

## Online Appendix A: Literature review of cross-classified multilevel modeling applications in psychology

*Literature Review Procedure.* The purpose of this literature review was to examine how often continuous level-1 predictors are centered in cross-classified multilevel models in practice, as well as how often cluster means of level-1 predictors are included as separate predictors. We first collected published articles on psychological topics that appeared when key terms such as "Cross Classified," "Cross Classified Multilevel Model", and "Cross Classified Model" were searched on PsycInfo, Google Scholar, and the University of British Columbia library ( $n=246$ ). We then inspected all papers and excluded those that did not include continuous level-1 predictors in their statistical analyses. Once this exclusion criterion was applied, we reviewed the articles in a random order until reaching 100 articles.

	Reference	Are level-1 predictors centered?	Type of centering used:	Are cluster means of level-1 variables included as predictors?
1	Barker, K. M., Subramanian, S. V., Berkman, L., Austin, S. B., & Evans, C. R. (2019). Adolescent sexual initiation: A cross-classified multilevel analysis of peer group-, school-, and neighborhood-level influences. <i>Journal of Adolescent Health, 65</i> (3), 390-396. <a href="https://doi.org/10.1016/j.jadohealth.2019.03.002">https://doi.org/10.1016/j.jadohealth.2019.03.002</a>	no	-	no
2	Sakai-Bizmark, R., Richmond, T. K., Kawachi, I., Elliott, M. N., Davies, S. L., Tortolero Emery, S., Peskin, M., Milliren, C. E., & Schuster, M. A. (2020). School social capital and tobacco experimentation among adolescents: Evidence from a cross-classified multilevel, longitudinal analysis. <i>Journal of Adolescent Health, 66</i> (4), 431-438. <a href="https://doi.org/10.1016/j.jadohealth.2019.10.022">https://doi.org/10.1016/j.jadohealth.2019.10.022</a>	no	-	no
3	Abdel Magid, H. S., Milliren, C. E., Pettee Gabriel, K., & Nagata, J. M. (2021). Disentangling individual, school, and neighborhood effects on screen time among adolescents and young adults in the United States. <i>Preventive Medicine, 142</i> , 106357-106357. <a href="https://doi.org/10.1016/j.ypmed.2020.106357">https://doi.org/10.1016/j.ypmed.2020.106357</a>	no	-	no
4	Ake-Little, E., von der Embse, N., & Dawson, D. (2020). Does class size matter in the university setting? <i>Educational Researcher, 49</i> (8), 595-605. <a href="https://doi.org/10.3102/0013189X20933836">https://doi.org/10.3102/0013189X20933836</a>	no	-	no
5	Reiss, M. V., & Tsvetkova, M. (2020). Perceiving education from Facebook profile pictures. <i>New Media &amp; Society, 22</i> (3), 550-570. <a href="https://doi.org/10.1177/1461444819868678">https://doi.org/10.1177/1461444819868678</a>	no	-	no
6	Akaeda, N. (2021). Welfare states and the health impact of social capital: Focusing on the crowding-out and crowding-in perspectives. <i>Social Indicators Research, 157</i> (3), 841-862. <a href="https://doi.org/10.1007/s11205-021-02679-7">https://doi.org/10.1007/s11205-021-02679-7</a>	no	-	no
7	Vinas-Forcade, J., Mels, C., Van Houtte, M., Valcke, M., & Derluyn, I. (2021). Can failure be prevented? using longitudinal data to identify at-risk students upon entering secondary school. <i>British Educational Research Journal, 47</i> (1), 205-225. <a href="https://doi.org/10.1002/berj.3683">https://doi.org/10.1002/berj.3683</a>	yes	grand mean centering	no
8	Moore, G. F., Anthony, R. E., Hawkins, J., Van Godwin, J., Murphy, S., Hewitt, G., & Melendez-Torres, G. J. (2020). Socioeconomic status, mental wellbeing and transition to secondary school: Analysis of the school health research Network/Health behaviour in School-aged children survey in Wales. <i>British Educational Research Journal, 46</i> (5), 1111-1130. <a href="https://doi.org/10.1002/berj.3616">https://doi.org/10.1002/berj.3616</a>	no	-	no
9	Renzo, C. (2021). The role of culture in the gendered division of domestic labor: Evidence from migrant populations in Europe. <i>Acta Sociologica, 64</i> (1), 24-47. <a href="https://doi.org/10.1177/0001699320930073">https://doi.org/10.1177/0001699320930073</a>	no	-	no
10	Kern, M. R., Heinz, A., Stevens, G. W. J. M., Walsh, S. D., & Willems, H. (2020). "What's a			

	normal weight?" – origin and receiving country influences on weight-status assessment among 1.5 and 2nd generation immigrant adolescents in Europe. <i>Social Science &amp; Medicine</i> (1982), 264, 113306-113306. <a href="https://doi.org/10.1016/j.socscimed.2020.113306">https://doi.org/10.1016/j.socscimed.2020.113306</a>	yes	standardized	no
11	Jiang, J., & Wang, P. (2022). Which generation is more likely to participate in society? A longitudinal analysis. <i>Social Indicators Research</i> , 162(1), 209-229. <a href="https://doi.org/10.1007/s11205-021-02830-4">https://doi.org/10.1007/s11205-021-02830-4</a>	yes	grand mean centering	no
12	Bozorgmehr, K., Maier, W., Brenner, H., Saum, K., Stock, C., Miksch, A., Holleczeck, B., Szecsenyi, J., & Razum, O. (2015). Social disparities in disease management programmes for coronary heart disease in Germany: A cross-classified multilevel analysis. <i>Journal of Epidemiology and Community Health</i> (1979), 69(11), 1091-1101. <a href="https://doi.org/10.1136/jech-2014-204506">https://doi.org/10.1136/jech-2014-204506</a>	no	-	no
13	De Clercq, B., Pfoertner, T., Elgar, F. J., Hublet, A., & Maes, L. (2014). Social capital and adolescent smoking in schools and communities: A cross-classified multilevel analysis. <i>Social Science &amp; Medicine</i> (1982), 119, 81-87. <a href="https://doi.org/10.1016/j.socscimed.2014.08.018">https://doi.org/10.1016/j.socscimed.2014.08.018</a>	no	-	no
14	Ding, C., & Cao, X. (2019). How does the built environment at residential and work locations affect car ownership? An application of cross-classified multilevel model. <i>Journal of Transport Geography</i> , 75, 37-45. <a href="https://doi.org/10.1016/j.jtrangeo.2019.01.012">https://doi.org/10.1016/j.jtrangeo.2019.01.012</a>	no	-	no
15	Dundas, R., Leyland, A. H., & Macintyre, S. (2014). Early-life school, neighborhood, and family influences on adult health: A multilevel cross-classified analysis of the Aberdeen children of the 1950s study. <i>American Journal of Epidemiology</i> , 180(2), 197-207. <a href="https://doi.org/10.1093/aje/kwu110">https://doi.org/10.1093/aje/kwu110</a>	no	-	no
16	Dunn, E. C., Richmond, T. K., Milliren, C. E., & Subramanian, S. V. (2015). Using cross-classified multilevel models to disentangle school and neighborhood effects: An example focusing on smoking behaviors among adolescents in the United States. <i>Health &amp; Place</i> , 31, 224-232. <a href="https://doi.org/10.1016/j.healthplace.2014.12.001">https://doi.org/10.1016/j.healthplace.2014.12.001</a>	no	-	no
17	Heck, R. H. (2009). Teacher effectiveness and student achievement: Investigating a multilevel cross-classified model. <i>Journal of Educational Administration</i> , 47(2), 227-249. <a href="https://doi.org/10.1108/09578230910941066">https://doi.org/10.1108/09578230910941066</a>	yes	standardized	yes (for only one cluster type)
18	Johnson, B. D. (2012). Cross-classified multilevel models: An application to the criminal case processing of indicted terrorists. <i>Journal of Quantitative Criminology</i> , 28(1), 163-189. <a href="https://doi.org/10.1007/s10940-011-9157-3">https://doi.org/10.1007/s10940-011-9157-3</a>	yes	grand mean centering	no
19	Huang, Y., Edwards, J., & Laurel-Wilson, M. (2020). The shadow of context: Neighborhood and school socioeconomic disadvantage, perceived social integration, and the mental and behavioral health of adolescents. <i>Health &amp; Place</i> , 66, 102425-102425. <a href="https://doi.org/10.1016/j.healthplace.2020.102425">https://doi.org/10.1016/j.healthplace.2020.102425</a>	no	-	no
20	Kim, Y. S. (2016). Examination of the relative effects of neighborhoods and schools on juvenile delinquency: A multilevel cross-classified model approach. <i>Deviant Behavior</i> , 37(10), 1196-1214. <a href="https://doi.org/10.1080/01639625.2016.1170537">https://doi.org/10.1080/01639625.2016.1170537</a>	yes	grand mean centering	no
21	Gustafsson, P. E., Bozorgmehr, K., Hammarström, A., & Sebastian, M. S. (2017). What role does adolescent neighborhood play for adult health? A cross-classified multilevel analysis of life course models in northern Sweden. <i>Health &amp; Place</i> , 46, 137-144. <a href="https://doi.org/10.1016/j.healthplace.2017.04.013">https://doi.org/10.1016/j.healthplace.2017.04.013</a>	no	-	no

22	Jones, R., Haardoerfer, R., Riosmena, F., & Cunningham, S. A. (2019). Health implications of migration: Cross-classified multilevel models to disentangle country of origin and state of resettlement effects of bodyweight (P04-106-19). <i>Current Developments in Nutrition</i> , 3(Suppl1) <a href="https://doi.org/10.1093/cdn/nzz051.P04-106-19">https://doi.org/10.1093/cdn/nzz051.P04-106-19</a>	no	-	no
23	Vanwynsberghe, G., Vanlaar, G., Van Damme, J., & De Fraine, B. (2017). Long-term effects of primary schools on educational positions of students 2 and 4 years after the start of secondary education. <i>School Effectiveness and School Improvement</i> , 28(2), 167-190. <a href="https://doi.org/10.1080/09243453.2016.1245667">https://doi.org/10.1080/09243453.2016.1245667</a>	yes	standardized	yes (for only one cluster type, and for only a subset of level-1 independent variables)
24	Pedersen, W., Bakken, A., & von Soest, T. (2018). Neighborhood or school? Influences on alcohol consumption and heavy episodic drinking among urban adolescents. <i>Journal of Youth and Adolescence</i> , 47(10), 2073-2087. <a href="https://doi.org/10.1007/s10964-017-0787-0">https://doi.org/10.1007/s10964-017-0787-0</a>	no	-	yes (for only a subset of level-1 independent variables)
25	Vanwynsberghe, G., Vanlaar, G., Van Damme, J., & De Fraine, B. (2017). Long-term effects of primary schools on mathematics achievement of students at age 17. <i>British Educational Research Journal</i> , 43(6), 1131-1148. <a href="https://doi.org/10.1002/berj.3311">https://doi.org/10.1002/berj.3311</a>	yes	standardized	no
26	Brannstrom, L. (2008). Making their mark: The effects of neighbourhood and upper secondary school on educational achievement. <i>European Sociological Review</i> , 24(4), 463-478. <a href="https://doi.org/10.1093/esr/jcn013">https://doi.org/10.1093/esr/jcn013</a>	no	-	no
27	Aminzadeh, K., Denny, S., Utter, J., Milfont, T. L., Ameratunga, S., Teevale, T., & Clark, T. (2013). Corrigendum to "Neighbourhood social capital and adolescent self-reported wellbeing in New Zealand: A multilevel analysis" [Soc Sci med 84 (2013) 13–21]. <i>Social Science &amp; Medicine</i> (1982), 91, 101-101.	yes	standardized	no
28	Cheung, C., Goodman, D., Leckie, G., & Jenkins, J. M. (2011). Understanding contextual effects on externalizing behaviors in children in out-of-home care: Influence of workers and foster families. <i>Children and Youth Services Review</i> , 33(10), 2050-2060. <a href="https://doi.org/10.1016/j.childyouth.2011.05.036">https://doi.org/10.1016/j.childyouth.2011.05.036</a>	yes	standardized	no
29	Huijts, T., & Kraaykamp, G. (2012). Immigrants' health in Europe: A cross-classified multilevel approach to examine origin country, destination country, and community effects. <i>The International Migration Review</i> , 46(1), 101-137. <a href="https://doi.org/10.1111/j.1747-7379.2012.00882.x">https://doi.org/10.1111/j.1747-7379.2012.00882.x</a>	no	-	no
30	Kislev, E. (2016). The effect of education policies on higher-education attainment of immigrants in western Europe: A cross-classified multilevel analysis. <i>Journal of European Social Policy</i> , 26(2), 183-199. <a href="https://doi.org/10.1177/0958928716637142">https://doi.org/10.1177/0958928716637142</a>	no	-	no
31	Nuño, L. E., & Katz, C. M. (2019). Understanding gang joining from a cross classified multi-level perspective. <i>Deviant Behavior</i> , 40(3), 301-325. <a href="https://doi.org/10.1080/01639625.2017.1421706">https://doi.org/10.1080/01639625.2017.1421706</a>	no	-	no
32	Tong, F., Luo, W., Irby, B. J., Lara-Alecio, R., & Rivera, H. (2017). Investigating the impact of professional development on teachers' instructional time and English learners' language development: A multilevel cross-classified approach. <i>International Journal of Bilingual Education and Bilingualism</i> , 20(3), 292-313. <a href="https://doi.org/10.1080/13670050.2015.1051509">https://doi.org/10.1080/13670050.2015.1051509</a>	no	-	no
33	West, P., Sweeting, H., & Leyland, A. (2004). School effects on pupils' health behaviours: Evidence in support of the health promoting school. <i>Research Papers in Education</i> , 19(3), 261-291. <a href="https://doi.org/10.1080/02671522.2004.10058645">https://doi.org/10.1080/02671522.2004.10058645</a>	yes	grand mean centering	no

34	Curby, T. W., Rimm-Kaufman, S. E., & Ponitz, C. C. (2009). Teacher-child interactions and children's achievement trajectories across kindergarten and first grade. <i>Journal of Educational Psychology, 101</i> (4), 912-925. <a href="https://doi.org/10.1037/a0016647">https://doi.org/10.1037/a0016647</a>	yes	grand mean centering	no
35	Bulotsky-Shearer, R. J., & Fantuzzo, J. W. (2011). Preschool behavior problems in classroom learning situations and literacy outcomes in kindergarten and first grade. <i>Early Childhood Research Quarterly, 26</i> (1), 61-73. <a href="https://doi.org/10.1016/j.ecresq.2010.04.004">https://doi.org/10.1016/j.ecresq.2010.04.004</a>	yes	standardized	no
36	Cernat, A., & Sakshaug, J. W. (2020). Nurse effects on measurement error in household biosocial surveys. <i>BMC Medical Research Methodology, 20</i> (1), 45-45. <a href="https://doi.org/10.1186/s12874-020-00922-2">https://doi.org/10.1186/s12874-020-00922-2</a>	no	-	no
37	Chaix, B., Bean, K., Daniel, M., Zenk, S. N., Kestens, Y., Charreire, H., Leal, C., Thomas, F., Karusisi, N., Weber, C., Oppert, J., Simon, C., Merlo, J., & Pannier, B. (2012). Associations of supermarket characteristics with weight status and body fat: A multilevel analysis of individuals within supermarkets (Record study). <i>PloS One, 7</i> (4), e32908-e32908. <a href="https://doi.org/10.1371/journal.pone.0032908">https://doi.org/10.1371/journal.pone.0032908</a>	no	-	no
38	Huff, J. (2021). Understanding police decisions to arrest: The impact of situational, officer, and neighborhood characteristics on police discretion. <i>Journal of Criminal Justice, 75</i> , 101829. <a href="https://doi.org/10.1016/j.jcrimjus.2021.101829">https://doi.org/10.1016/j.jcrimjus.2021.101829</a>	yes	grand mean centering	no
39	Jenson, J. M., & Dieterich, W. A. (2007). Effects of a skills-based prevention program on bullying and bully victimization among elementary school children. <i>Prevention Science, 8</i> (4), 285-296. <a href="https://doi.org/10.1007/s11121-007-0076-3">https://doi.org/10.1007/s11121-007-0076-3</a>	yes	scaled so that 1 unit increase = 135 days	no
40	Milliren, C. E., Richmond, T. K., Evans, C. R., Dunn, E. C., & Johnson, R. M. (2017). Contextual effects of neighborhoods and schools on adolescent and young adult marijuana use in the United States. <i>Substance Abuse : Research and Treatment, 2017</i> (11), 1178221817711417-1178221817711417. <a href="https://doi.org/10.1177/1178221817711417">https://doi.org/10.1177/1178221817711417</a>	no	-	no
41	Miltenburg, E. M., & van der Meer, T. W. G. (2018). Lingering neighbourhood effects: A framework to account for residential histories and temporal dynamics. <i>Urban Studies (Edinburgh, Scotland), 55</i> (1), 151-174. <a href="https://doi.org/10.1177/0042098016639012">https://doi.org/10.1177/0042098016639012</a>	no	-	no
42	Pina-Sánchez, J., Grech, D., Brunton-Smith, I., & Sferopoulos, D. (2020). Corrigendum to “Exploring the origin of sentencing disparities in the crown court: Using text mining techniques to differentiate between court and judge disparities” [soc. sci. res. 84C (2019) 102343]. <i>Social Science Research, 85</i> , 102371-102371. <a href="https://doi.org/10.1016/j.ssresearch.2019.102371">https://doi.org/10.1016/j.ssresearch.2019.102371</a>	no	-	no
43	Piontek, D., Kraus, L., Pabst, A., & Legleye, S. (2012). An age-period-cohort analysis of Cannabis use prevalence and frequency in Germany, 1990–2009. <i>Journal of Epidemiology and Community Health (1979), 66</i> (10), 908-913. <a href="https://doi.org/10.1136/jech-2011-200180">https://doi.org/10.1136/jech-2011-200180</a>	no	-	no
44	Pruitt, S. L., Leonard, T., Zhang, S., Schootman, M., Halm, E. A., & Gupta, S. (2014). Physicians, clinics, and neighborhoods: Multiple levels of influence on colorectal cancer screening. <i>Cancer Epidemiology, Biomarkers &amp; Prevention, 23</i> (7), 1346-1355. <a href="https://doi.org/10.1158/1055-9965.EPI-13-1130">https://doi.org/10.1158/1055-9965.EPI-13-1130</a>	no	-	no
45	Rapp, T. L., & Mathieu, J. E. (2019). Team and individual influences on members' identification and performance per membership in multiple team membership arrangements. <i>Journal of Applied</i>	yes	grand mean centering	no

	<i>Psychology</i> , 104(3), 303-320. <a href="https://doi.org/10.1037/ap10000344">https://doi.org/10.1037/ap10000344</a>			
46	Shuttleworth, I., & Gould, M. (2010). Distance between home and work: A multilevel analysis of individual workers, neighbourhoods, and employment sites in northern Ireland. <i>Environment and Planning, A</i> , 42(5), 1221-1238. <a href="https://doi.org/10.1068/a41372">https://doi.org/10.1068/a41372</a>	no	-	no
47	Wilk, P., Clark, A. F., Maltby, A., Smith, C., Tucker, P., & Gilliland, J. A. (2018;2017;). Examining individual, interpersonal, and environmental influences on children's physical activity levels. <i>SSM - Population Health</i> , 4, 76-85. <a href="https://doi.org/10.1016/j.ssmph.2017.11.004">https://doi.org/10.1016/j.ssmph.2017.11.004</a>	no	-	no
48	Xiao, L., Liu, L., Song, G., Ruiters, S., Zhou, S., Lippe, L., & Social Networks, Solidarity and Inequality. (2018). Journey-to-crime distances of residential burglars in China disentangled: Origin and destination effects. <i>ISPRS International Journal of Geo-Information</i> , 7(8), 325. <a href="https://doi.org/10.3390/ijgi7080325">https://doi.org/10.3390/ijgi7080325</a>	no	-	no
49	Ding, C., Lin, Y., & Liu, C. (2014). Exploring the influence of built environment on tour-based commuter mode choice: A cross-classified multilevel modeling approach. <i>Transportation Research. Part D, Transport and Environment</i> , 32, 230-238. <a href="https://doi.org/10.1016/j.trd.2014.08.001">https://doi.org/10.1016/j.trd.2014.08.001</a>	no	-	no
50	Gregory, A., & Huang, F. (2013). It takes a village: The effects of 10th grade college-going expectations of students, parents, and teachers four years later. <i>American Journal of Community Psychology</i> , 52(1-2), 41-55. <a href="https://doi.org/10.1007/s10464-013-9575-5">https://doi.org/10.1007/s10464-013-9575-5</a>	yes	grand mean centering	no
51	Huang, C. (2019). Generation effects? evolution of independence–unification views in Taiwan, 1996–2016. <i>Electoral Studies</i> , 58, 103-112. <a href="https://doi.org/10.1016/j.electstud.2018.12.010">https://doi.org/10.1016/j.electstud.2018.12.010</a>	no	-	no
52	Li, S., Colson, V., Lejeune, P., & Vanwambeke, S. O. (2016). On the distance travelled for woodland leisure via different transport modes in Wallonia, south Belgium. <i>Urban Forestry &amp; Urban Greening</i> , 15, 123-132. <a href="https://doi.org/10.1016/j.ufug.2015.12.007">https://doi.org/10.1016/j.ufug.2015.12.007</a>	no	-	no
53	Lloyd, J. E. V., Li, L., & Hertzman, C. (2010). Early experiences matter: Lasting effect of concentrated disadvantage on children's language and cognitive outcomes. <i>Health &amp; Place</i> , 16(2), 371-380. <a href="https://doi.org/10.1016/j.healthplace.2009.11.009">https://doi.org/10.1016/j.healthplace.2009.11.009</a>	yes	standardized	no
54	Lüdtke, O., Robitzsch, A., Trautwein, U., Kreuter, F., & Ihme, J. M. (2007). Are there test administrator effects in large-scale educational assessments? Using cross-classified multilevel analysis to probe for effects on mathematics achievement and sample attrition. <i>Methodology</i> , 3(4), 149-159. <a href="https://doi.org/10.1027/1614-2241.3.4.149">https://doi.org/10.1027/1614-2241.3.4.149</a>	yes	standardized	no
55	Martin, O. M., & Cervino, J. (2011). Towards an integrative framework of brand country of origin recognition determinants: A cross-classified hierarchical model. <i>International Marketing Review</i> , 28(6), 530-558. <a href="https://doi.org/10.1108/02651331111181402">https://doi.org/10.1108/02651331111181402</a>	no	-	no
56	Pauwels, L., Weerman, F. M., Bernasco, W., & Bruinsma, G. J. N. (2015). How much variance in offending, self-control and morality can be explained by neighbourhoods and schools? An exploratory cross-classified multi-level analysis. <i>European Journal on Criminal Policy and Research</i> , 21(4), 523-537. <a href="https://doi.org/10.1007/s10610-014-9262-6">https://doi.org/10.1007/s10610-014-9262-6</a>	no	-	no
57	Rudnev, M. (2014). Value adaptation among intra-European migrants: Role of country of birth and country of residence. <i>Journal of Cross-Cultural</i>	yes	standardized	no

	<i>Psychology</i> , 45(10), 1626-1642. <a href="https://doi.org/10.1177/0022022114548482">https://doi.org/10.1177/0022022114548482</a>			
58	Slik, F. W. P. v. d., Hout, R. W. N. M. v., & Schepens, J. J. (2019). The role of morphological complexity in predicting the learnability of an additional language. the case of la (additional language) Dutch. <i>Second Language Research</i> , 35(1), 47-70. <a href="https://doi.org/10.1177/0267658317691322">https://doi.org/10.1177/0267658317691322</a>	yes	grand mean centering	no
59	Brunton-Smith, I., Sturgis, P., & Leckie, G. (2017). Detecting and understanding interviewer effects on survey data by using a cross-classified mixed effects location-scale model. <i>Journal of the Royal Statistical Society. Series A, Statistics in Society</i> , 180(2), 551-568. <a href="https://doi.org/10.1111/rssa.12205">https://doi.org/10.1111/rssa.12205</a>	no	-	no
60	Townsend, N., Rutter, H., & Foster, C. (2012). Age differences in the association of childhood obesity with area-level and school-level deprivation: Cross-classified multilevel analysis of cross-sectional data. <i>International Journal of Obesity</i> , 36(1), 45-52. <a href="https://doi.org/10.1038/ijo.2011.191">https://doi.org/10.1038/ijo.2011.191</a>	no	-	no
61	Uyar, B., & Brown, K. (2007). Neighborhood affluence, school-achievement scores, and housing prices: Cross-classified hierarchies and HLM. <i>Journal of Housing Research</i> , 16(2), 97-116. <a href="https://doi.org/10.1080/10835547.2007.12091980">https://doi.org/10.1080/10835547.2007.12091980</a>	yes	grand mean centering	no
62	Williams, J., Scarborough, P., Townsend, N., Matthews, A., Burgoine, T., Mumtaz, L., & Rayner, M. (2015). Associations between food outlets around schools and BMI among primary students in England: A cross-classified multi-level analysis. <i>PloS One</i> , 10(7), e0132930-e0132930. <a href="https://doi.org/10.1371/journal.pone.0132930">https://doi.org/10.1371/journal.pone.0132930</a>	no	-	no
63	Zhan, M., Downey, C., & Dyke, M. (2021). International postgraduate students' labour mobility in the United Kingdom: A cross-classified multilevel analysis. <i>Population Space and Place</i> , 27(1), n/a. <a href="https://doi.org/10.1002/psp.2381">https://doi.org/10.1002/psp.2381</a>	yes	grand mean centering	no
64	Bell, B. A., Owens, C. M., Ferron, J. M., & Kromrey, J. D. (2013). Parsimony vs. complexity: A comparison of two-level, three-level, and cross-classified models using add health and AHA data. <i>SESUG Proceedings (c) SESUG, Inc (http://www.sesug.org) Paper PO091 [cited 2013 May 13]. Available from: http://analytics.ncsu.edu/sesug/2008/PO-091.pdf.</i>	yes	grand mean centering & standardized	yes (for only one cluster type, and for only a subset of level-1 independent variables)
65	Cafri, G., & Fan, J. (2018). Between-within effects in survival models with cross-classified clustering: Application to the evaluation of the effectiveness of medical devices. <i>Statistical Methods in Medical Research</i> , 27(1), 312-319. <a href="https://doi.org/10.1177/0962280216628561">https://doi.org/10.1177/0962280216628561</a>	no	-	no
66	Langford, I. H., & Bentham, G. (1996). Regional variations in mortality rates in England and Wales: An analysis using multi-level modelling. <i>Social Science &amp; Medicine</i> (1982), 42(6), 897-908. <a href="https://doi.org/10.1016/0277-9536(95)00188-3">https://doi.org/10.1016/0277-9536(95)00188-3</a>	no	-	no
67	Mollick, E. (2012). People and process, suits and innovators: The role of individuals in firm performance. <i>Strategic Management Journal</i> , 33(9), 1001-1015. <a href="https://doi.org/10.1002/smj.1958">https://doi.org/10.1002/smj.1958</a>	no	-	no
68	Morris, T. T., Guggenheim, J. A., Northstone, K., & Williams, C. (2020). Geographical variation in likely myopia and environmental risk factors: A multilevel cross classified analysis of A UK cohort. <i>Ophthalmic Epidemiology</i> , 27(1), 1-9. <a href="https://doi.org/10.1080/09286586.2019.1659979">https://doi.org/10.1080/09286586.2019.1659979</a>	yes	standardized	no
69	Leckie, G. (2009). The complexity of school and neighbourhood effects and movements of pupils on school differences in models of educational achievement. <i>Journal of the Royal Statistical</i>	yes	standardized	

	<i>Society: Series A (Statistics in Society)</i> , 172(3), 537-554.			yes (for only one cluster type, and for only a subset of level-1 independent variables)
70	Vagi, R. L., Collins, C., & Clark, T. (2017). Identifying scalable policy solutions: A state-wide cross-classified analysis of factors related to early childhood literacy. <i>Education Policy Analysis Archives</i> , 25, 9. <a href="https://doi.org/10.14507/epaa.25.2686">https://doi.org/10.14507/epaa.25.2686</a>	yes	cluster mean centering (only centering by one cluster type)	no
71	Zhao, H., Andersson, B., Guo, B., & Xin, T. (2017). Sequential effects in essay ratings: Evidence of assimilation effects using cross-classified models. <i>Frontiers in Psychology</i> , 8, 933-933. <a href="https://doi.org/10.3389/fpsyg.2017.00933">https://doi.org/10.3389/fpsyg.2017.00933</a>	no	-	no
72	Boehler, C. E. H., & Lord, J. (2016). Mind the gap! A multilevel analysis of factors related to variation in published cost-effectiveness estimates within and between countries. <i>Medical Decision Making</i> , 36(1), 31-47. <a href="https://doi.org/10.1177/0272989X15579173">https://doi.org/10.1177/0272989X15579173</a>	no	-	no
73	Ghielen, S. T. S., De Cooman, R., & Sels, L. (2021). The interacting content and process of the employer brand: Person-organization fit and employer brand clarity. <i>European Journal of Work and Organizational Psychology</i> , 30(2), 292-304. <a href="https://doi.org/10.1080/1359432X.2020.1761445">https://doi.org/10.1080/1359432X.2020.1761445</a>	no	-	no
74	Gooty, J., & Yammarino, F. J. (2016). The Leader–Member exchange relationship: A multisource, cross-level investigation. <i>Journal of Management</i> , 42(4), 915-935. <a href="https://doi.org/10.1177/0149206313503009">https://doi.org/10.1177/0149206313503009</a>	yes	grand mean centering	yes (but in separate models)
75	Lemmerer, A. (2016). Modeling the correct level of analysis in non-aggregated household panel data: A simulation approach. <i>Marketing Letters</i> , 27(2), 247-257. <a href="https://doi.org/10.1007/s11002-014-9330-1">https://doi.org/10.1007/s11002-014-9330-1</a>	no	-	no
76	Lockwood, B. (2012). The influence of travel distance on treatment noncompletion for juvenile offenders. <i>The Journal of Research in Crime and Delinquency</i> , 49(4), 572-600. <a href="https://doi.org/10.1177/0022427811414198">https://doi.org/10.1177/0022427811414198</a>	no	-	no
77	Moon, G., Twigg, L., Jones, K., Aitken, G., & Taylor, J. (2019). The utility of geodemographic indicators in small area estimates of limiting long-term illness. <i>Social Science &amp; Medicine (1982)</i> , 227, 47-55. <a href="https://doi.org/10.1016/j.socscimed.2018.06.029">https://doi.org/10.1016/j.socscimed.2018.06.029</a>	yes	grand mean centering	no
78	Tessema, T. (2018). Modelling Under-Five Mortality among Hospitalized Pneumonia Patients in Hawassa City, Ethiopia: A Cross-Classified Multilevel Analysis. <i>Annals of Data Science</i> , 5(2), 111-132.	no	-	no
79	Tong, Y., Chen, F., & Su, W. (2019). Living arrangements and older people's labor force participation in Hong Kong, 1986–2016. <i>Social Science &amp; Medicine (1982)</i> , 229, 50-59. <a href="https://doi.org/10.1016/j.socscimed.2018.10.011">https://doi.org/10.1016/j.socscimed.2018.10.011</a>	no	-	no
80	Ye, Y., & Shu, X. (2022). Lonely in a crowd: Cohort size and happiness in the United Kingdom. <i>Journal of Happiness Studies</i> , 23(5), 2235-2257. <a href="https://doi.org/10.1007/s10902-021-00495-x">https://doi.org/10.1007/s10902-021-00495-x</a>	no	-	no
81	Armingeon, K., & Guthmann, K. (2014). Democracy in crisis? The declining support for national democracy in European countries, 2007-2011. <i>European Journal of Political Research</i> , 53(3), 423-442. <a href="https://doi.org/10.1111/1475-6765.12046">https://doi.org/10.1111/1475-6765.12046</a>	no	-	no
82	Brons, M. E., Bolt, G. S., Helbich, M., Visser, K., & Stevens, G. W. J. M. (2022). Independent			

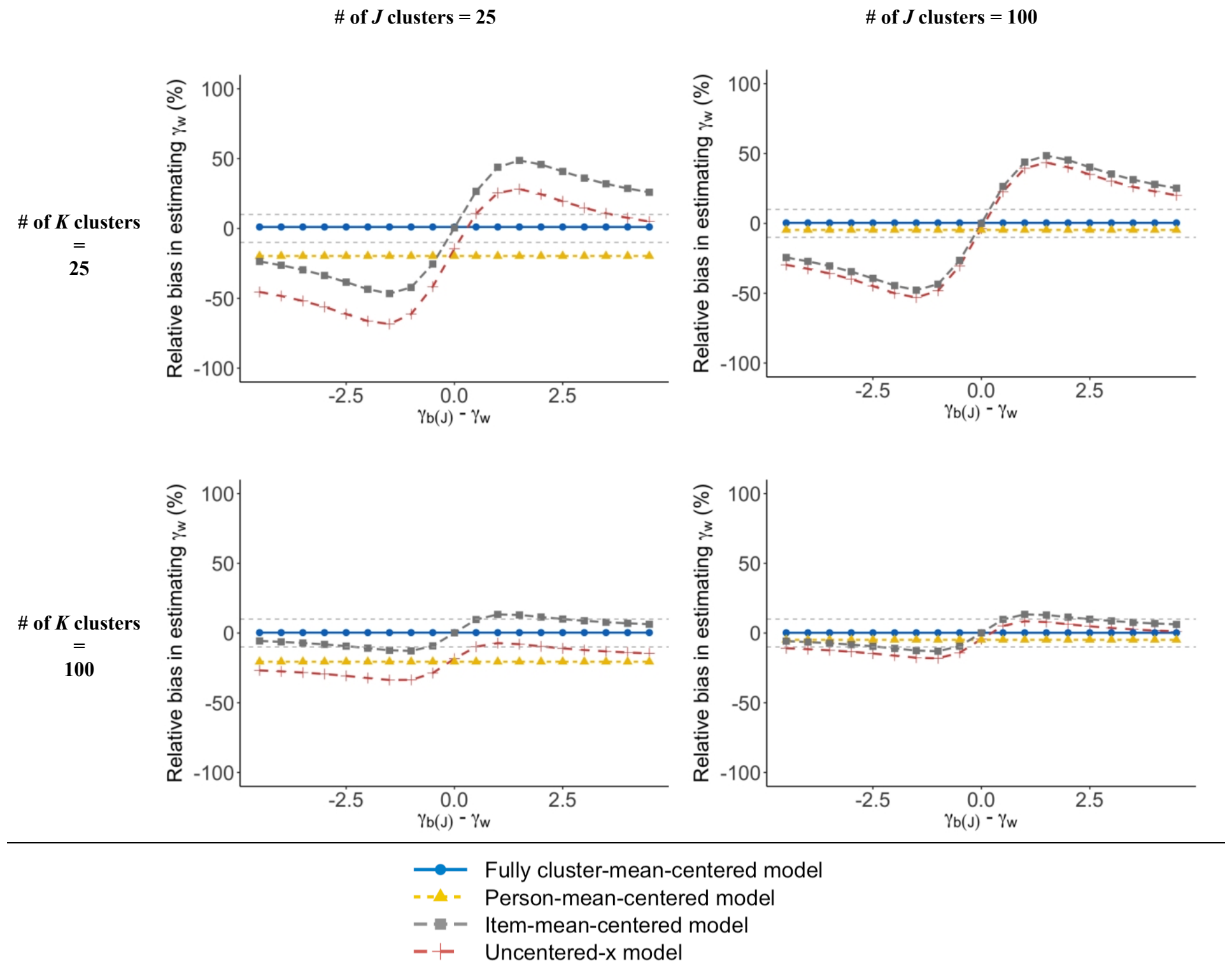
	associations between residential neighbourhood and school characteristics and adolescent mental health in the Netherlands. <i>Health &amp; Place</i> , 74, 1-102765. <a href="https://doi.org/10.1016/j.healthplace.2022.102765">https://doi.org/10.1016/j.healthplace.2022.102765</a>	no	-	no
83	Carroll-Scott, A., Gilstad-Hayden, K., Rosenthal, L., Eldahan, A., McCaslin, C., Peters, S. M., & Ickovics, J. R. (2015). Associations of neighborhood and school socioeconomic and social contexts with body mass index among urban preadolescent students. <i>American Journal of Public Health (1971)</i> , 105(12), 2496-2502. <a href="https://doi.org/10.2105/AJPH.2015.302882">https://doi.org/10.2105/AJPH.2015.302882</a>	no	grand mean centering	no
84	Kraus, L., Tinghög, M. E., Lindell, A., Pabst, A., Piontek, D., & Room, R. (2015). Age, period and cohort effects on time trends in alcohol consumption in the Swedish adult population 1979-2011. <i>Alcohol and Alcoholism (Oxford)</i> , 50(3), 319-327. <a href="https://doi.org/10.1093/alcalc/agt013">https://doi.org/10.1093/alcalc/agt013</a>	no	-	no
85	Livingston, M., Raninen, J., Slade, T., Swift, W., Lloyd, B., & Dietze, P. (2016). Understanding trends in Australian alcohol consumption-an age-period-cohort model. <i>Addiction (Abingdon, England)</i> , 111(9), 1590-1598. <a href="https://doi.org/10.1111/add.13396">https://doi.org/10.1111/add.13396</a>	no	-	no
86	Patchan, M. M., Schunn, C. D., & Correnti, R. J. (2016). The nature of feedback: How peer feedback features affect students' implementation rate and quality of revisions. <i>Journal of Educational Psychology</i> , 108(8), 1098-1120. <a href="https://doi.org/10.1037/edu0000103">https://doi.org/10.1037/edu0000103</a>	yes	grand mean centering	no
87	Kim, Y. K., & Sax, L. J. (2014). The effects of Student-Faculty interaction on academic self-concept: Does academic major matter? <i>Research in Higher Education</i> , 55(8), 780-809. <a href="https://doi.org/10.1007/s11162-014-9335-x">https://doi.org/10.1007/s11162-014-9335-x</a>	yes	grand mean centering	no
88	Kroneberg, C. (2008). Ethnic communities and school performance among the new second generation in the United States: Testing the theory of segmented assimilation. <i>The Annals of the American Academy of Political and Social Science</i> , 620(1), 138-160. <a href="https://doi.org/10.1177/0002716208322714">https://doi.org/10.1177/0002716208322714</a>	yes	normalized	no
89	Pong, S., & Hao, L. (2007). Neighborhood and school factors in the school performance of immigrants' children. <i>The International Migration Review</i> , 41(1), 206-241. <a href="https://doi.org/10.1111/j.1747-7379.2007.00062.x">https://doi.org/10.1111/j.1747-7379.2007.00062.x</a>	no	-	no
90	Pustjens, H., Van de Gaer, E., Van Damme, J., Onghena, P., & Van Landeghem, G. (2007). The short-term and the long-term effect of primary schools and classes on mathematics and language achievement scores. <i>British Educational Research Journal</i> , 33(3), 419-440. <a href="https://doi.org/10.1080/01411920701243677">https://doi.org/10.1080/01411920701243677</a>	no	-	no
91	Sariaslan, A., Langstrom, N., D'onofrio, B., Hallqvist, J., Franck, J., & Lichtenstein, P. (2013). The impact of neighbourhood deprivation on adolescent violent criminality and substance misuse: A longitudinal, quasi-experimental study of the total Swedish population. <i>International Journal of Epidemiology</i> , 42(4), 1057-1066. <a href="https://doi.org/10.1093/ije/dyt066">https://doi.org/10.1093/ije/dyt066</a>	yes	standardized	no
92	Swoboda, B., & Morbe, L. (2019). International Grocery Retailers' Country Environment, Resources and Local Performance. A Cross-classified Multi-level Approach. <i>Marketing ZFP</i> , 41(1), 4-23.	no	grand mean centering	no
93	van Tubergen, F. (2005). Self-employment of immigrants: A cross-national study of 17 western societies. <i>Social Forces</i> , 84(2), 709-732. <a href="https://doi.org/10.1353/sof.2006.0039">https://doi.org/10.1353/sof.2006.0039</a>	no	-	no
94	Magalhães, P. C., & Garoupa, N. (2020). Judicial performance and trust in legal systems: Findings	no	-	no



	from a decade of surveys in over 20 European countries. <i>Social Science Quarterly</i> , 101(5), 1743-1760. <a href="https://doi.org/10.1111/ssqu.12846">https://doi.org/10.1111/ssqu.12846</a>			
95	Thomas, M., Stillwell, J., & Gould, M. (2015). Modelling multilevel variations in distance moved between origins and destinations in England and Wales. <i>Environment and Planning. A</i> , 47(4), 996-1014. <a href="https://doi.org/10.1068/a130327p">https://doi.org/10.1068/a130327p</a>	yes	centered by a constant value	no
96	Voicu, B., & Vasile, M. (2014). Do 'cultures of life satisfaction' travel? <i>Current Sociology</i> , 62(1), 81-99. <a href="https://doi.org/10.1177/0011392113516651">https://doi.org/10.1177/0011392113516651</a>	no	-	no
97	Chum, A., & O'Campo, P. (2013). Contextual determinants of cardiovascular diseases: Overcoming the residential trap by accounting for non-residential context and duration of exposure. <i>Health &amp; Place</i> , 24, 73-79. <a href="https://doi.org/10.1016/j.healthplace.2013.07.007">https://doi.org/10.1016/j.healthplace.2013.07.007</a>	no	-	no
98	Vitali, A., & Arpino, B. (2015). Living arrangements of second-generation immigrants in Spain: A cross-classified multilevel analysis. <i>Regional Studies</i> , 49(2), 189-203. <a href="https://doi.org/10.1080/00343404.2012.759649">https://doi.org/10.1080/00343404.2012.759649</a>	no	-	no
99	Rohm, T., Carstensen, C. H., Fischer, L., & Gnamb, T. (2021). Disentangling interviewer and area effects in large-scale educational assessments using cross-classified multilevel item response models. <i>Journal of Survey Statistics and Methodology</i> , 9(4), 722-744. <a href="https://doi.org/10.1093/jssam/smaa015">https://doi.org/10.1093/jssam/smaa015</a>	yes	grand mean centering	no
100	Thi Hoang Oanh, N. (2019). Determinants of firms' total factor productivity in manufacturing industry in Vietnam: An approach of a cross-classified model. <i>Journal of Asian Business and Economic Studies</i> , 26(1), 4-28. <a href="https://doi.org/10.24311/jabes/2019.26.S01.1">https://doi.org/10.24311/jabes/2019.26.S01.1</a>	no	-	no

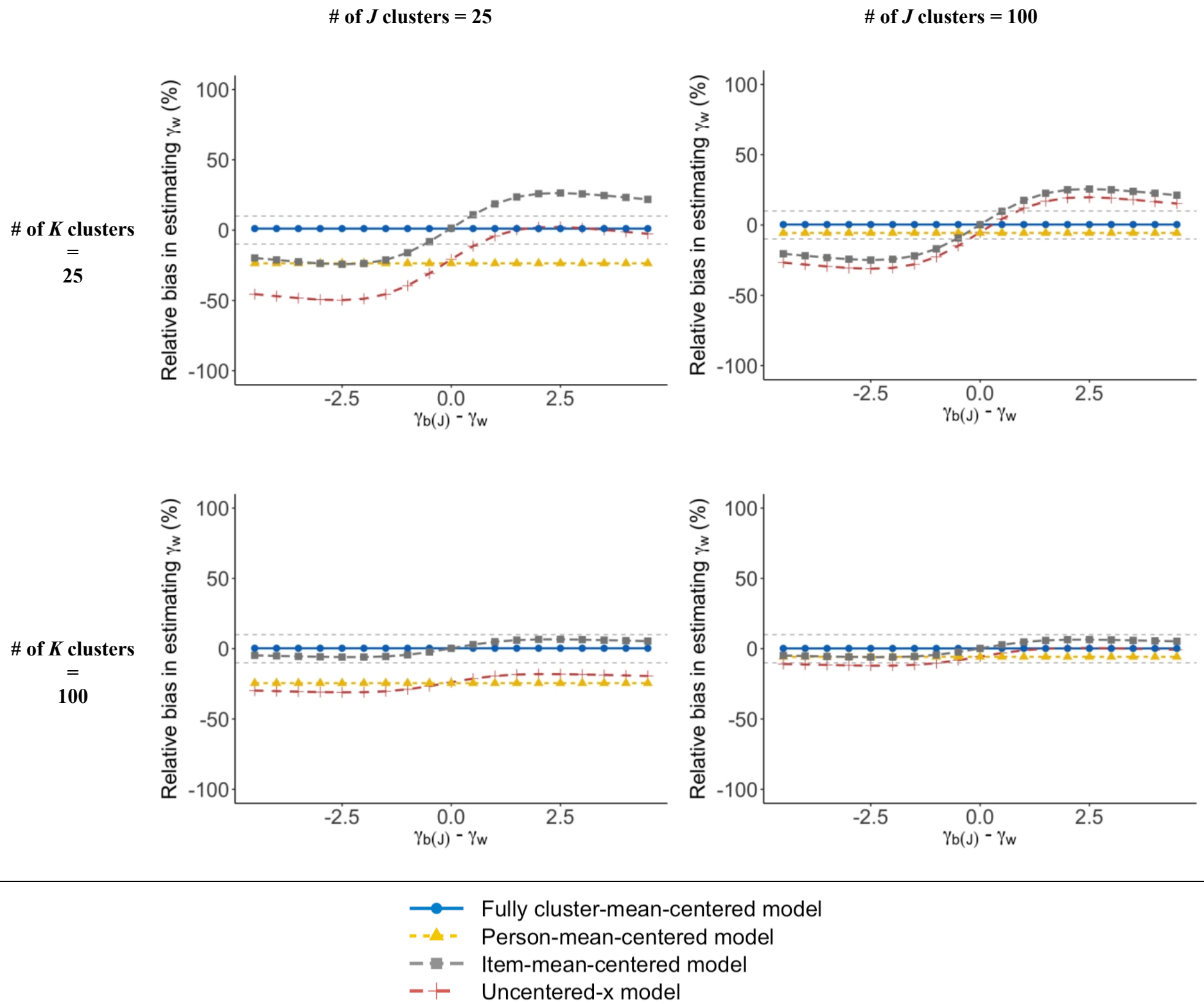
Online Appendix B: Additional simulation results

Figure OA1. Simulation results: Impact of fixed conflation in estimating  $\gamma_w$ , conditions in which  $\gamma_{b(K)} \neq \gamma_w$ , with a small ICC (.06) for  $J$  clusters and large ICC (.31) for  $K$  clusters



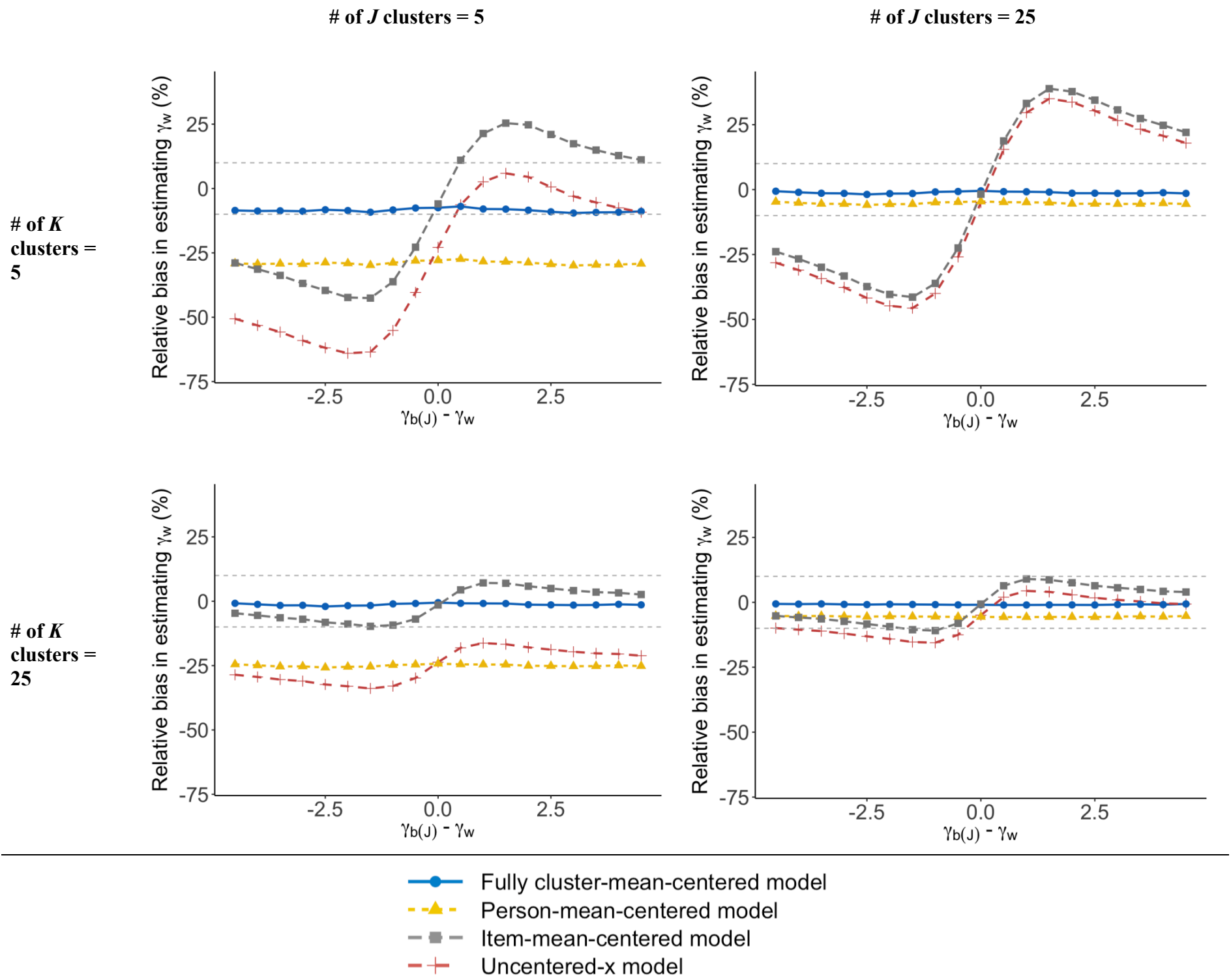
Note. Generating parameters are the same as those for manuscript Figure 4, with the exception that here  $\tau_{00(J)} = 1$ .

**Figure OA2.** Simulation results: Impact of fixed conflation in estimating  $\gamma_w$ , conditions in which  $\gamma_{b(K)} \neq \gamma_w$ , with a small ICC (.06) for  $K$  clusters and a large ICC (.31) for  $J$  clusters



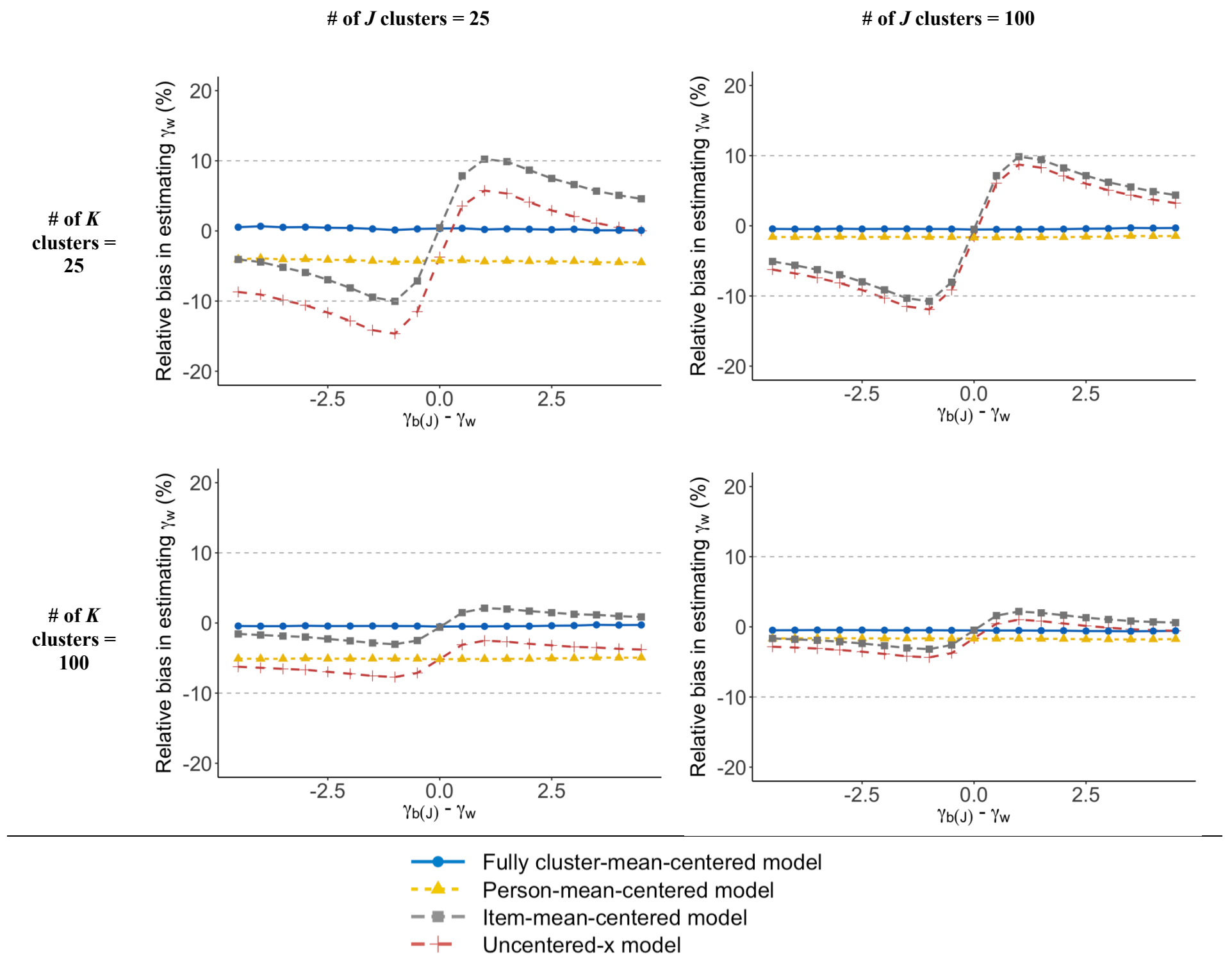
Note. Generating parameters are the same as those for manuscript Figure 4, with the exception that here  $\tau_{00(K)} = 1$ .

**Figure OA3.** Impact of fixed conflation in estimating  $\gamma_w$ , conditions in which  $\gamma_{b(K)} \neq \gamma_w$ , with 5 observations per cell and a very small number of clusters.



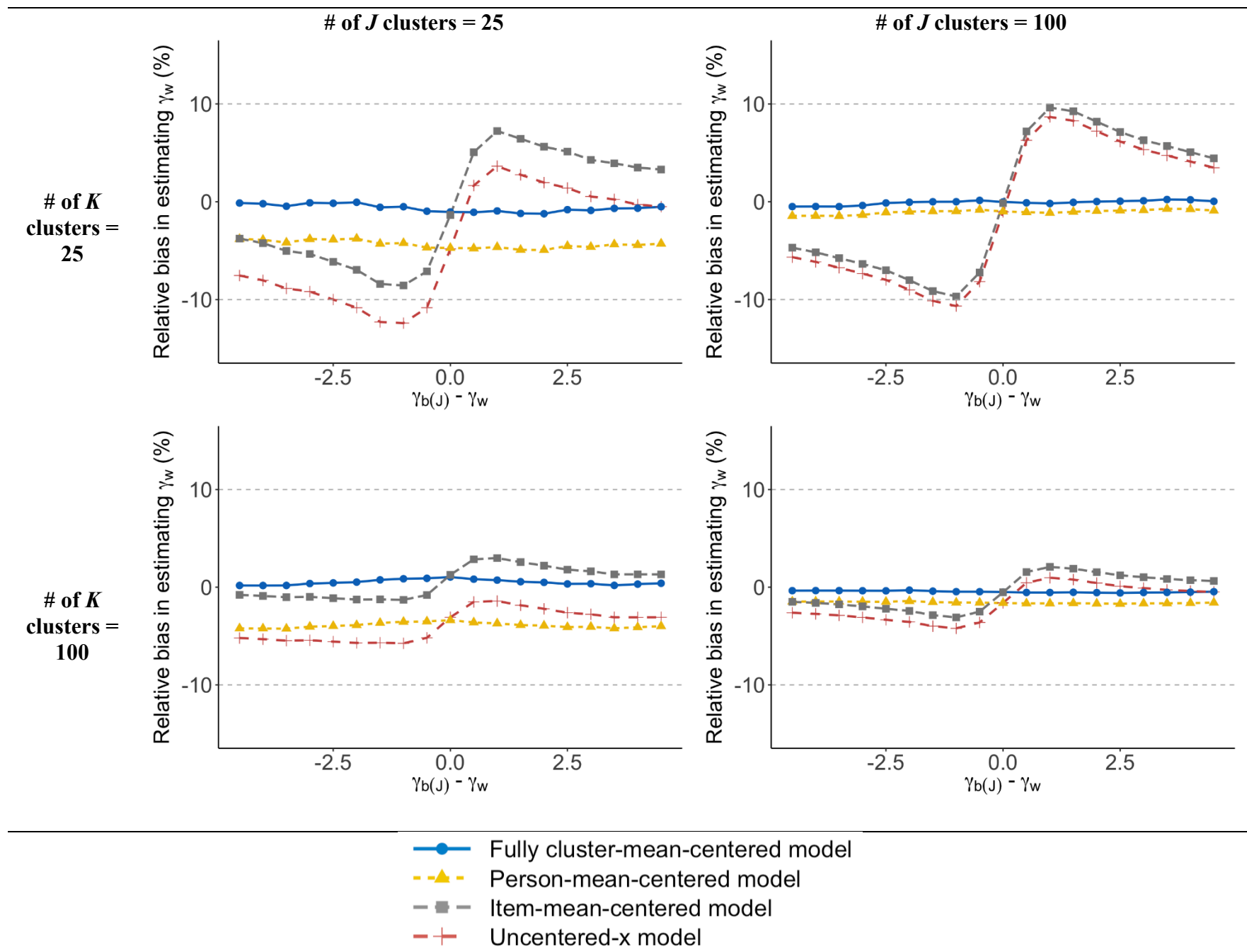
*Note.* Generating parameters are the same as those for manuscript Figure 7, with the exception that here the number of clusters for each type is either 5 or 25.

**Figure OA4.** Simulation results: Impact of fixed conflation in estimating  $\gamma_w$ , conditions in which  $\gamma_{b(K)} \neq \gamma_w$ , with *unbalanced* data with *average* cell size = 5.



*Note.* Generating parameters are the same as those for manuscript Figure 7, with the exception that here cell size is not constant, and cluster sizes are selected from a discrete uniform distribution ranging from 0 to 10.

**Figure OA5.** Simulation results: Impact of fixed conflation in estimating  $\gamma_w$ , conditions in which  $\gamma_{b(K)} \neq \gamma_w$ , with *sparse* unbalanced data with average cell size = 5.



*Note.* Generating parameters are the same as those for manuscript Figure 7, with the exception that here cell size is not constant, and the vast majority (80%) of cells have sample size of 0 (with the overall average cell size still being 5).

### Online Appendix C: Empirical example results with random slopes

As discussed in the manuscript, Table OA2 expands the empirical example (Table 2) to include random slopes of each level-1 predictor. As detailed in Appendix B, this leads to a fully cluster-mean-centered model with unconfated random slope variances (wherein  $\tau_{11(J)} = \text{var}(u_{wj})$  and  $\tau_{11(K)} = \text{var}(u_{wk})$ ), a person-mean-centered model with partially conflated random slopes (wherein  $\tau_{11(J)}$  is the variance of a weighted combination of  $u_{wj}$  and  $u_{bj}$  and  $\tau_{11(K)}$  is the variance of a weighted combination of  $u_{wk}$  and  $u_{hk}$ ), a trait-pair-mean-centered model with partially conflated random slopes (wherein  $\tau_{11(J)}$  is the variance of a weighted combination of  $u_{wj}$  and  $u_{hj}$  and  $\tau_{11(K)}$  is the variance of a weighted combination of  $u_{wk}$  and  $u_{bk}$ ), and a contextual effect model with fully conflated random slopes (wherein  $\tau_{11(J)}$  is the variance of a weighted combination of  $u_{wj}$ ,  $u_{bj}$ , and  $u_{hj}$  and  $\tau_{11(K)}$  is the variance of a weighted combination of  $u_{wk}$ ,  $u_{bk}$ , and  $u_{hk}$ ). In this example, observable differences between models are fairly minor (partially attributable to the scale of the outcome variable and the small variances, and the fact that the fixed effect portion of the models are equivalent).

**Table OA2.** Empirical example results: Predicting *face correlation* from *trait similarity* using fully cluster-mean-centered model and contextual effect models with conflated or unconfated random effects

Parameter	Fully cluster-mean-centered model with unconfated random slope		Person-mean-centered model with partially conflated random slope		Trait-pair-mean-centered model with partially conflated random slope		Contextual effect model with fully conflated random slope	
	Estimate (SE)	p	Estimate (SE)	p	Estimate (SE)	p	Estimate (SE)	p
Intercept	0.117 (0.030)	<0.001	0.121 (0.029)	<.001	0.113 (0.031)	<.001	0.129 (0.031)	<.001
Slope of fully cluster-mean-centered <i>trait similarity</i>	0.038 (0.010)	<0.001	--	--	--	--	--	--
Slope of person-mean-centered <i>trait similarity</i>	--	--	0.036 (0.010)	<0.001	--	--	--	--
Slope of trait-pair-mean-centered <i>trait similarity</i>	--	--	--	--	0.035 (0.009)	<.001	--	--
Slope of uncentered <i>trait similarity</i>	--	--	--	--	--	--	0.033 (0.009)	<.001
Slope of person-mean <i>trait similarity</i>	-0.004 <sup>b</sup> (0.016)	0.779	-0.016 <sup>b</sup> (0.016)	0.310	-0.058 <sup>c</sup> (0.016)	<.001	-0.051 <sup>c</sup> (0.017)	.002
Slope of trait-pair-mean <i>trait similarity</i>	0.366 <sup>b</sup> (0.036)	<0.001	0.297 <sup>c</sup> (0.033)	<0.001	0.366 <sup>b</sup> (0.041)	<.001	0.315 <sup>c</sup> (0.040)	<.001
Random effects								
$\sigma^2$	0.203		0.202		0.203		0.202	
$\tau_{00(J)}$	0.013		0.013		0.012		0.012	
$\tau_{11(J)}$	0.002		0.002		0.002		0.002	
$\rho_{01(J)}$	-.358		-.085		-.296		-.026	
$\tau_{00(K)}$	0.012		0.011		0.013		0.013	
$\tau_{11(K)}$	0.001		0.001		0.001		0.001	
$\rho_{01(K)}$	.522		.577		.166		.332	

Notes. All models were fit using REML estimation with the *lmer* function in the *lme4* package in R (Bates et al., 2015). *b* = between-cluster effect; *c* = contextual effect (between-cluster effect – within-cluster effect = contextual effect).