**Equations and details of the item response models**

**1. Polytomous item response model**

Equation (1) specifies a polytomous IRT model, where *P* is the probability of responding in a certain category (*Yij*=*c*−1) minus the probability of responding in the next category (i.e. *Yij*=*c*), *θj* is the ability of the participant *j*, *ai* is the discrimination parameter of the item *i*, and *bi,c* is the difficulty parameter of category *c* of item *i*. The *bi,c* is the point on the ability scale that corresponds to 50% probability of endorsing a certain category of an item. The *ai* estimates how well an item can differentiate among respondents with different levels of ability.

 (Eq 1)

**2. Compensatory multidimensional grade response model**

Equation (2) specifies a compensatory MGRM, where *Pijc* is the probability of subject *j* responding to category *c* (and above) of item *i*, ***ai*** is the discrimination parameter vector of item *i*, ***θj*** is the ability vector of subject *j*, *bi,c* is the difficulty parameter of category *c* of item *i*, and *E*(***θj***) is the expected score (the linear accumulation of probability of responding to each category of an item) of subject *j* with ability vector ***θj***. The parameters were estimated by the Markov chain Monte Carlo method.

 (Eq 2)