3

Stage-specific effects of an action control intervention on dental flossing

Schüz, B., Sniehotta, F. F., & Schwarzer, R. (2007). Stage-specific effects of an action control intervention on dental flossing. *Health Education Research, 22*, 332-341.

Abstract

Health behavior interventions may have different effects when targeting individuals at different stages of change. A *motivation* stage, during which intentions are formed, has been distinguished from a *volition* stage, implying that the latter requires self-regulatory effort in implementing and maintaining behavior. To test this stage assumption, an action control intervention (self-monitoring tool for dental flossing) matched to the volition stage and mismatched to the motivation stage was provided to 151 university students, with follow-up measures of action control and flossing after 2 and 6 weeks. Separate regression analyses for motivational and volitional participants indicated that only volitional participants benefited from the volitional intervention. This supports the usefulness of stage assumptions and the advantage of tailoring interventions to participants who reside either in the motivational or in the volitional stage.

Key words

Stage theories, action control, self-regulation, dental flossing, match-mismatch test

3.1. Introduction

A major aim of health education is to provide evidence-based information and tools for maintaining or improving health and to promote individual health behavior change. Evidence from recent research suggests that informing and motivating people is a necessary, but not sufficient condition for behavior change [1]. Despite being informed and intending to act healthily, many people fail to conduct and maintain health behaviors, suggesting that taking an informed decision to act and translating this intention into practice are two distinct processes [2].

This gap between intention and behavior is particularly pronounced in repetitive everyday self-care behaviors such as oral hygiene. Dental flossing, for example, is an indispensable supplement to tooth brushing in order to prevent oral diseases such as gingivitis, periodontal disease, and interdental caries [3]. Oral diseases not only impair quality of life [4], they also establish risk factors for cardiovascular disease [5]. The American Dental Association (ADA) and the British Dental Association (BDA), therefore, recommend interdental flossing as part of the daily oral care routine [6, 7]. However, prevalence of dental flossing is low [8].

Previous research using social-cognitive theories of behavior has shown that motivational factors, such as behavioral intentions and self-efficacy, are predictive of dental flossing [9]. There is also evidence that most of the variance in behavior is unaccounted for by motivational factors, and, more important, that interventions based on social cognition models fail to result in sustainable effects on behavior. For example, an intervention study based on Social Cognitive Theory [10] found limited support for the efficacy of theory-based interventions. Experimental groups outperformed controls during treatment periods, but flossing rates approximated baseline soon after the intervention ceased. In summary, this line of research suggests that translating good intentions into oral self-care behavior may cause volitional problems not addressed in social-cognitive theories of behavior.

3.1.1. Stage Theories of Health Behavior Change

Stage theories offer a framework for understanding and modifying behavior change taking different motivational and volitional states into account. They assume that individuals move through qualitatively different stages during the process of behavior change [11-13]. Among the defining criteria for stage theories, Weinstein, Rothman, and Sutton [14] note (a) common barriers towards change for individuals in the same stage, and (b) different barriers towards change for individuals at different stages. This allows matching psychological interventions to stages by addressing stage-specific psychosocial factors and stage-specific barriers. Treatments mismatched to

a person's stage might cause reactance, disappointment, and dropout. Tailoring interventions to specific stages may prevent from such negative effects.

Despite differences in numbers of stages and processes relevant for stage progressions, stage theories such as the Transtheoretical Model (TTM;[11]), the Precaution Adoption Process Model (PAPM;[13]), and the Health Action Process Approach (HAPA;[12]) distinguish between persons who have not yet decided to change their behavior (predecisional or *motivational* stage) and those who have decided to change or who have already implemented the changes and perform the target behavior (postdecisional or *volitional* stage [2, 14, 15]). In the motivational stage, cognitions about the target behavior, such as outcome expectancies and self-efficacy, characterize a deliberative decision process. This deliberation process cumulates in forming intentions, and individuals commit themselves to a certain behavior. Immediately after intentions are formed, a person's focus and mindset shift from motivation to volition, to the initiation and maintenance of behavior. Here, volitional processes, such as action control [16-18], help translate intentions into action.

According to stage assumptions, participants can be classified as being *motivational* when they have not yet formed behavioral intentions, and as being *volitional* after they have committed themselves to behavior change.

3.1.2. Validity of Stage Theories

The empirical evidence for stage theories, especially the TTM, is poor. After decades of research, there is no clear evidence that stage-matched interventions based on the TTM are more effective than others, or indeed effective at all [19-24]. A systematic review on TTM-based interventions [19] accordingly found only scarce support for stage-matched interventions and finer differentiations of the volitional stage.

Successful applications of stage-matched interventions have been built upon the broader discrimination of a motivational and volitional stage, rather than using finer stage differentiations, especially in the TTM [25]. For example, in a study on home radon testing [26], a motivational intervention (risk communication), a volitional intervention (information on easily available protection measures), and a combination of both were randomly delivered to participants in the motivational and the volitional stages. The combination intervention was most effective in both groups. However, participants in the volitional groups equally benefited from the volitional intervention, thus supporting the idea of stage-matched interventions.

The motivation-volition distinction is also supported by research on planning (implementation intentions). Forming definite plans on when, where and how to act leads to medium-to-large effects on goal attainment only if individuals have previously formed a goal intention [15]. Thus,

the present study examines stage-specific intervention effects focussing on volitional *action control* [17, 18]:

3.1.3. Action Control

Similar to planning (implementation intentions) [27, 28], action control touches upon the volitional phase of health behavior regulation, after people have decided to engage in a specific activity. While planning is a prospective *ex-situ* strategy, that is, behavioral plans are made *before* the situation specified in the plan is encountered [29], action control is an *in-situ* self-regulatory strategy, where actual behavior "on the scene" is evaluated with regard to a self-set behavioral standard [30]. Differences between actual behavior (e.g., flossing frequency) and the self-set standard (e.g., flossing daily) lead to compensatory action (increased flossing frequency) to reduce these discrepancies. This idea is based on negative feedback loops [16, 31] derived from cybernetic (feedback-based) regulation models [31].

Previous research has shown that action control, comprising the facets *self-monitoring*, *awareness of standards,* and *self-regulatory effort,* can be understood as a proximal predictor of behavior, mediating the effects of intentions and planning [28]. Although these facets represent conceptually distinct actions during the process of self-regulation, they are effective only complementarily, and they can therefore be seen as indicators of one construct [18, 28]. As self-regulation based on feedback loops depends on reference values (standards), it is hypothesized to be only effective in individuals who have set themselves standards in terms of intentions (i.e., *volitional* individuals). Interventions targeted at increasing action control have been based on enhancing self-control capacities by providing self-monitoring tools [30, 32]. In this study, a dental flossing calendar was developed to increase self-regulation based on negative feedback loops.

3.1.4. Aims of the Study

The present study does not intend to evaluate a program or to demonstrate that a treatment group outperforms a control group. Instead, it investigates stage-specific effects of an action control intervention, that is, whether the generally administered treatment operates better in a specific subgroup. In particular, it is hypothesized that:

1. The action control intervention (dental flossing calendar) leads to higher action control levels at Time 2, thus indicating volitional effects.
2. The action control intervention does not increase behavioral intentions, thus indicating no motivational effects.
3. Action control facilitates flossing behavior in volitional individuals only (stage-matched condition), thus indicating qualitative differences between behavioral stages.

These hypotheses were examined in a study with three measurement points in time over a six-week period.

3.2. Method

3.2.1. Participants and Procedure

During the term, 258 undergraduate psychology and educational science students were invited to participate in the study, of which 252 (97.67%) agreed and filled in questionnaires assessing behavioral stage, flossing intention, and baseline measures of flossing and action control. All participants received sample boxes of dental floss (5 m) and were shown slides with flossing instructions based on the recommendations of the ADA [6]. The action control intervention was based on a self-monitoring tool (dental calendar). Self-monitoring is a crucial part of volitional self-regulation [17, 18], triggering the comparison between intended and actual behavior. Time 2 questionnaires were sent two weeks later with another sample of dental floss and a stamped return envelope. Participants were asked to return the questionnaire together with the leftover (residual) dental floss in order to confirm self-reports of behavior. Time 3 questionnaires were sent with stamped return envelopes four weeks after Time 2.

Data were available at all three measurement points for 157 participants (62.3% of the original sample). Stage assessments were available from 151 persons. The remaining 6 participants, therefore, were excluded from further analyses. To check for systematic dropout, a MANOVA was conducted. No differences were found in intentions, action control, and flossing between those participants who completed all questionnaires and those who only completed the first one, suggesting that the final longitudinal sample was representative of the initial sample ($F(3,254) = 1.15$, *ns*). Those persons who completed all questionnaires were classified as being *volitional* significantly more often than those who had only completed the first questionnaire ($\chi^2 = 5.57$; $df = 1$; $p = .02$). Participants comprised 122 women and 29 men. Mean age was 25.15 years ($SD = 6.99$).

3.2.2. Action Control Intervention

A dental calendar was designed to enhance action control processes. The calendar comprised a cardboard sheet with three rows representing the weeks and seven columns representing the days. Participants were instructed to deposit the calendar in their bathroom and tick every day they flossed their teeth for the next two weeks. Self-monitoring tools such as calendars have been found effective in enhancing self-regulation via action control [30, 32, 33].

3.2.3. Measures

In the Time 1 questionnaire, the baseline for the dependent variable (flossing) was assessed with the items "How often did you use dental floss *during the last week*?" and "If you do *not* use dental floss on a weekly basis, how often did you use dental floss *during the last month*?" In the Time 2 and Time 3 questionnaires, flossing was assessed with the questions "How often did you use dental floss during the *first (last)* of the last two weeks," or "How often did you use dental floss during the *first* (*second, third, last*) of the last four weeks?" The validity of Time 2 self-reported behavior was examined by correlating it with the residual dental floss available from $n = 95$ participants ($r = .69$; $p < .01$). The dependent variable for the longitudinal analysis, Time 3 flossing, was the sum of the responses to the flossing behavior items in the last questionnaire.

Behavioral Stages

Participants were classified into the *motivational* and *volitional* stages using a staging instrument approximately based on Weinstein, Lyon, et al. [26]. After the question "What do you think about using dental floss?" participants were asked to tick one of the following statements: (1) "I know what to use dental floss for," (2) "I have thought about using dental floss before," (3) "I have resolved to floss my teeth," (4) "I have already used dental floss," (5) "Currently, I am using dental floss," (6) "I am flossing as often as I intend to," and (7) "Flossing is habitual to me and requires no effort at all." According to the stage assumptions outlined above, participants choosing Items 3-6 and beyond were classified as being *volitional*, all others were classified as being *motivational*.[5]

Items for intention and action control were all assessed on four-point rating scales ranging from *totally disagree* (1), *disagree* (2), *agree* (3) *,* to *totally agree* (4), and scale scores were obtained by averaging item responses.

Intention ($\alpha = .87$) was assessed in the Time 1 questionnaire by three items based on Rise, Åstrøm and Sutton [9], such as "I intend to use dental floss regularly at least 2-3 times a week for the next four weeks." *Action control* was assessed at Time 1 ($\alpha = .91$) and Time 2 ($\alpha = .93$) by adapting the action control instrument [28] to dental flossing. Three items were used to assess the *self-monitoring facet*; examples are: "In the recent past, I have consistently monitored myself whether I have flossed as often as I intended to," "At the moment, I watch carefully whether I find enough time for cleaning my interdental spaces," and "At the moment, I pay close attention to really flossing my teeth regularly." The *awareness of standards facet* was assessed by three items: "Currently, I have my intention to regularly floss my teeth always in mind," "I am always aware when, where, and how I wanted to floss my teeth," and "At the moment, I often think about my plans to clean my

[5] In order to examine the discriminant validity of the stage construct and intentions, non-parametric correlations were examined. A correlation of $\tau = .42$ (Kendall's τ ; $p<.01$) indicates that only 18% of intention variance is being accounted for by stages. Thus, sufficient discriminant validity of the stage construct can be assumed.

interdental spaces." The action control facet *self-regulatory effort* was assessed with four items: "At the moment, I really try to follow the recommendations for flossing," "I try my best to floss my teeth as often as I intended," "If necessary, I pull myself together to regularly clean my interdental spaces," and "Currently, I really try to act exactly in accordance with my intentions for dental care."

3.2.4. Analytical Procedure

Repeated measures ANOVAs with action control as the dependent variable were conducted to examine the effect of the action control intervention. After that, residualized change scores from regressing action control Time 2 onto action control Time 1 were obtained as indicators of the individual change during the intervention on action control.

In order to detect different effects of change in action control for motivational and volitional participants, Time 3 flossing behavior was regressed separately for motivational and volitional participants on Time 1 flossing, intentions, and change in action control, according to Baron and Kenny [34], who recommended to analyze multiple group models for categorical moderators.

Variable	1	2	3	4	5	α
1. Time 1 Flossing	1	.64**	.61**	.48**	.60**	[a]
2. Intentions		1	.68**	.62**	. 53**	.87
3. Time 1 Action Control			1	.60**	.43**	.91
4. Time 2 Action Control				1	.54**	.93
5. Time 3 Flossing					1	.95

Note. $^{**}p < .01$; [a]single item

Table 3.1: Internal Consistencies (Cronbach's α and Intercorrelations)

3.3. Results

Scale reliabilities were very satisfactory (see Table 3.1). All study variables were intercorrelated, indicating that the data set is suitable for multiple regression analysis.

3.3.1. Missing Values

Missing values (< 5% on all variables) were imputed using the expectation maximization (EM) algorithm [35] in SPSS 12. Deleting cases with missing values would only be appropriate if data were missing completely at random [36]. EM estimation has been recommended to estimate data missing at random and has proved more robust than regression imputation [37].

3.3.2. Motivational and Volitional Participants

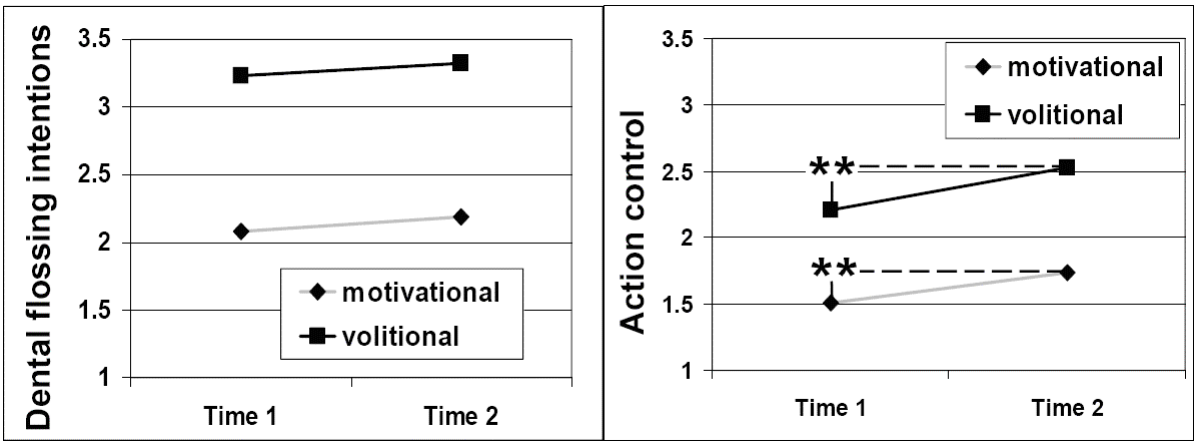
From the longitudinal sample, 47 participants (32 women and 15 men) were classified as being *motivational*, and 104 (90 women and 14 men) were classified as being *volitional*. Significant differences between motivational and volitional participants were found on all variables (see Table 3.2), indicating higher levels of Time 1 flossing, intentions, Time 1 action control, Time 3 action control, and Time 3 flossing in volitional participants.

Variable	Group	Range	*Mean*	*SD*	*T*	*p*
Time 1 Flossing	Total sample	0-7	2.03	2.42	6.83	<.01
	Motivational		.50	1.47		
	Volitional		2.71	2.46		
Intentions	Total sample	1-4	2.88	.94	8.56	<.01
	Motivational		2.08	.81		
	Volitional		3.24	.75		
Time 1 Action Control	Total sample	1-4	1.99	.74	5.98	<.01
	Motivational		1.51	.60		
	Volitional		2.21	.73		
Time 2 Action Control	Total sample	1-4	2.28	.82	5.50	<.01
	Motivational		1.74	.63		
	Volitional		2.53	.77		
Time 3 Flossing	Total sample	1-28	10.51	8.99	5.66	<.01
	Motivational		5.43	6.59		
	Volitional		12.81	9.02		

Table 3.2: Means, Standard Deviations (SD), and t Values for the Difference Between Motivational and Volitional Participants

3.3.3. Action Control

A repeated-measures ANOVA with stage as between-subjects factor indicated that action control increased significantly from Time 1 to Time 2, ($F(1,150) = 20.04$, $p < .01$; $eta^2 = .12$) with a significant main effect of stage ($F(1,150) = 48.56$, $p < .01$; $eta^2 = .25$ No interaction effect for Time x Stage was found , indicating that the distribution of the self-monitoring calendar corresponds with increasing levels in action control irrespective of stage, thus indicating the intended effect on a volitional variable ($F(1,150) = .61$, *n.s.*; $eta^2 < .01$). A similar repeated-measures ANOVA with intentions as the dependent variable was conducted to examine whether the distribution of the calendar affected motivation, that is, whether intentions increased as well. Neither a significant time effect ($F(1,150) = 2.11$, *n.s.*; $eta^2 = .01$) nor an interaction for Time x Stage ($F(1,150) = .03$, *n.s.*; $eta^2 < .01$) was found. This indicates that the intervention had volitional effects (increasing action control), but had no motivational effects (no increase in intentions).



Note. ** $p < .01$

Figure 3.1: Estimated Marginal Means of Intentions and Action Control in Motivational and Volitional Participants at Time 1 and Time 2

3.3.4. Action Control and the Prediction of Behavior

The main hypothesis was that there are stage-specific effects of changes in action control. Intervention effects on action control were hypothesized to be beneficial for volitional participants only. According to Baron and Kenny [34], these differences were examined by running hierarchical linear regression analyses separately for motivational and volitional participants. Time 3 dental flossing was regressed onto baseline flossing in the first step in order to predict behavior change. Intentions were entered in the second step. In the last step, the residualized change score of action control as indicator of individual effects of the intervention [38] was entered. This residualized change score was obtained by regressing Time 2 action control onto Time 1 action control (Adjusted $R^2 = .35$; $\beta = .60$; $p < .001$).

In the first step, baseline behavior obtained significant β values in both groups, $\beta = .54$, $p < .01$ for motivational and $\beta = .50$, $p < .01$ for volitional participants. Both equations were significant (motivational: $F(1,46) = 18.37$, $p < .01$, $R^2 = .29$; volitional: $F(1,103) = 34.07$, $p < .01$, $R^2 = .25$). Intentions in the second step obtained a significant β only in the motivational group ($\beta = .30$, $p < .01$). In the volitional group, the β value was not significant ($\beta = .17$, *n.s.*). The increase in variance explained was significant in the motivational group only ($F(1,45) = 5.22$, $p = .03$; $\Delta R^2 = .08$; volitional: $F(1,102) = 2.42$, *n.s.*; $\Delta R^2 = .02$). This suggests that motivation (level of intention), is a significant predictor of behavior change in motivational participants only.

In the third step, the residualized change score of action control was entered as indicator of individual changes in action control. A highly significant β was obtained in the volitional group ($\beta = .29$, $p < .01$), but not in the motivational group ($\beta = .11$, *n.s.*). The increase in variance ex-

plained was significant in the volitional group only ($F(1,101) = 12.32$, $p < .01$; $\Delta R^2 = .08$; motivational: $F(1,44) = .85$, *n.s.*; $\Delta R^2 = .01$). Thus, change in flossing can be predicted by intentions in *motivational* participants and by action control changes in *volitional* participants. These findings demonstrate that motivation can predict behavior change only in motivational participants. Volitional processes, indicated by changes in action control, in turn predict behavioral change in volitional persons only.

Step	Variable Entered	Group	beta Step 1	beta Step 2	beta Step 3
1	Time 1 Flossing	Motivational	.54**	.41**	.40**
		Volitional	.50**	.41**	.43**
2	Intentions	Motivational		.30**	.28**
		Volitional		.17 *n.s.*	.11 *n.s.*
3	Change in action control	Motivational			.11 *n.s.*
		Volitional			.29**
ΔR^2		Motivational	.29	.08	.01
		Volitional	.25	.02	.08
ΔF		Motivational	18.37**	5.22**	.85 *n.s.*
		Volitional	34.07**	2.42 *n.s.*	12.32**
R^2		Motivational	.29**	.37**	.38**
		Volitional	.25**	.27**	.35**

Note. $^{**}p < .01$.

Table 3.3: Hierarchical Linear Regression Analyses of Time 3 Flossing on Time 1 Flossing, Time 1Intentions and Change in Action Control from Time 1 to Time 2 for Motivational and Volitional Participants

These findings confirm the main hypothesis, namely that there are qualitative differences in behavioral self-regulation between motivational and volitional stages of behavior change.

3.4. Discussion

This study aimed at testing qualitative differences between the motivational and volitional stage of health behavior change. We examined the key assumption of stage models that different barriers towards change in each stage require different self-regulatory processes. The self-monitoring intervention in this study aimed at increasing action control, a strategy to control the execution of intended behavior. Thus, it is matched to the volitional and mismatched to the motivational stage of health behavior change. Volitional constructs, such as action control, are important means to test stage models of behavior change, as previous research has mainly focused on motivational variables [39].

3.4.1. Effects of the Action Control Intervention

The intervention was associated with increases in action control in all participants, regardless of behavioral stage, indicated by a nonsignificant Time x Stage interaction. No increases in intentions were found. However, there were significantly higher levels of action control in volitional participants at all measurement points. This is in line with the assumption that action control based on self-monitoring, awareness of standards, and self-regulatory efforts is a relevant strategy for individuals in the volitional stage only.

3.4.2. Stage-Specific Effects of Increases in Action Control

In order to examine stage-specific effects of action control, hierarchical regression analyses were conducted separately for motivational and volitional participants. Change in action control was predictive of changes in dental flossing in volitional participants only, intentions were not a significant predictor of behavior change in this group. Change in action control to the equation increased R^2 significantly from 27% to 35%, indicating an effect size of $\Delta R^2 = .08$. This indicates that only volitional participants benefited from the increment in action control. In this group, increase in action control predicted flossing over and above the flossing baseline and intentions. Therefore, qualitative differences between the motivational and volitional stage can be assumed, at least in terms of the impact of intentions and action control on dental hygiene behavior.

This result is in line with theory, as it suggests that only individuals who intend to act benefit from self-regulatory efforts. Another important finding is that parsimonious self-monitoring interventions, such as dental calendars, may bring forth notable effects if given to persons in the volitional stage.

3.4.3. Selective Dropout

This study faces a minor problem of selective dropout. More volitional participants remained in the study. The fact that, in such studies, more participants in the mismatched groups (here: motivational participants) drop out is a problem commonly found in longitudinal intervention studies [40]. There were, however, no significant differences in flossing, intentions and action control between the Time 1 sample and the longitudinal sample, which indicates that the longitudinal sample was representative for the initial sample in terms of these variables.

3.4.4. Limitations

There are some limitations to the present study. First, there was no control group of persons who did not receive the intervention. Therefore, residualized change scores were computed to indicate the individual effects of the self-monitoring calendar. This approach differs from usual practice in

the evaluation of theory-based interventions of conducting mediation analyses with changes in the manipulated variable as a covariate [38]. However, as the primary goal of the present research was to identify qualitative differences between stages of behavior change, the focus was less on evaluating the effects of the intervention in comparison to a control group, but rather on identifying stage-specific effects. Second, the time interval may have been too small to examine long-lasting effects of the action control intervention. Third, a student sample limited in size (N=151) cannot be considered representative, as health behavior is generally more favorable in people with higher education than in the general population [41]. But as the aim of this study was to test the validity of stages of behavior change, rather than to implement an intervention for health promotion, this problem may be less pertinent. Fourth, behavioral self-reports are evaluated as behavioral outcomes. Given the strong correlation ($r = .69$; $p < .01$) of self-reported flossing and residual floss at Time 2, however, sufficient validity of self-reported behavior may be assumed.

3.4.5. Implications and Conclusions

The findings from this study are important in several ways. Changes in action control enhance flossing behavior in volitional participants. These changes, intentions, and behavioral stage at Time 1 are predictors of Time 3 flossing. This allows designing effective interventions tailored to motivational and volitional individuals. Although tailoring interventions to stages is faced with several problems, such as validity of staging algorithms, or oversimplification of complex behavior change processes [22], it promises parsimonious interventions that are less likely to evoke reactance due to mismatched information. In the field of interdental hygiene, a motivational intervention could, for example, communicate risk information, provide participants with knowledge about oral diseases, increase positive and decrease negative expectations about the outcomes of interdental hygiene, move away barriers, and foster perceived motivational self-efficacy. In contrast, a volitional intervention could focus on action control, but also on action planning, coping planning, and volitional self-efficacy beliefs [42].

The finding that tailoring an intervention produces stage-specific effects encourages the employment of a full matched/mismatched research design, where the effects of a motivational intervention may be tested against the effects of a volitional intervention at both stages. The results of this study support the idea of two qualitatively different stages in the process of health behavior change, namely a motivational stage and a volitional stage. The stage-specific effects of action control encourage designing evidence-based targeted interventions, for example aiming at the formation of intentions in motivational individuals and at self-regulatory competence in volitional ones.

3.5. Acknowledgement

Flossing samples by courtesy of Oral-B Gillette Germany. We thank Amelie Wiedemann for her support and contributions in developing and conducting this study.

3.6. References

1. Orbell S and Sheeran P. Regulation of behaviour in pursuit of health goals. *Psychology and Health* 1998;**13**:753-758.

2. Renner B and Schwarzer R. Social-cognitive Factors in health behavior change. In: Suls J and Wallston KA (eds). *Social Psychological Foundations of Health and Illness*. Oxford: Blackwell, 2003, 169-196.

3. Bellamy P, Barlow A, Puri G, et al. A new in vivo interdental sampling method comparing a daily flossing regime versus a manual brush control. *Journal of Clinical Dentistry* 2004;**15**:59-65.

4. John MT, Hujoel P, Miglioretti DL, et al. Dimensions of oral-health-related quality of life. *Journal for Dental Research* 2004;**83**:956-60.

5. Khader YS, Albashaireh ZS and Alomari MA. Periodontal diseases and the risk of coronary heart and cerebrovascular diseases: a meta-analysis. *Journal of Periodontology* 2004;**75**:1046-53.

6. ADA. *Cleaning Your Teeth and Gums (Oral Hygiene).*
http://www.ada.org/public/topics/cleaning_faq.asp#4. [November 11th, 2005]

7. BDA. *Flossing.*
http://www.bdadentistry.org.uk/smile/adults/adults.cfm?contentid=1267&contentparentid=1036. [February 3rd, 2006]

8. Bader HI. Floss or die: implications for dental professionals. *Dentistry Today* 1998;**17**:76-78, 80-82.

9. Rise J, Åstrøm A and Sutton S. Predicting intentions and use of dental floss among adolescents: An application of the theory of planned behaviour. *Psychology & Health* 1998;**13**:223-236.

10. McCaul KD, Glasgow RE and O'Neill HK. The problem of creating habits: Establishing health-protective dental behaviors. *Health Psychology* 1992;**11**:101-110.

11. Prochaska JO, DiClemente CC and Norcross JC. In search of how people change: Applications to addictive behaviors. *American Psychologist* 1992;**47**:1102-1114.

12. Schwarzer R. Self-efficacy in the adoption and maintenance of health behaviors: Theoretical approaches and a new model. In: Schwarzer R (eds). *Self-Efficacy: Thought Control of Action*. Washington, DC: Hemisphere, 1992, 217-242.

13. Weinstein ND and Sandman PM. A model of the precaution adoption process: Evidence from home radon testing. *Health Psychology* 1992;**11**:170-180.

14. Weinstein ND, Rothman AJ and Sutton SR. Stage theories of health behavior: Conceptual and methodological issues. *Health Psychology* 1998;**17**:290-299.

15. Gollwitzer PM and Brandstätter V. Implementation intentions and effective goal pursuit. *Journal of Personality & Social Psychology* 1997;**73**:186-199.

16. Carver CS and Scheier MF. *On the self-regulation of behavior*. Cambridge: Cambridge University Press, 1998.

17. Karoly P. Mechanisms of self-regulation: A systems view. *Annual Review of Psychology* 1993;**44**:23-52.

18. Sniehotta FF, Nagy G, Scholz U, et al. Action Control During the First Weeks of Health Behaviour Change: A Longitudinal Study with CHD patients. *British Journal of Social Psychology* in press;

19. Bridle C, Riemsma RP, Pattenden J, et al. Systematic review of the effectiveness of health behavior interventions based on the transtheoretical model. *Psychology & Health* 2005;**20**:283-301.

20. West R. What Does it Take for a Theory to be Abandoned? The Transtheoretical Model of Behavior Change as a Test Case. *Addiction* 2005;**100**:1048-1050.

21. van Sluijs EMF, van Poppel MNM and van Mechelen W. Stage-Based Lifestyle Interventions in Primary Care: Are They Effective? *American Journal of Preventive Medicine* 2004;**29**:330-343.

22. Adams J and White M. Why don't stage-based activity promotion interventions work? *Health Education Research* 2005;**20**:237-243.

23. Brug J, Conner M, Harré N, et al. The Transtheoretical Model and stages of change: A critique. Observations by five Commentators on the paper by Adams, J. and White, M. (2004) Why don't stage-based activity promotion interventions work? *Health Education Research* 2005;**20**:244-258.

24. Davidson R. Prochaska and DiClemente's model of change: A case study? *British Journal of Addiction* 1992;**87**:821-822.

25. Marshall SJ and Biddle SJH. The transtheoretical model of behavior change: A meta-analysis of applications to physical activity and exercise. *Annals of Behavioral Medicine* 2001;**23**:229-246.

26. Weinstein ND, Lyon JE, Sandman PM, et al. Experimental evidence for stages of health behavior change: The precaution adoption process model applied to home radon testing. *Health Psychology* 1998;**17**:445-453.

27. Sheeran P, Milne S, Webb TL, et al. Implementation intentions and health behaviours. In: Conner M and Norman P (eds). *Predicting health behaviour: Research and practice with social cognition models*. Buckingham: Open University Press, 2005, 276-323.

28. Sniehotta FF, Scholz U and Schwarzer R. Bridging the intention-behaviour-gap: Planning, self-efficacy, and action control in the adoption and maintenance of physical exercise. *Psychology and Health* 2005;**20**:143-160.

29. Sniehotta FF, Schwarzer R, Scholz U, et al. Action Planning and Coping Planning for Long-Term Lifestyle Change: Theory and Assessment. *European Journal of Social Psychology* 2005;**35**:565-576.

30. Sniehotta FF, Scholz U, Schwarzer R, et al. Long-term effects of two psychological interventions on physical exercise and self-regulation after coronary rehabilitation. *International Journal of Behavioral Medicine* 2005;**12**:244-255.

31. Miller GA, Galanter E and Pribram KH. *Plans and the structure of behavior.* Oxford, England: Holt, 1960.

32. Muraven M, Baumeister RF and Tice DM. Longitudinal improvement of self-regulation through practice: Building self-control strength through repeated exercise. *Journal of Social Psychology* 1999;**139**:446-457.

33. McFall RM and Hammen CL. Motivation, structure, and self-monitoring: Role of nonspecific factors in smoking reduction. *Journal of Consulting & Clinical Psychology* 1971; **37**:80-86.

34. Baron RM and Kenny DA. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality & Social Psychology* 1986;**51**:1173-1182.

35. Enders CK. A primer on maximum likelihood algorithms available for use with missing data. *Structural Equation Modeling* 2001;**8**:128-141.

36. Little RJA and Rubin DB. *Statistical Analyses with Missing Data.* Hoboken, NJ: Wiley, 2002.

37. Gold MS and Bentler PM. Treatments of missing data: A Monte Carlo comparison of RBHDI, iterative stochastic regression imputation, and expectation-maximization. *Structural Equation Modeling* 2000;**7**:319-355.

38. Michie S and Abraham C. Interventions to change health behaviours: Evidence-based or evidence-inspired? *Psychology and Health* 2004;**19**:29-49.

39. Armitage CJ and Arden MA. Exploring discontinuity patterns in the transtheoretical model: An application of the theory of planned behavior. *British Journal of Health Psychology* 2002;**7**:89-103.

40. Prochaska JO, DiClemente CC, Velicer WF, et al. Standardized, individualized, interactive, and personalized self-help programs for smoking cessation. *Health Psychology* 1993;**12**:399-405.

41. Blaxter M. *Health and Lifestyles.* London: Routledge, 1990.

42. De Vet E, Brug J, De Nooijer J, et al. Determinants of forward stage transitions: A Delphi study. *Health Education Research* 2005;**20**:195-205.