Comparing stage of change and behavioral intention to understand fruit intake

Emely de Vet¹,²*, Jascha de Nooijer², Nanne K. de Vries² and Johannes Brug¹

Abstract
We explored if the pre-action Transtheoretical stages of change are indeed discrete stages for fruit intakes. In a longitudinal design, a cohort of 735 adults completed electronic questionnaires assessing fruit intake, stages of change and intention to increase fruit intake at baseline and 35 and 67 days follow-up. A dichotomization of a continuous intention measure (‘pseudostages’) was compared with precontemplation and contemplation stages. The results showed (i) that pseudostages and stages of change were strongly associated; (ii) that for most respondents, stability and transitions in stages of change resembled transitions in pseudostage, while test–retest reliabilities for both measures were similar and (iii) that pseudostages and the continuous intention measure were stronger predictors of fruit intake than stage of change. We conclude that pre-action stages of change for fruit are not different from a mere categorization of a continuous intention measure.

Introduction
Health behavior theories aim to describe and explain the determinants of health behavior and are used as a basis for the development and evaluation of behavior change interventions. A number of such theories have been described, such as the Transtheoretical model (TTM) [1], the Theory of Planned Behavior [2] or the Social Cognitive Theory [3]. It is however unclear which theory one should choose for what purpose. There is no consensus that some models are more accurate than others or that some variables are more influential than others [4, 5]. Different theories seem to include very similar concepts, though use different terminology for these concepts [6, 7]. There is a lack of empirical research to determine which theory offers a superior explanation of the behavior under study or to find out whether concepts that appear similar are redundant or not [4, 5, 7].

Interestingly, the TTM, one of the most widely applied theories, has been least often compared with another theory [7]. According to the TTM, behavior change is a dynamic process, which involves movement through a sequence of five discrete and qualitatively different stages [8]. These so-called stages of change should be characterized by a qualitative difference, which means that people in these different stages are assumed to differ on important and relevant factors [9]. The most important implication of stages of change is that interventions should be stage-matched, that is, different interventions should be designed for each stage of change targeting the relevant stage-specific factors. Yet, to date, not much evidence exists for the merits of stage matching [10–12]. This may be due to the limited knowledge of stage-specific behavior change determinants [13], but it may also be that the underlying stage concept is invalid.

In recent years, the TTM has been subject to criticism [14–16]. One important comment is that
the Transtheoretical stages of change might not reflect real discrete, qualitatively different stages, but rather represent ‘pseudostages’, that is a mere categorization of a continuous variable, such as behavioral intention [7, 9, 14]. We examine this hypothesis in the present paper.

Pseudostages can be created by dividing a continuous intention measure into segments and to compare these segments of intention to the Transtheoretical stages of change [9, 14]. Although numerous health behavior theories exist, all seem to share the notion that motivation is an important proximal determinant of health behavior [17]. So, on a conceptual level, stage of change, in particular the pre-action stages and behavioral intention appear to greatly overlap.

Kraft et al. [18] categorized a continuous intention measure into three pseudostages, i.e. a low, medium and high intention and compared these with the precontemplation, contemplation and preparation stages of change, respectively, on their association with three important variables from TTM, i.e. pros, cons and self-efficacy. They found that the intention and the pseudostage measure showed stronger associations with the perceived pros, cons and self-efficacy than the stage of change measure. Their results therefore support a continuum model of health behavior change rather than a stage model. Kraft et al. [18] also showed a lack of difference between the contemplation and preparation stages, consistent with earlier research in which these stages often have been merged [e.g. 19, 20]. De Vries and Backbier [21] overcame this problem with the distinction between contemplation and preparation stages, consistent with earlier research in which these stages often have been merged [e.g. 19, 20]. De Vries and Backbier [21] overcame this problem with the distinction between contemplation and preparation by creating only two pseudostages. They created ‘precontemplation’ and ‘contemplation’ pseudostages by dichotomizing a continuous intention scale and found differences in attitudes and social support between these groups, but did not include a true measure of stage of change.

Additionally, only one longitudinal study has been conducted, that included both stages of change and intention. The study showed that intention predicted forward and backward stage transitions from all stages with respect to exercise [22], which may also support a continuum theory of health behavior rather than stages of change.

None of these studies specifically examined the relation of stage of change, pseudostage or intentions with actual behavior. Given that health behavior theories share the idea that motivation (either as intention or stages of change) influences behavior, the overlap should be reflected in the prediction of behavior as well.

In the present study, we longitudinally explored the validity of stages of change by comparing a stage measure to a continuous intention measure and to pseudostages, i.e. stage-like categories of a continuous intention measure. We addressed the following research questions: first, what is the association of stages of change with intention and pseudostages? Second, how do stability of and transition between stages of change compare to pseudostages? Third, how well do stages of change predict behavior as compared with intention and pseudostages?

The present study focused on fruit intake, since fruit intake is considered to contribute to the prevention of chronic diseases [23–25], while fruit intake is below recommended intake levels in many countries [26, 27]. In the Netherlands, ~70% of the population eat less than the recommended minimum amount of two servings (250 g) of fruit per day [28]. Further, earlier studies have shown that intentions [e.g. 29] as well as stages of change may predict fruit intake [e.g. 30].

Methods

Participants and procedures

Potential participants were identified from a random sample of 1500 people aged 18 years and older from a Dutch Internet research panel. At the time of the study, the size of the entire panel was ~8165 persons. People were invited by an e-mail letter to participate in a longitudinal cohort study. Respondents could indicate their willingness to participate in the entire study by completing the first electronic questionnaire (T0). Completed questionnaires were returned by 929 respondents. Thirteen respondents were excluded from the study because stage of
change \((n = 1)\) or fruit consumption \((n = 12)\) could not be calculated. Of the remaining 916 respondents, for each stage of change at baseline, 20% were selected randomly to participate in a different study. The remaining 735 respondents were sent a second electronic questionnaire 35 days after baseline \((T1, n = 610, \text{response rate } 83\%)\). The third assessment took place 32 days after \(T1 (T2, n = 592, \text{response rate } 81\%)\). In total, 73% \((n = 538)\) of the respondents completed all three questionnaires. Respondents who did not complete all three questionnaires were significantly younger \([F (1,735) = 24.20, P < 0.001]\), were higher educated \([\chi^2 (2, n = 732) = 6.50, P = 0.04]\) and were more often male \([\chi^2 (1, n = 735) = 6.50, P = 0.04]\) than respondents who did complete all questionnaires.

Respondents used a personal login code to open and complete the questionnaires. All questionnaires had to be completed within 1 week after the e-mailed completion request. Respondents’ answers were automatically entered into a data file, and after the deadline had passed by, the respondents could not enter the questionnaire anymore. Answers could not be saved, and the questionnaire could not be completed more than once.

Measures

‘Fruit intake’ was measured with a validated 14-item food frequency questionnaire (FFQ) with a 1-month reference period assessing the frequency and amount [pieces or small bowls (for small fruit such as berries) per day] of consumption with separate questions for the most common fruits in the Netherlands, i.e. citrus fruit, apples and pears, bananas, freshly squeezed or unsweetened fruit juice, tangerines and for other fruit including preserved fruit. From this information, daily fruit intake in grams was calculated. The FFQ has been validated compared with 7-day dietary records and biomarkers for fruit consumption levels (see for details [31, 32]).

‘Stage of change’ was assessed consistent with Nigg et al. [33] and Laforge et al. [34]. Respondents were asked whether they ate at least the recommended two servings of fruit each day by selecting one of five statements each representing a stage of change: ‘No, and I do not intend to change this within the next six months’ (precontemplation), ‘No, but I intend to change this within the next six months’ (contemplation), ‘No, but I intend to change this within the next month’ (preparation), ‘Yes, and I have started doing so in the last six months’ (action), ‘Yes, and I have done so for more than six months’ (maintenance).

‘Intention’ was assessed with two items: ‘Do you intend to achieve eating at least two servings of fruit each day?’ ['certainly not’ (–2) to ‘certainly yes’ (+2)] and ‘How sure are you that you want to start eating at least two servings of fruit each day?’ ['certainly not’ (–2) to ‘certainly yes’(+2)]. Pearson \(r\) correlation for the two items was 0.88 \((P < 0.001)\) and test–retest reliability with a 2-week interval showed a Pearson correlation of 0.83 \((P < 0.001)\). A mean score for intention was computed.

Data analyses

Noar and Zimmerman [7] suggested that contemplation/preparation stages might be comparable to positive behavioral intentions. To make this comparison, contemplation and preparation stages were combined (as was also outlined in the introduction). Respondents in action and maintenance stages were not included in the analyses; therefore, respondents progressing to action at each follow-up time point are excluded from the corresponding analyses. \(T\)-tests and chi-square tests were used to test for differences in demographic characteristics between pre-contemplators and contemplator/preparators. Second, \(T\)-tests were conducted to test for differences in mean intention scores between precontemplation and contemplation/preparation. Next, for respondents in the pre-action stages, the continuous intention measure was divided into two stage-like categories creating unmotivated and motivated pseudostages. Respondents with a mean intention score \(\leq 0\) were classified as unmotivated. Respondents with a positive mean intention score were classified as motivated.

The proportion of respondents classified in the same pseudostage and stage of change (precontemplation and unmotivated or contemplation/preparation and motivated) was calculated. Next, the
strength of the association between stage of change and pseudostage was computed for each assessment using the phi coefficient ($r_{\Phi}$) for $2 \times 2$ tables [35]. According to Cohen’s guidelines for interpretation of correlations, a large effect size was defined as a correlation $\geq 0.50$. A correlation between 0.30 and 0.50 is regarded as a medium effect size, and a correlation between 0.10 and 0.30 is defined as a small effect size [36].

The phi coefficient was used to evaluate the stability (test–retest reliability) in the stages of change and the pseudostages separately for both time intervals. Cohen’s kappa was used to evaluate whether transitions and stability in stages of change corresponded to the transitions in pseudostages. A $\kappa > 0.75$ was considered excellent agreement, a $\kappa$ between 0.40 and 0.75 as fair to good and a $\kappa < 0.40$ as poor [37].

Finally, two series of linear regression analyses were done to test whether stages of change and intention and stages of change and pseudostages predicted fruit intake, as recommended by Noar and Zimmerman [7]. First, stage of change at T0 and intention at T0 were entered separately in the analyses to predict fruit intake at T1. Next, both variables were entered simultaneously. Since the continuous intention measure can be expected to be more sensitive than the dichotomous stage measure, the analyses were repeated with dichotomous pseudostage measure. Similar analyses were repeated for the T1–T2 time interval. The variance inflation factor (VIF) was used to evaluate multicollinearity in the multiple regression analyses. If the variables in the model reveal an average VIF $> 1$, multicollinearity is indicated [38].

**Results**

**Participants**

In total, 503, 382 and 354 respondents were in the pre-action stages at T0, T1 and T2, respectively. Of the respondents in pre-action at baseline, mean age was 35.88 (SD = 13.35) years, 52% were female and 90% were of Dutch origin. Of these respondents, 16, 48 and 36% had a low, medium or high level of education. At baseline, 48% of the respondents were in precontemplation, 31% in contemplation and 21% in preparation. Respondents in precontemplation were significantly older (37.53 versus 34.35 years, $t = 2.69, P < 0.01$) and more often male (56 versus 42%, $\chi^2 (1, n = 503) = 9.89, P < 0.01$) than respondents in contemplation/preparation. No differences between pre-contemplators and contemplators/preparers were found with respect to level of education and ethnicity.

**Intention, stages of change and pseudostages**

Respondents in precontemplation (T0: $M = -0.44$, SD = 0.93; T1: $M = -0.60$, SD = 1.01; T2: $M = -0.75$, SD = 0.99) had a significant lower intention than respondents in contemplation/preparation (T0: $M = 0.92$, SD = 0.76; T1: $M = 0.89$, SD = 0.77; T2: $M = 0.75$, SD = 0.80) for T0 ($t = -17.89, P < 0.001$), T1 ($t = -16.10, P < 0.001$) and T2 ($t = -15.49, P < 0.001$), respectively.

Of the pre-contemplators, 81% ($n = 196$), 86% ($n = 157$) and 90% ($n = 196$) were classified into the unmotivated pseudostage at T0, T1 and T2, respectively. Of the contemplators/preparers, 82% ($n = 211$), 78% ($n = 155$) and 72% ($n = 123$) were classified into the motivated pseudostage at T0, T1 and T2. A large effect size was found for the association between stages of change and pseudostages for the three assessments ($r_{\Phi} = 0.63$ at T0 and T2 and $r_{\Phi} = 0.64$ at T1, all $P < 0.001$).

**Stability and transitions in stages of change and pseudostages**

Of the 503 respondents in pre-action at T0, 352 (69%) were still in pre-action at T1. Of the 382 respondents in pre-action at T1, 270 (63%) were still in pre-action at T2. Respondents progressing to action/maintenance at each follow-up time point are excluded from the corresponding analyses (between T0 and T1, $n = 66$; between T1 and T2, $n = 45$).

Test–retest reliabilities for the two intervals varied from $r_{\Phi} = 0.61$ to 0.67 for stage of change and from $r_{\Phi} = 0.64$ to 0.73 for pseudostage (all $P < 0.001$). Overall, 73 and 75% of respondents
had similar transitions for pseudostage as for stage of change between T0 and T1 and between T1 and T2, respectively (both time intervals \( \kappa = 0.59, P < 0.001 \)). The correspondence in specific transitions for the T0–T1 interval is depicted in Table I.

### Predicting fruit intake by stage of change and pseudostage

Table II describes mean fruit intake by stage of change and pseudostage for each of the assessments. At T0, 30% of the respondents met the Dutch recommendations for fruit intake, whereas 33 and 28% of the respondents met these recommendations at T1 and T2, respectively.

Stage of change and intention at T0 were both significantly associated with fruit intake at T1, but intention explained a larger proportion of the variance (Table III). When stage of change and intention were entered in one analysis, only the association of intention with fruit intake remained significant (VIF of 1.52). The same pattern was found in the analyses with pseudostages instead of the continuous intention measure (VIF of 1.49; Table IV). Intention and pseudostages at T1 were, but stage of change was not associated with fruit intake at T2. In the multiple linear regression analysis with the continuous intention measure and stages of change, the association of intention with fruit intake remained significant. Also stages of change predicted fruit intake, but with a negative beta (VIF = 1.77; Table III). In the simple as well as the multiple regression analyses with pseudostages instead of the continuous measure, pseudostages but not stages of change predicted fruit intake (VIF = 1.63; Table IV).

### Discussion

In the present study, we found several indications that intention and the pre-action stages of change overlap to a large extent. First, strong correlations were found between stages of change and pseudostages. Second, for a majority of respondents, stability and transitions in stages of change resembled transitions in pseudostage, while test–retest reliabilities for both measures were similar. Finally, when both stages of change and pseudostages were entered in one analysis to predict fruit intake, multicollinearity was found.

In the literature further indications can be found that pre-action stages of change and behavioral intentions might reflect the same concept. First, different dietary behaviors, intention and other psychological variables (e.g. self-efficacy) have shown to be linearly associated not only with stages of change but also with behavioral intention [18, 29, 30, 39–47]. Additionally, one longitudinal study showed that intention predicted forward and backward stage transitions from all stages with respect to exercise [22]. It has been argued that a real-stage model would show discontinuity patterns in relevant variables across the stages and that determinants of stage

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**Table I. Transitions in pseudostages and stages of change between T0 and T1**

<table>
<thead>
<tr>
<th>Stage of change transition (% within stage of change)</th>
<th>Pseudostage transition</th>
<th>Unmotivated stable</th>
<th>Unmotivated progress</th>
<th>Motivated stable</th>
<th>Motivated regress</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC stable</td>
<td>123 (90.4%)*</td>
<td>3 (2.2%)</td>
<td>3 (2.2%)</td>
<td>7 (5.1%)</td>
<td>136</td>
<td></td>
</tr>
<tr>
<td>PC progress</td>
<td>9 (20.9%)</td>
<td>16 (37.2%)</td>
<td>13 (30.2%)</td>
<td>5 (11.6%)</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>C/PR stable</td>
<td>15 (10.3%)</td>
<td>9 (6.2%)</td>
<td>108 (74.5%)</td>
<td>13 (9.0%)</td>
<td>145</td>
<td></td>
</tr>
<tr>
<td>C/PR regress</td>
<td>11 (42.3%)</td>
<td>—</td>
<td>5 (19.2%)</td>
<td>10 (38.5%)</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>158</td>
<td>28</td>
<td>129</td>
<td>35</td>
<td>350*</td>
<td></td>
</tr>
</tbody>
</table>

PC = precontemplation, C/PR = contemplation/preparation.

*Corresponding transitions are printed in italics. *Note that this figure represents the number of participants who were in pre-action at T0 and are still in pre-action at T1.
transitions should vary stage by stage [40]. Second, some studies showed that stages of change could be subdivided into several other stages [48–51]. For example, Norman et al. [51] distinguished four subtypes in the precontemplation stage, in the contemplation stage as well as in the preparation stage, resulting in 12 pre-action stages. As a result of such an ongoing segmentation, stages may in an increasing degree resemble a continuum rather than clear-cut discrete stages of change.

Despite the large overlap between pseudostage and stage measure, a small difference in the prediction of fruit intake in favor of the intention and pseudostage measure was found. Three explanations may be given for this difference. First, intention might have predicted fruit intake better than stage of change, due to a flawed stage of change measure. The current stage measure, however, met the criteria for a good staging instrument (a clear definition of the target behavior in terms of frequency, intensity and duration; understandable criteria so that individuals can accurately stage themselves and a five-choice response format), which resulted from a comparison study of staging instruments [52]. Second, the result that somewhat more variance in fruit intake was explained by the intention measure than by the stage of change measure may be related to the greater specificity in the wording of the intention items. This measure

Table II. Fruit intake by stages of change and pseudostages for T0, T1 and T2

<table>
<thead>
<tr>
<th></th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Stage of change</td>
<td>n = 503</td>
<td>n = 382</td>
<td>n = 354</td>
</tr>
<tr>
<td>PC</td>
<td>186</td>
<td>141</td>
<td>156</td>
</tr>
<tr>
<td>C/PR</td>
<td>221</td>
<td>106</td>
<td>214</td>
</tr>
<tr>
<td>Pseudostage</td>
<td>n = 500</td>
<td>n = 381</td>
<td>n = 348</td>
</tr>
<tr>
<td>Unmotivated</td>
<td>171</td>
<td>122</td>
<td>148</td>
</tr>
<tr>
<td>Motivated</td>
<td>234</td>
<td>120</td>
<td>229</td>
</tr>
</tbody>
</table>

Fruit intake in grams per day; PC = precontemplation, C/PR = contemplation/preparation.

Table III. Linear regression analyses for stage of change and intention on post-test fruit intake

<table>
<thead>
<tr>
<th>Predictors</th>
<th>B</th>
<th>SE (B)</th>
<th>β</th>
<th>Model R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0–T1 (n = 412)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit intake at T0</td>
<td>0.62</td>
<td>0.04</td>
<td>0.59</td>
<td>0.35</td>
</tr>
<tr>
<td>Simple</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stages of change</td>
<td>28.51</td>
<td>10.39</td>
<td>0.11**</td>
<td>0.36</td>
</tr>
<tr>
<td>Intention</td>
<td>24.26</td>
<td>4.83</td>
<td>0.20***</td>
<td>0.39</td>
</tr>
<tr>
<td>Multiple</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stages of change</td>
<td>−5.78</td>
<td>13.07</td>
<td>−0.02</td>
<td>0.39</td>
</tr>
<tr>
<td>Intention</td>
<td>25.97</td>
<td>6.2</td>
<td>0.22***</td>
<td>0.39</td>
</tr>
<tr>
<td>T1–T2 (n = 326)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit intake at T1</td>
<td>0.77</td>
<td>0.04</td>
<td>0.7</td>
<td>0.48</td>
</tr>
<tr>
<td>Simple</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stages of change</td>
<td>10.68</td>
<td>10.79</td>
<td>0.04</td>
<td>0.48</td>
</tr>
<tr>
<td>Intention</td>
<td>20.49</td>
<td>4.72</td>
<td>0.19***</td>
<td>0.51</td>
</tr>
<tr>
<td>Multiple</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stages of change</td>
<td>−28.13</td>
<td>13.42</td>
<td>−0.11*</td>
<td>0.52</td>
</tr>
<tr>
<td>Intention</td>
<td>28.44</td>
<td>6.04</td>
<td>0.26***</td>
<td>0.52</td>
</tr>
</tbody>
</table>

All analyses were corrected for fruit intake at T0 and T1, respectively. Next, either stage of change or intention was entered in the model (simple), followed by a model in which both were entered simultaneously (multiple). Significant at *P < 0.05, **P < 0.01, ***P < 0.001.

Table IV. Linear regression analyses for stage of change and pseudostages on post-test fruit intake

<table>
<thead>
<tr>
<th>Predictors</th>
<th>B</th>
<th>SE (B)</th>
<th>β</th>
<th>Model R²</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
</tr>
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<td>0.04</td>
<td>0.59</td>
<td>0.35</td>
</tr>
<tr>
<td>Simple</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stages of change</td>
<td>28.51</td>
<td>10.39</td>
<td>0.11**</td>
<td>0.36</td>
</tr>
<tr>
<td>Pseudostage</td>
<td>48.63</td>
<td>10.45</td>
<td>0.19***</td>
<td>0.38</td>
</tr>
<tr>
<td>Multiple</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stages of change</td>
<td>−1.75</td>
<td>13.08</td>
<td>−0.007</td>
<td>0.38</td>
</tr>
<tr>
<td>Pseudostage</td>
<td>49.75</td>
<td>13.37</td>
<td>0.19***</td>
<td>0.38</td>
</tr>
<tr>
<td>T1–T2 (n = 326)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit intake at T1</td>
<td>0.77</td>
<td>0.04</td>
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<td>0.48</td>
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<td>Stages of change</td>
<td>10.68</td>
<td>10.79</td>
<td>0.04</td>
<td>0.48</td>
</tr>
<tr>
<td>Pseudostage</td>
<td>35.59</td>
<td>11.06</td>
<td>0.14***</td>
<td>0.5</td>
</tr>
<tr>
<td>Multiple</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stages of change</td>
<td>−16.99</td>
<td>13.75</td>
<td>−0.07</td>
<td>0.5</td>
</tr>
<tr>
<td>Pseudostage</td>
<td>46.81</td>
<td>14.31</td>
<td>0.18***</td>
<td>0.5</td>
</tr>
</tbody>
</table>

All analyses were corrected for fruit intake at T0 and T1, respectively. Next, either stage of change or intention was entered in the model (simple), followed by a model in which both were entered simultaneously (multiple). Significant at **P < 0.01, ***P < 0.001.

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included words as ‘achieve’ and ‘sure you want to start eating’ rather than ‘change’ in the stage of change measure, which may be more strongly related to actual fruit intake. It should be noted that the present study used two items to construe behavioral intention. Courneya et al. [22] argued that there are two kinds of intention: (i) choice intention (what a person intends to do), which is reflected in the ‘achieve’ item and (ii) behavioral intention (how strongly the person intends to do it), which is reflected in the ‘sure’ item. In their view, the choice intention might be comparable to stages of change since behavioral intention may be seen as a kind of commitment to the choice intention [22]. However, the result that behavioral intention was predictive of all forward and backward stage transitions [22] may indicate that stage of change, choice and behavioral intention may overlap. In the present study, an almost perfect correlation between the two intention items was found and we therefore combined both items. Additionally, repeating the analyses with only the choice intention item showed similar results. According to the TTM, intention to adopt a behavioral criterion is essential in distinguishing the early stages of change, but becomes irrelevant as soon as the criterion is reached (action stage) [53]. Staging algorithms should thus assess both intentionality and the target behavior [53], which is further illustrated by the overlap between stages of change and intention in our study. This brings us to the third explanation. In our analyses, respondents who progressed to action were excluded from the analyses. As the TTM argues that a separate stage, action, is involved with the prediction of behavior, excluding individuals who make the progression toward the action stage may have weakened the prediction of fruit intake by stages of change.

Additional limitations should be addressed. The contemplation and preparation stages were combined for reasons outlined in the introduction. However, due to this combination, the possible unique value of the contemplation and preparation stages may have been underestimated. Furthermore, one could debate where to put the cutoff point in the continuous intention measure in order to distinguish the motivated and unmotivated pseudostages. A different cutoff point may lead to different results. We believe, however, that the negative–positive split in intention is the most plausible way to discriminate unmotivated from motivated respondents. It is also consistent with the results from De Vries and Backbier [21].

Another limitation of the present study is the use of a FFQ to assess fruit intake, which reflects self-reported intake and not actual intake. Often, the use of FFQs to assess dietary intake leads to an overestimation of actual intake [32], although self-report measures tend to be more accurate for fruit intake than for other foods, such as vegetables [e.g. 54, 55]. Further, the FFQ that was used in the present study has been validated against biomarkers of consumption levels and 7-day dietary records in a Dutch adult population and revealed similar validity scores compared with other frequently used FFQs (see for a detailed comparison of validity scores of FFQs: [31, 32]). Nevertheless, it would be interesting to repeat the multicollinearity analyses when using a criterion measure of fruit intake.

The present study was restricted to the early, motivational, stages of behavior change. It has been argued that other stage models may be more valid than the TTM, such as the Health Action Process Approach [56] that suggest that behavior change includes three phases: pre-intentional, post-intentional and post-action. A second alternative stage model is the Precaution Adoption Process Model (PAPM) [57]. In a study similar to the present investigation, both intention and precaution adoption stages predicted radon testing, but when both were entered in the analyses simultaneously, precaution adoption stages predicted radon testing and intention was reduced to insignificance [58]. This may indicate that PAPM stages of change are more useful than a continuous intention measure.

It would be interesting to test the true stage-like character of other stage models than the TTM. Since our single longitudinal study cannot provide a definitive view on the issue, also further experimental research is needed to more definitely test the pseudostage-like character of the TTM stages of change. For this purpose, two types of experimental...
tests can be employed: (i) a match–mismatch test, which tests whether stage-matched interventions are more effective than stage-mismatched interventions (i.e. matched to a different irrelevant stage) and (ii) a sequence test, which tests whether stage-matched interventions delivered in the sequence of the stages are more effective than stage-matched interventions delivered in different order. These tests would be complex, since not much evidence exists for the merits of stage matching [10–12].

As is repeatedly called for in the past decade, our study did attempt to look for commonalities among theories and concepts in health behavior change instead of highlighting the differences [5–7]. Proponents of the TTM have claimed that many misinterpretations and misapplications of the TTM exist. Prochaska and Velicer [59] have rightly argued, for example, that stages of change is a variable which should not be equated with theory since a theory should also include a description of systematic relationships between variables. They have further argued, therefore, that stages of change do not have to meet strict stage model requirements. As Prochaska and DiClemente [60, p. 43] stated ‘models are not meant to be assessed by absolute criteria. For us a key question is how well the TTM performs relative to other leading theories’. West [61, p. 1049] argued ‘the onus is very much on the proponents of the TTM [...] to point to evidence that their approach predicts actual behavior better than simple alternatives’. From our results, it may be concluded that stages of change have no clear merits above its simpler alternative, behavioral intention. An alternative conclusion would be that pseudo-stages measured by a dichotomization of a continuous measure of intention produces similar results to a traditional categorical stage measure for differentiating between precontemplation and contemplation–preparation. From both points of view, our results indicate that intention and stage of change show great overlap.

What do our results suggest for health education practice? Probably, one of the most important lessons learned from the TTM is that a large proportion of at-risk populations may not be ready for behavior change and will not be helped by traditional action-oriented programs [62]. Whether from the perspective of stages of change or from that of behavioral intention, practitioners should acknowledge these individuals by planning to recruit these individuals to participate in interventions and by assuring that those individuals receive health-promoting interventions corresponding to their motivations to change. Behavior change approaches that do consider motivations to change, such as motivational interviewing (MI) or computer tailoring, might yield promising results. Computer-tailored interventions provide individualized feedback and advice about respondents’ behaviors, motivations and relevant psychosocial characteristics [63]. MI is another behavior change approach, which takes into account an individual’s readiness for change. Facilitating behavior change by helping individuals to explore and resolve their ambivalence about behavior change is the main focus of MI [64]. In contrast to reviews on the effectiveness on stage-based interventions, recent reviews showed positive effects of computer tailoring [e.g. 63, 65] and of MI for behavior change [66].

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**Conflict of interest statement**

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**References**

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