and helpful tool. He will enjoy the music and I'll enjoy knowing his teeth are properly brushed.'* Male aged under 7 years old.

*'When I used to brush my teeth I would just put toothpaste on and scrub for about 30 seconds. After that my teeth still felt disgusting so I asked my dentist what would help. She said to time myself. I found this app and ever since then I have glisening teeth. Thank You Brush DJ!!!!'* Female aged 7–12 years old.

*'Because it helps to not get cavities and makes my teeth white.'* Male aged 13–17.

## DISCUSSION

The objective of this preliminary investigation was to assess user perception of an oral health app to give a basis for future research.

The majority of respondents were female and aged 7–12 years old. It is not possible to say whether this is the age and gender that most use the app or whether, as has been found in other studies, that young females are more likely to respond to a survey.<sup>38</sup> It is important to note that although the majority of respondents reported brushing their teeth twice a day, 20.6% reported only brushing once a day. The reason for this requires further investigation, the findings of which could be used to develop the app to include

an effective behaviour change techniques to motivate twice a day brushing in this group.

It is promising that 70% of respondents reported their teeth felt cleaner since using the app and 39.3% reported their gums bleed less. It is not possible to determine whether this perceived improvement in oral health corresponds to a reduced risk of caries and periodontal disease, but this does justify further investigation of the app with a clinical trial.

Eighty-eight percent of respondents reported the app motivated them to brush their teeth for longer. A study in the US found the average length of time people spend brushing their teeth was 46 seconds<sup>39</sup> and research has shown brushing for two minutes removes 26% more plaque than brushing for 45 seconds.<sup>40</sup> This increased length of brushing reported by users of the app is promising and the use of music appears to motivate this extended brushing time. Studies have shown listening to music while carrying out sport motivate increased lengths of activity by reducing fatigue and making the experience more pleasurable.<sup>41</sup>

Over 90% of users reported they would recommend the Brush DJ app to their friends and family. While the Friends and Family test has received criticism<sup>42</sup> it was felt by the authors to be a useful guide to the appeal of the app for this initial investigation. The 7% of respondents who would not recommend the app were not asked why in this preliminary investigation. This is something that needs investigating in future research to help improve the app.

The final question asked of respondents 'could you explain to me why the Brush DJ app helps your toothbrushing?' gave the greatest insight into users feelings and beliefs about the app. Motivation was the most reported theme. This was motivation of the individual user of the app and for parents the motivation of their child/children to toothbrush. Motivation to brush due to the reminders (Figs 2–4) was also given as a reason the app helped toothbrushing.

The second major theme to emerge was education. It is important that if people are going to change behaviour they are being educated to use a new behaviour that is evidence-based. The helpfulness of the animated videos showing how to carry out oral hygiene tasks was reported. The use of animated videos to convey a health message has been shown to be effective resulting in long-term knowledge retention.<sup>43</sup> Given an estimated 5 million videos are viewed on YouTube every 60 seconds, compared to 2.66 million Google searches, video is a useful means of communication and health promotion.<sup>44</sup> Any future research should

measure oral health knowledge before using the app and after its use in the short and long-term.

Health apps have been justifiably criticised for not using recognised behaviour change techniques.<sup>45</sup> The app investigated in this study uses a number of recognised behaviour change techniques<sup>46</sup> to motivate an evidence-based oral health routine.

- Instruction on how to perform an activity: animated videos give instructions on how to use a manual toothbrush, floss and use an interdental toothbrush
- Demonstration of the behaviour: animated videos demonstrate how to use a manual toothbrush, floss and use an interdental toothbrush
- Prompts/cues: prompts use of the app (Figs 2,3), prompts users to interdental clean before brushing (Fig. 12), prompt to users to spit out, not rinse after brushing and cues to move to different parts of the mouth visually, by a vibration and a sound after each 30 seconds
- Social reward: users can share the name of the song and artist they have listened to via social media
- Nonspecific reward: users are rewarded with a smile and applause when they achieve two minutes of brushing (Fig. 1).

Theoretically, the use of an app to raise awareness of evidence-based oral health information has financial advantages over traditional methods such as leaflets as there is no printing, storage, distribution, or disposal cost associated with an app. Apps are instantly scalable and updatable with the cost of producing one app being the same as any multiple, unlike a physical product. Apps can use local reminders generated by the app itself, so they have an advantage over text message reminders, which have been used to motivate better oral health.<sup>47</sup> Text messaging offers only passive engagement and can have a financial cost to the receiver and sender. Text messaging requires a person to give out their telephone number, which then needs to be stored giving possible concerns about confidentiality and data protection. The cost effectiveness of an app requires further investigation.

If further research provides evidence that apps are more or equally effective as medications used to treat and prevent dental disease, prescribing an app in the same way fluoride toothpastes are currently prescribed in the UK, would be reasonable. A cardiologist in the US has reported prescribing more apps to his patients than medications.<sup>48</sup> In the US low income consumers are given a

discount on phone services in an initiative unofficially named the 'Obama phone'.<sup>49</sup> This could reduce the barrier to uptake of mobile apps in a socioeconomic group that has a high risk of dental disease.<sup>50</sup>

### Study limitations

For this preliminary investigation it was decided that a questionnaire was the most practical and effective way to gather information. The use of a questionnaire allowed for large amounts of information to be gathered in a relatively short period of time in a cost effective manner. As an anonymous questionnaire it allowed recruitment to be undertaken from those who downloaded the app. However, it is recognised that this study has limitations and is preliminary in nature. The option to complete the questionnaire was offered to users of the app after it had been opened at least three times, but it is not possible to know how many users saw the questionnaire and therefore it is impossible to quantify the response rate. It is recognised that the voluntary nature of participation in this study probably introduced bias to the findings, as it is known that people are much more likely to respond to questionnaires concerning subjects about which the respondent feels positive. However, even if only a small proportion of people introduced to the app react to it in the way the respondents describe, the app still appears to have great potential to improve the oral health of those who use it.

The questionnaire permitted respondents to skip questions, this was deliberately allowed as it is recognised that questionnaires, which force the respondent to answer a question before continuing may discourage the completion of the questionnaire.<sup>51</sup> It can be argued that questionnaires cannot be accurately used to measure changes in behaviour as they rely on recall, truthfulness, interpretation of the questions, and the thought the responder has put into answering each question.<sup>52</sup> The questionnaire was developed by the app owner and as such was subject to researcher imposition, which might have resulted in questions being developed on the researchers own assumptions of what is important to the user. Despite its limitations, this study may mark the start of an important new era in oral health promotion, in which traditional methods are replaced by technology driven, evidence-based, psychologically sound interventions as it clearly demonstrates the substantial potential that mobile technology has to personalise and promote positive health behaviours.

### CONCLUSION

A mobile app is a promising tool to motivate an evidence-based oral hygiene routine.

Further research to assess effectiveness and cost effectiveness of an app compared to current methods used to motivate an evidence-based oral hygiene routine in the population is needed.

### Acknowledgements

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### Declaration of interests

Ben Underwood is the owner of the Brush DJ app.

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