Modeling Overdistribution in Source Memory

Julie Linzer David Kellen Henrik Singmann Karl Christoph Klauer
Albert-Ludwigs-Universität Freiburg

Background

A very important distinction in the memory literature is between item memory and source memory. While item memory concerns the ability to remember previously acquired information (``Did I see this word before?''), source memory is concerned with contextual details associated with the acquisition of information (e.g., ``who said this word?'').

Source memory can be evaluated using two different test procedures, one in which an old-new and source judgment is given to each trial (e.g., Batchelder & Riefer, 1990), or via a so-called conjoint process-dissociation task (CPD; Brainerd & Reyna, 2008). In the CPD task, one of different test probes ("Source A?", "Source B?", "Old?") is presented along with each test item. The subject's task is to answer "Yes" or "No".

Brainerd, Reyna, Holliday, and Nakamura (2012) argue that the response probabilities to each test probe can be interpreted as source-membership probabilities. From these probabilities it is possible to compute the probability of an item being attributed to both sources.

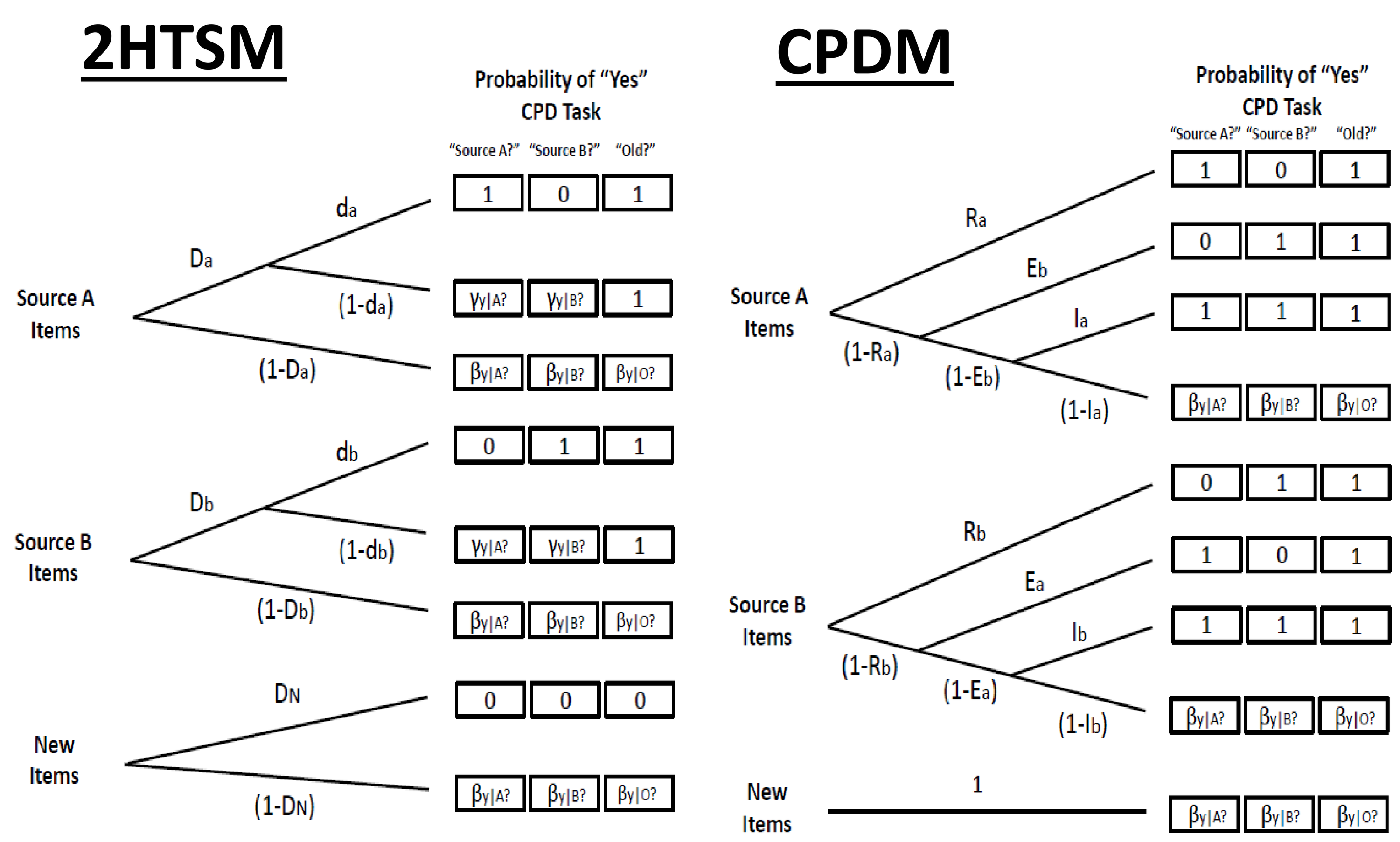
$$P(Y \mid \text{"A and B?"}) = P(Y \mid \text{"A?"}) + P(Y \mid \text{"B?"}) - P(Y \mid \text{"A or B?"})$$

The probability conjunction (designated as *source overdistribution*) above is illogical given that source membership is mutually exclusive. Brainerd et al. (2012) showed that the observed response proportions for the different test probes lead to overdistribution values that are consistently above zero.

Furthermore, Brainerd et al. (2012) argue that overdistribution is not accountable by traditional source-memory models such as the 2HTSM (Bayen, Murnane, & Erdfelder, 1996). As a solution they propose a new model (CPDM) which assumes radically different memory states than the 2HTSM.
The supposed superiority of the CPDM led Brainerd et al. (2012) to make controversial claims, such as that source-memory/recollection can be present in the absence of item-memory/familiarity.

Source-Memory Models

The model comparison made by Brainerd et al. (2012) is flawed in the sense that the models were grossly misspecified. Furthermore, the experimental designs used did not allow for a full specification of the models. We extended the CPD task by introducing a "skip" response option.



A further extended CPDM, including a distractor detection state was also considered (CPDM$_N$).

Hierarchical Bayesian Modeling

Hierarchical extensions of the models were considered. In particular we relied on Klauer's (2010) latent-trait approach in which group and individual-level parameter are specified as linear model via a probit-link function.

$$\theta_{i,j} = \Phi(\mu_j + \xi_j \delta_{i,j})$$

With $\theta_{i,j}$ being the *i*th parameter of the *j*th participant. The hierarchical modeling was implemented under a Bayesian framework using non-informative priors. The models were evaluated in terms of the Deviance Information Criterion as well as posterior predictive p-values (Klauer, 2010).

Experiment

Participants. 32 undergraduate psychology students (24 female; mean age = 21.5, SD = 3.18, ranging from 18 to 30 years) from the University of Freiburg served as participants for the experiment.

Design and Procedure. The computer-based experiment consisted of a single study followed by a single test phase. In the study phase 180 words (90 Source A and 90 Source B items) were presented for 2000ms each. Source A items were presented in red on the left side of the screen and Source B items in blue on the right side of the screen.
Participants were tested using three different test probes ("A?", "B?", and "Old?") and could respond either Yes, Skip or No.

Model-Fitting Results

			2HTSM				
Model Fit	T_1	T_2	p_D	DIC			
	.44	.52	233.36	15165.60			
Parameter Estimates	D_A	D_B	D_N	d_A	d_B		
	.52 [.44, .63]	.51 [.40, .63]	.25 [.16, .38]	.11 [.01, .25]	.16 [.05, .34]		
	$\beta_{y\|A?}$	$\beta_{s\|A?}$	$\beta_{y\|B?}$	$\beta_{s\|B?}$	$\beta_{y\|O?}$	$\beta_{s\|O?}$	
	.18 [.12, .25]	.65 [.41, .85]	.26 [.16, .38]	.66 [.43, .91]	.25 [.18, .34]	.33 [.21, .44]	
	$\gamma_{y\|A?}$	$\gamma_{s\|A?}$	$\gamma_{y\|B?}$	$\gamma_{s\|B?}$			
	.73 [.53, .91]	.11 [.00, .55]	.75 [.52, .90]	.09 [.01, .76]			
Predicted Overdistribution	Source A	Source B	New				
	0.28	0.27	0.17				
			CPDM				
Model Fit	T_1	T_2	p_D	DIC			
	.00	.03	213.09	15332.51			
Parameter Estimates	R_A	R_B	E_A	E_B	I_A	I_B	
	.10 [.04, .18]	.13 [.06, .21]	.01 [.00, .06]	.04 [.00, .10]	.36 [.26, .46]	.33 [.23, .43]	
	$\beta_{y\|A?}$	$\beta_{s\|A?}$	$\beta_{y\|B?}$	$\beta_{s\|B?}$	$\beta_{y\|O?}$	$\beta_{s\|O?}$	
	.12 [.07, .18]	.54 [.40, .72]	.17 [.11, .24]	.54 [.39, .74]	.21 [.15, .29]	.30 [.19, .46]	
Predicted Overdistribution	Source A	Source B	New				
	0.39	0.36	0.12				
			CPDM$_N$				
Model Fit	T_1	T_2	p_D	DIC			
	.35	.09	222.57	15218.50			
Parameter Estimates	R_A	R_B	E_A	E_B	I_A	I_B	D_N
	.17 [.07, .24]	.19 [.13, .26]	.12 [.06, .19]	.10 [.04, .19]	.29 [.19, .40]	.26 [.10, .36]	.26 [.16, .37]
	$\beta_{y\|A?}$	$\beta_{s\|A?}$	$\beta_{y\|B?}$	$\beta_{s\|B?}$	$\beta_{y\|O?}$	$\beta_{s\|O?}$	
	.18 [.12, .29]	.67 [.48, .83]	.28 [.18, .40]	.69 [.51, .89]	.27 [.20, .36]	.31 [.18, .42]	
Predicted Overdistribution	Source A	Source B	New				
	0.32	0.30	0.15				

The average source overdistribution values observed for A, B, and new items were .30, .29, and .17, respectively

Conclusions

Contrary to Brainerd et al.'s (2012) claims, the 2HTSM is able to account for the observed probability overdistribution.

Furthemore the guessing-based account of the 2HTSM is superior in terms of DIC. A second experiment using three sources replicated the results reported above.

References

Batchelder, W. H., & Riefer, D. M. (1990). Multinomial processing models of source monitoring. Psychological Review, 97, 548-564.
Bayen, U. J., Murnane, K., & Erdfelder, E. (1996). Source discrimination, item detection, and multinomial models of source monitoring. Journal of Experimental Psychology: Learning, Memory, and Cognition, 22, 197-215.
Brainerd, C. J., & Reyna, V. F. (2008). Episodic over-distribution: A signature effect of recollection without familiarity. Journal of Memory and Language, 58, 765-786.
Brainerd, C. J., Reyna, V. F., Holliday, R. E., & Nakamura, K. (2012). Overdistribution in source memory. Journal of Experimental Psychology: Learning, Memory, and Cognition, 38, 413-439.
Klauer, K. C. (2010). Hierarchical multinomial processing tree models: a latent-trait approach. Psychometrika, 75, 70-98.