

1

2

3

4

5

6

7 Response-Order Effects in Survey Methods: A Randomized Controlled Crossover Study in

8 the Context of Sport Injury Prevention

9

10 Full citation: Chan, D. K. C., Ivarsson, A., Stenling, A., Yang, X. S., Chatzisarantis, N. L. D.,  
11 & Hagger, M. S. (2015). Response-order effects in survey methods: A randomized controlled  
12 crossover study in the context of sport injury prevention. *Journal of Sport and Exercise*  
13 *Psychology*, 37, 666-673. doi: 10.1123/jsep.2015-0045

14

15

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22

### Abstract

Consistency tendency is characterized by the propensity for participants responding to subsequent items in a survey consistent with their responses to previous items. This method effect might contaminate the results of sport psychology surveys using cross-sectional design. We present a randomized controlled crossover study examining the effect of consistency tendency on the motivational pathway (i.e., autonomy support → autonomous motivation → intention) of self-determination theory in the context of sport injury prevention. Athletes from Sweden ( $N = 341$ ) responded to the survey printed in either low inter-item distance (IID; consistency tendency likely) or high IID (consistency tendency suppressed) on two separate occasions, with a one-week interim period. Participants were randomly allocated into two groups, and they received the survey of different IID at each occasion. Bayesian structural equation modeling showed that low IID condition had stronger parameter estimates than high IID condition, but the differences were not statistically significant.

**Keywords:** Consistency motif; proximity effect; Socratic effect; common method variance; response bias; general response tendency.

1 Response-Order Effects in Survey Methods: A Randomized Controlled Crossover Study in  
2 the Context of Sport Injury Prevention

3 Sport and exercise psychology research often uses self-reported survey methods with  
4 cross-sectional designs and correlational analyses leading to the possibility that results could  
5 be confounded by a method effect known as consistency tendency. Consistency tendency  
6 characterizes the propensity where respondents provide consistent answers to consecutive  
7 items in a survey, thus inducing artificial covariance between predictor and criterion variable  
8 (Salancik, 1984; Salancik & Pfeffer, 1977). It is regarded as one of the main causes of  
9 common method bias, producing a systematic measurement error that may lead to an inflation  
10 or a deflation of the relationship between study variables (Doty & Glick, 1998; Podsakoff,  
11 MacKenzie, Lee, & Podsakoff, 2003). The most effective means to allay common method  
12 variance is to separate measures of different constructs by intentionally placing a time-lag or  
13 physical gap between the measurements of different variables (Podsakoff et al., 2003;  
14 Podsakoff, MacKenzie, & Podsakoff, 2012). The proposed effects of consistency tendency  
15 and item separation led us to speculate that the inter-item distance (IID; i.e., average distance  
16 between the items of distinct constructs) might have an effect on factor correlations in a sport  
17 psychology survey. Therefore, this study used a randomized controlled crossover design in  
18 the context sport injury prevention to examine the effects of response order on the  
19 relationships between conceptually-related constructs (i.e., perceived autonomy support,  
20 autonomous motivation, intention) from self-determination theory (Deci & Ryan, 1985).

21 In this study, we aimed to experimentally examine if the factor structure and factor  
22 relationships in a cross-sectional survey would be influenced by inter-item distance. The  
23 survey used items that measured theoretically-related constructs from the self-determination  
24 theory (SDT; Deci & Ryan, 1985; Deci & Ryan, 2000). The theory proposed that perceived  
25 autonomy support (i.e., the provision of choice, option, care, and respect) would positively

1 predicted autonomous motivation (i.e., engaging in a behavior for reasons of interest, personal  
2 values, and life goals or aspirations that are perceived to be important and meaningful), which  
3 in turn associated with intention or adherence of a target behavior. Relations in the sequence  
4 were proposed to be statistically significant and positive according to previous research in the  
5 context of sport injury prevention or rehabilitation (Chan & Hagger, 2012a, 2012b, 2012c).

6 Based on previous literature on consistency tendency and inter-item separation  
7 (Podsakoff et al., 2003; Podsakoff et al., 2012), we hypothesized that the proposed relations  
8 among the SDT variables and the hypothesized motivational sequence (perceived autonomy  
9 support from coaches → autonomous motivation → intention) would be stronger when inter-  
10 item distance between factors was reduced (consistency tendency facilitated).

## 11 **Method**

12 After we obtained ethical approval from the Research Ethic Committee of University  
13 [name masked for blind review], athletes ( $N = 341$ , 46.92% male; mean age = 19.84,  $SD =$   
14 3.30) were recruited to participate in the study from sport science educations (university level)  
15 and local sports clubs in Sweden (response rate = 90.2%). They engaged in a variety of sports,  
16 such as football, floorball, golf, and handball for an average of 9.23 ( $SD = 4.75$ ) years.

17 Following a randomized controlled crossover design, participants were randomly  
18 assigned to one of two groups. Each group was required to complete two separate  
19 questionnaires, one per week over two consecutive weeks (see Appendix A) with only the  
20 format of the questionnaire differing between the groups. Participants assigned to Group 1 ( $n$   
21 = 140) were asked to complete the study questionnaire with low IID in Week 1 and complete  
22 the same questionnaire but with high IID in Week 2 ( $n = 65$ ; 53.57% of dropout). Conversely,  
23 Group 2 ( $n = 201$ ) completed the two formats of the questionnaire in the opposite order ( $n =$   
24 133; 33.83% of dropout in Week 2). The one week gap between the two measurement points  
25 followed the methodological recommendations of previous survey-based studies that

1 attempted to reduce the common method variance of measuring motivational constructs in  
2 sport and exercise psychology (e.g., Chan & Hagger, 2012c; Chan, Hagger, & Spray, 2011).

3         The questionnaire comprised standard measures of the study variables, including  
4 perceived autonomy support from coaches (Health Care Climate Questionnaire; Williams,  
5 Grow, Freedman, Ryan, & Deci, 1996), autonomous motivation (Treatment Self-Regulation  
6 Questionnaire for Sport Injury Prevention; Chan & Hagger, 2012c), and intention (i.e., items  
7 developed by Chan and Hagger (2012a) of sport injury preventive behavior. These scales  
8 were originally English, so we either adopted the Swedish version of the scale (for perceived  
9 autonomy support) in a previous study (Stenling, Lindwall, & Hassmén, 2015) or translated  
10 the items (for autonomous motivation and intention) into Swedish using the standard  
11 translate-back-translate procedures (Hambleton, 2005). The descriptive statistics, correlation  
12 matrix, and internal consistency of the study variables are displayed in Appendix B.

13         The manipulation of IID in the questionnaire was achieved by inter-mixing the items  
14 (Podsakoff et al., 2003). For low IID condition, the items were in the sequence of an alternate  
15 item order where one item of autonomy support was followed by one item of autonomous  
16 motivation, and then one item of intention, and this rotation continued until all items of were  
17 presented in the questionnaire. For high IID condition, the items were in the sequence of  
18 ensemble item order where all the items of autonomy support were presented first, that of  
19 autonomous motivation second, and that of intention last. The average IID of the  
20 questionnaire with low IID (i.e., 5.22 item-units,  $SD = 5.60$ ) was significantly lower than that  
21 with high IID (i.e., 11.25 item-units,  $SD = 6.09$ ;  $t(143) = 4.56$ ,  $p < .01$ , Cohen's  $d = .76$ ).

22         We ran single-group Bayesian structural equation models (BSEM; Muthén &  
23 Asparouhov, 2012) to examine model fit for four datasets (i.e., Group 1 Time 1 – low IID,  
24 Group 2 Time 1 – high IID, Group 1 Time 2 – high IID, and Group 2 Time 2 – low IID), each  
25 representing the data of one group at each time point. Weakly informative priors (zero mean,

1 small-variance priors = .01) for cross-loadings and correlated residuals were used in the  
2 measurement part of the models. Model fit was assessed with the posterior predictive  $p$  value  
3 (PP $p$ ) and its corresponding 95% credibility interval (CI). A PP $p$  larger than .05 with a 95%  
4 CI containing zero indicates that the model fits the data (Muthén & Asparouhov, 2012).  
5 Convergence was assessed with the potential scale reduction factor (PSRF) and a PSRF < 1.1  
6 was considered as evidence of convergence (Gelman et al., 2014). All models were first run  
7 with a convergence criteria of .01 and then replicated with 100000 iterations. The first half of  
8 the iterations was used as burn-in phase. Multi-group BSEM then examined approximate  
9 invariance of the measurement model between two pairs of datasets (Muthén & Asparouhov,  
10 2013; Van De Schoot et al., 2013). A zero mean, small-variance prior (.01) was used on  
11 estimating the difference in factor loadings and intercepts between the groups. In the first  
12 step, approximate measurement invariance was estimated for all factor loadings and  
13 intercepts; in the second step, the noninvariant parameters were freely estimated and invariant  
14 parameters were constrained to exact equality (Muthén & Asparouhov, 2013). Between- and  
15 within-group differences in the structural parameters were statistically significant when the  
16 range of 95% CI did not contain zero. Missing values (< 7.90%) were treated as random and  
17 all available information were included in the analyses (Muthén & Asparouhov, 2010).

## 18 **Result**

19 Single-group BSEM showed that the proposed model yielded acceptable fit with the  
20 four datasets (see Table 1). All the structural parameters were positive and statistically  
21 significant (credibility interval did not include zero). Multi-group BSEM for each pair of  
22 datasets showed approximate invariance only for the factor loadings but not for the intercepts.  
23 Noninvariant intercepts were released and freely estimated in the second step of the  
24 invariance test of the measurement model. Full details of the approximate invariance tests of  
25 the measurement models can be obtained from the first author. The structural parameters of

1 low IID datasets were generally higher than that of high IID datasets (Table 2), but the CI for  
2 the difference between parameters all included zero. Hence, the results provide little evidence  
3 for a statistical between- or within-group difference in the structural parameters.

#### 4 **Discussion**

5 This study is the first investigation examining the effects of inter-item distance (IID)  
6 on the factor structure and relationships among constructs in a well-evidenced motivational  
7 sequence, derived from self-determination theory (Deci & Ryan, 1985, 2000), within a cross-  
8 sectional survey in the context of sport injury prevention. Our findings provided little supports  
9 to our propositions derived from consistency tendency (Salancik, 1984; Salancik & Pfeffer,  
10 1977), and temporal or proximal separation (Doty & Glick, 1998; Podsakoff et al., 2003;  
11 Podsakoff et al., 2012; Weijters, Geuens, & Schillewaert, 2009).

12 In agreement of tenets of self-determination theory (Deci & Ryan, 1985, 2000), the  
13 pathways of perceived autonomy support from coaches → autonomous motivation → intention  
14 were positive, and the magnitudes of the parameter estimates in alternate order appeared to be  
15 stronger than those in the ensemble order. This pattern of effects seemed to be in favor of our  
16 speculation that consistency tendency could lead to an inflation of the relationships between  
17 factors to some extent, and method variance associated with consistency tendency could  
18 plausibly be manipulated by changing the IID. Nevertheless, non-significant within-group and  
19 between-group differences suggested that the effects of IID on parameter estimates were  
20 small and that a larger sample size may be required to detect the statistically significant  
21 differences.

22 We hope that the findings of the present study will raise researchers' awareness of the  
23 potential confounding effects of consistency tendency in survey-based research. Researchers  
24 should consider randomizing and maximizing the temporal or physical (and maybe  
25 psychological) separation between the measurements of different factors in order to reduce

1 the effects of consistency tendency. This is especially true for cross-sectional survey-based  
2 studies that simultaneously assess multiple constructs using a highly consistent or  
3 homogeneous response format (e.g., Likert-scale). A time gap, a short break, or a section  
4 break between the measures of criterion variables and outcome variables should preferably be  
5 offered in a survey in order to minimize the possibility that consistency tendency induces  
6 artificial covariance in the hypothesized directions (Doty & Glick, 1998; Podsakoff et al.,  
7 2003; Podsakoff et al., 2012; Weijters et al., 2009). Also, it is important that researchers  
8 should report the way in which the items are arranged in the questionnaire, and discuss if  
9 consistency tendency could interfere study findings and how future studies could account for  
10 this confounding factor. It is as important as the information such as example items, scale  
11 anchors, factorial validity, and prior use of the scale because item order is not only shown to  
12 be influential to the factor scoring (Duan, Alegria, Canino, McGuire, & Takeuchi, 2007;  
13 McClendon, 1991), but it could also contribute to the extent to which method effects  
14 moderate the relationships between factors. This reporting practice is recommended not only  
15 for sport and exercise psychology research, but for all studies that include measurements of  
16 multiple constructs in a survey or similar forms of assessment.

17         While the current study has numerous strengths in terms of research design and  
18 analytic approach, we should note a number of limitations that may stimulate future research  
19 in this field. First, the present study mainly looked at the effects of consistency tendency on  
20 the concurrent for theoretically positively related psychological constructs measured by  
21 positively worded items, but its impacts on convergent validity, predictive validity and test-  
22 retest reliability among theoretically negatively related factors measured by negatively  
23 worded items still remain under-researched. Second, previous research has identified a  
24 number of method effects could potentially influence factor correlations. For example,  
25 acquiescence (yes-saying effects) and naysaying effects, primacy and recency effects, and

1 social desirability effects (Kline, Sulsky, & Rever-Moriyama, 2000; McClendon, 1991;  
2 Podsakoff et al., 2003; Podsakoff et al., 2012) could affect patterns of responses to survey  
3 items and confound results. Also, it has been proposed that method effects could be more  
4 substantial in certain cases, such as similarity in the format of responses (e.g., Likert-scale),  
5 ambiguous items, exhaustion over lengthy questionnaires, and respondents with low  
6 education level (Cronbach, 1946, 1950; Krosnick, 1991; Krosnick & Schuman, 1988;  
7 McClendon, 1991; Podsakoff et al., 2003). Although our randomized controlled crossover  
8 design may somewhat counter-balance the confounding effects, they are difficult to  
9 completely resolve unless further research incorporates these factors by using cluster  
10 randomized controlled designs. Third, the present investigation is correlational in design and  
11 investigated self-reported psychological variables in the context of sport injury prevention.  
12 Although this methodological approach is common in sport and exercise psychology research  
13 (Andersen, McCullagh, & Wilson, 2007; Biddle, Markland, Gilbourne, Chatzisarantis, &  
14 Sparkes, 2001; Hagger & Chatzisarantis, 2009), future research should include more objective  
15 assessments (e.g., other-reported measures, implicit association test), and behavioral or  
16 clinical outcomes (e.g., sport injury). Finally, culture and background of participants and  
17 behavioral contexts being investigated might have impacted on the extent of method effects in  
18 survey (Chan, Zhang, Fung, & Hagger, 2014; Hagger et al., 2007; Hui & Triandis, 1989). It  
19 is, therefore, important to replicate our study in a variety of sport or health contexts, with  
20 preferably larger sampling population for more robust tests of the generalizability of the  
21 present findings.

## 22 **Conclusion**

23 This study is the first investigation on the effects of consistency tendency, as one of  
24 the major sources of common method bias, on the relationships between autonomy support,  
25 autonomous motivation, and intention in the context of sport injury prevention. Results

- 1 provide some evidence that consistency tendency could be manipulated by modifying the
- 2 temporal or proximal separation between the items, but its effects on factor correlation were
- 3 small. Researchers in sport and exercise psychology should be aware of the potential method
- 4 effects of consistency tendency when designing and reporting research methods, particularly
- 5 when cross-sectional survey designs with correlational analysis are adopted.

## References

- 1
- 2 Andersen, M. B., McCullagh, P., & Wilson, G. J. (2007). But what do the numbers really tell  
3 us?: Arbitrary metrics and effect size reporting in sport psychology research. *Journal*  
4 *of sport & exercise psychology*, 29(5), 664-672.
- 5 Biddle, S. J. H., Markland, D., Gilbourne, D., Chatzisarantis, N. L. D., & Sparkes, A. C.  
6 (2001). Research methods in sport and exercise psychology: quantitative and  
7 qualitative issues. *Journal of Sports Sciences*, 19(10), 777-809.
- 8 Chan, D. K. C., & Hagger, M. S. (2012a). Self-determined forms of motivation predict sport  
9 injury prevention and rehabilitation intentions. *Journal of Science and Medicine in*  
10 *Sport*, 15(5), 398-406. doi: 10.1016/j.jsams.2012.03.016
- 11 Chan, D. K. C., & Hagger, M. S. (2012b). Theoretical integration and the psychology of sport  
12 injury prevention. *Sports Medicine*, 42(9), 725-732. doi: 10.1007/BF03262291
- 13 Chan, D. K. C., & Hagger, M. S. (2012c). Trans-contextual development of motivation in  
14 sport injury prevention among elite athletes. *Journal of Sport and Exercise*  
15 *Psychology*, 34(5), 661-682.
- 16 Chan, D. K. C., Hagger, M. S., & Spray, C. M. (2011). Treatment motivation for  
17 rehabilitation after a sport injury: Application of the trans-contextual model.  
18 *Psychology of Sport and Exercise*, 12, 83-92.
- 19 Chan, D. K. C., Zhang, X., Fung, H. H., & Hagger, M. S. (2014). Does emotion and its daily  
20 fluctuation correlate with depression? A cross-cultural analysis among six developing  
21 countries. *Journal of Epidemiology and Global Health, Advanced online publication*.  
22 doi: 10.1016/j.jegh.2014.09.001
- 23 Cronbach, L. J. (1946). Response sets and test validity. *Educational and Psychological*  
24 *Measurement*, 6(4), 475-493. doi: 10.1177/001316444600600405
- 25 Cronbach, L. J. (1950). Further evidence on response sets and test design. *Educational and*  
26 *Psychological Measurement*, 10(1), 3-31. doi: 10.1177/001316445001000101
- 27 Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human*  
28 *behavior*. New York: Plenum.
- 29 Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and  
30 the self-determination of behavior. *Psychological Inquiry*, 11(4), 227-268.
- 31 Doty, D. H., & Glick, W. H. (1998). Common methods bias: Does common methods variance  
32 really bias results? *Organizational Research Methods*, 1(4), 374-406. doi:  
33 10.1177/109442819814002
- 34 Duan, N., Alegria, M., Canino, G., McGuire, T. G., & Takeuchi, D. (2007). Survey  
35 conditioning in self-reported mental health service use: Randomized comparison of  
36 alternative instrument formats. *Health Services Research*, 42(2), 890-907. doi:  
37 10.1111/j.1475-6773.2006.00618.x
- 38 Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A., & Rubin, D. B. (2014).  
39 *Bayesian data analysis* (3rd ed.). Boca Raton: CRC Press.
- 40 Hagger, M. S., Asci, F. H., Lindwall, M., Hein, V., Mulazimoglu-Balli, O., Tarrant, M., . . .  
41 Sell, V. (2007). Cross-cultural validity and measurement invariance of the social  
42 physique anxiety scale in five European nations. *Scandinavian Journal of Medicine*  
43 *and Science in Sports*, 17(6), 703-719. doi: 10.1111/J.1600-0838.2006.00615.X
- 44 Hagger, M. S., & Chatzisarantis, N. L. D. (2009). Assumptions in research in sport and  
45 exercise psychology. *Psychology of Sport and Exercise*, 10(5), 511-519. doi:  
46 10.1016/j.psychsport.2009.01.004
- 47 Hambleton, R. K. (2005). Issues, designs, and technical guidelines for adapting tests into  
48 multiple languages and cultures. In R. K. Hambleton, P. Merenda & C. Spielberger

- 1 (Eds.), *Adapting educational and psychological tests for cross-cultural assessment*  
2 (pp. 3-38). Mahwah, NJ: Lawrence Erlbaum.
- 3 Hui, C. H., & Triandis, H. C. (1989). Effects of culture and response format on extreme  
4 response style. *Journal of cross-cultural psychology*, 20(3), 296-309. doi:  
5 10.1177/0022022189203004
- 6 Kline, T. J. B., Sulsky, L. M., & Rever-Moriyama, S. D. (2000). Common method variance  
7 and specification errors: A practical approach to detection. *Journal of Psychology*,  
8 134(4), 401-421. doi: 10.1080/00223980009598225
- 9 Krosnick, J. A. (1991). Response strategies for coping with the cognitive demands of attitude  
10 measures in surveys. *Applied Cognitive Psychology*, 5(3), 213-216. doi:  
11 10.1002/acp.2350050305
- 12 Krosnick, J. A., & Schuman, H. (1988). Attitude intensity, importance, and certainty and  
13 susceptibility to response effects. *Journal of Personality and Social Psychology*,  
14 54(6), 940-952. doi: 10.1037/0022-3514.54.6.940
- 15 McClendon, M. J. (1991). Acquiescence and recency response-order effects in interview  
16 surveys. *Sociological Methods and Research*, 20(1), 60-103. doi:  
17 10.1177/0049124191020001003
- 18 Muthén, B., & Asparouhov, T. (2010). Bayesian analysis using Mplus: Technical  
19 implementation. Mplus technical report. Retrieved from <http://www.statmodel.com>
- 20 Muthén, B., & Asparouhov, T. (2012). Bayesian structural equation modeling: A more  
21 flexible representation of substantive theory. *Psychological Methods*, 17(3), 313-335.
- 22 Muthén, B., & Asparouhov, T. (2013). BSEM Measurement Invariance Analysis. Mplus  
23 WebNote No. 17. Retrieved from <http://www.statmodel.com>
- 24 Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method  
25 biases in behavioral research: A critical review of the literature and recommended  
26 remedies. *Journal of Applied Psychology*, 88(5), 879-903. doi: 10.1037/0021-  
27 9101.88.5.879
- 28 Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2012). Sources of method bias in  
29 social science research and recommendations on how to control it. . *Annual Review of*  
30 *Psychology*, 63, 539-569. doi: 10.1146/annurev-psych-120710-100452
- 31 Salancik, G. R. (1984). On Priming, consistency, and order effects in job-attitude assessment:  
32 With a note on current research. *Journal of Management*, 10(2), 250-254. doi:  
33 10.1177/014920638401000209
- 34 Salancik, G. R., & Pfeffer, J. (1977). An examination of need-satisfaction models of job  
35 attitudes. *Administrative Science Quarterly*, 22(3), 427-456. doi: 10.2307/2392182
- 36 Stenling, A., Lindwall, M., & Hassmén, P. (2015). Changes in perceived autonomy support,  
37 need satisfaction, motivation, and well-being in young elite athletes. *Sport, Exercise,*  
38 *and Performance Psychology*, 1, 50-61. doi: 10.1037/spy0000027
- 39 Van De Schoot, R., Kluytmans, A., Tummers, L., Lugtig, P., Hox, J., & Muthén, B. (2013).  
40 Facing off with Scylla and Charybdis: a comparison of scalar, partial, and the novel  
41 possibility of approximate measurement invariance. *Frontiers in Psychology*, 4(770),  
42 1-15. doi: 10.3389/fpsyg.2013.00770
- 43 Weijters, B., Geuens, M., & Schillewaert, N. (2009). The proximity effect: The role of inter-  
44 item distance on reverse-item bias. *International Journal of Research in Marketing*,  
45 26(1), 2-12. doi: 10.1016/j.ijresmar.2008.09.003
- 46 Williams, G. C., Grow, V. M., Freedman, Z. R., Ryan, R. M., & Deci, E. L. (1996).  
47 Motivational predictors of weight loss and weight-loss maintenance. *Journal of*  
48 *Personality and Social Psychology*, 70(1), 115-126.

1 Table 1  
 2 *Model fit of the Single- and Multi-Group BSEM Models*

Dataset(s)	PPp	2.5% PP limit	97.5 % PP limit
<u>Single-Group Analyses</u>			
Group 1 Time 1	.61	-52.76	38.58
Group 2 Time 1	.58	-51.08	41.38
Group 1 Time 2	.74	-63.20	31.54
Group 2 Time 2	.62	-53.01	39.29
Full Low IID	.56	-49.28	41.99
Full High IID	.57	-49.79	41.95
<u>Multi-Group Analyses (Between-Group)</u>			
<u>Group 1 Time 1 vs Group 2 Time 1</u>			
Approximate invariance step 1 <sup>a</sup>	.18	-36.08	98.44
Approximate invariance step 2	.39	-55.99	72.30
Structural model	.33	-49.50	79.32
<u>Group 1 Time 2 vs Group 2 Time 2</u>			
Approximate invariance step 1 <sup>b</sup>	.61	-75.68	57.60
Approximate invariance step 2	.41	-58.87	73.54
Structural model	.36	-54.70	76.45
<u>Full Low IID vs Full High IID</u>			
Approximate invariance step 1 <sup>c</sup>	.20	-39.01	94.62
Approximate invariance step 2	.46	-61.23	68.01
Structural model	.39	-56.67	72.72
<u>Multi-Group Analyses (Within-Group)</u>			
<u>Group 1 Time 1 vs Group 1 Time 2</u>			
Approximate invariance step 1 <sup>d</sup>	.77	-91.08	41.37
Approximate invariance step 2	.62	-76.99	53.72
Structural model	.55	-71.97	60.57
<u>Group 2 Time 1 vs Group 2 Time 2</u>			
Approximate invariance step 1 <sup>e</sup>	.17	-33.86	99.73
Approximate invariance step 2	.13	-28.64	102.95
Structural model	.13	-28.48	102.58

3 *Note.* PPp = posterior predictive *p* value.

4 <sup>a</sup>Non-invariant intercepts: autonomous motivation items 3, 4, 5, and 6, and intention items 1  
 5 and 3.

6 <sup>b</sup>Non-invariant intercepts: autonomy support item 3.

7 <sup>c</sup>Non-invariant intercepts: autonomous motivation items 3, 4, 5, and 6, and intention items 1,  
 8 2, and 3.

9 <sup>d</sup>Full approximate invariance.

10 <sup>e</sup>Non-invariant intercepts: autonomous motivation items 3, 4, and 6, and intention item 1.

11

1 Table 2

2 *Parameter Estimates and Credibility Intervals in the Structural Models*

Dataset(s)	Autonomy Support → Autonomous Motivation	Autonomous Motivation → Intention
Standardized Beta [Credibility Interval]		
1. Group 1 Time 1 (Low IID)	.39 [.17, .56]	.57 [.38, .71]
2. Group 2 Time 1 (High IID)	.26 [.05, .45]	.43 [.18, .63]
3. Group 2 Time 1 (High IID)	.23 [.01, .42]	.45 [.17, .65]
4. Group 2 Time 2 (Low IID)	.46 [.22, .63]	.48 [.26, .64]
5. Full Low IID	.40 [.21, .55]	.57 [.40, .70]
6. Full High IID	.24 [.06, .41]	.45 [.22, .62]
Difference of Parameter Estimates [Credibility Interval]		
<b>Between-Group Time 1</b> (Dataset 1 vs Dataset 2)	-.15 [-.47, .18]	-.18 [-.53, .18]
<b>Between-Group Time 2</b> (Dataset 3 vs Dataset 4)	.09 [-.28, .46]	.17 [-.23, .57]
<b>Within-Group Group 1</b> (Dataset 1 vs Dataset 3)	-.10 [-.54, .33]	.27 [-.21, .75]
<b>Within-Group Group 2</b> (Dataset 2 vs Dataset 4)	-.27 [-.64, .08]	.01 [-.38, .40]
<b>Between-Condition</b> (Dataset 5 vs Dataset 6)	-.18 [-.47, .10]	-.14 [-.48, .18]

3 *Note.* IID = inter-item distance. All the parameter estimates had non-zero credibility intervals,  
 4 thus were positive and statistically significant.

5

1

2

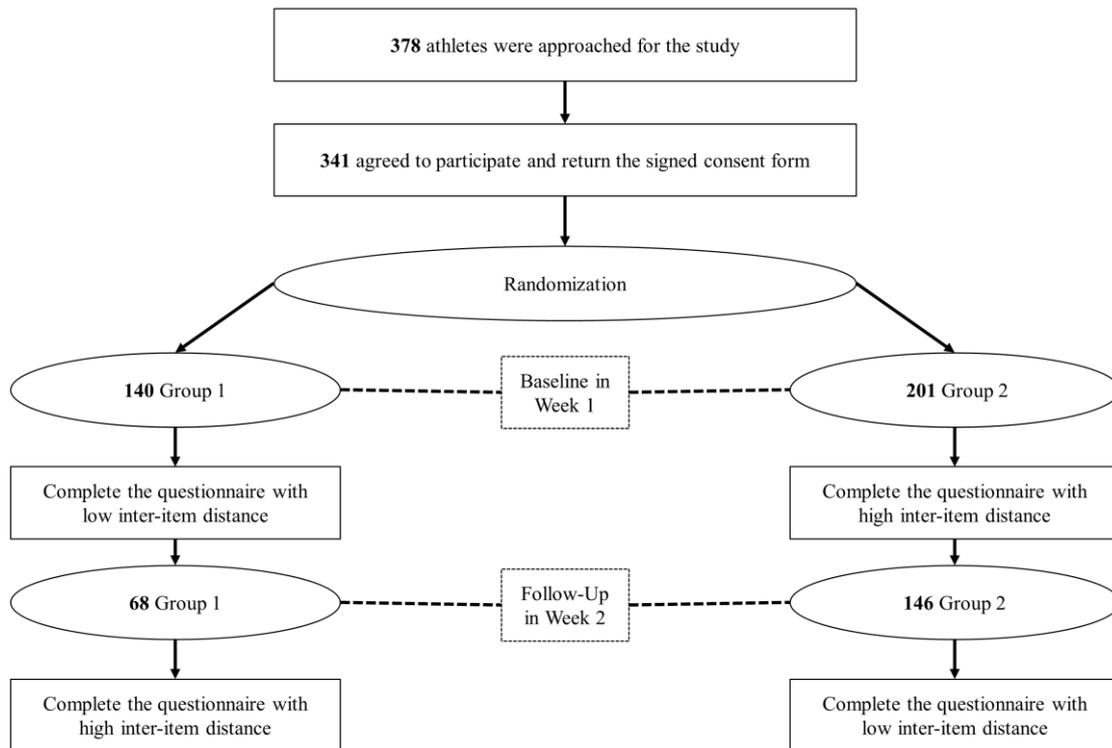
3

4

## Appendix A

(Supplementary online material)

### Experimental Procedures



5

6

1  
2  
3  
4  
5  
6  
7  
8

Appendix B

(Supplementary online material)

*Descriptive Statistics and Correlations Between Latent Factors*

Correlations		1	2	3	4	5	6
				<u>Group 1</u>			
Time 1	1. Autonomy Support	1	.39*	.43*	.90*	.36*	.60*
	2. Autonomous Motivation	.26*	1	.67*	.09	.77*	.49*
	3. Intention	.10	.33*	1	.36*	.49*	.83*
Time 2	4. Autonomy Support	.77*	.34*	.16	1	.28	.47*
	5. Autonomous Motivation	.13	.69*	.48*	.35*	1	.44*
	6. Intention	.14	.47*	.66*	.34*	.62*	1
Group 1	Mean	4.97	5.49	4.79	5.19	5.59	4.06
	SD	1.34	1.01	1.45	1.40	1.15	1.59
	Cronbach's Alpha	.91	.79	.87	.95	.91	.96
	Mean Factor Loading	.83	.68	.85	.90	.84	.93
	Mean Standard Error	.06	.13	.09	.05	.07	.05
Group 2	Mean	4.98	6.03	4.02	4.73	5.21	4.55
	SD	1.30	0.88	1.55	1.15	1.11	1.36
	Cronbach's Alpha	.92	.85	.96	.90	.87	.86
	Mean Factor Loading	.83	.75	.92	.80	.77	.85
	Mean Standard Error	.05	.08	.04	.07	.10	.07

*Note.* The correlation matrix of Group 1 is presented at the upper diagonal, and that of Group 2 is displayed at the lower diagonal. \*Credibility interval did not include zero.