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Individual differences in everyday retrospective memory failures

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ABSTRACT

The present study examined individual differences in everyday retrospective memory failures. Undergraduate students completed various cognitive ability measures in the laboratory and recorded everyday retrospective memory failures in a diary over the course of a week. The majority of memory failures were forgetting information pertaining to exams and homework, forgetting names, and forgetting login and ID information. Using latent variable techniques the results also suggested that individual differences in working memory capacity and retrospective memory were related to some but not all everyday memory failures. Furthermore, everyday memory failures predicted SAT scores and partially accounted for the relation between cognitive abilities and SAT scores. These results provide important evidence for individual differences in everyday retrospective memory failures as well as important evidence for the ecological validity of laboratory measures of working memory capacity and retrospective memory.

Our ability to encode, store, and retrieve memories is one of the most important functions of our cognitive system. Our memory system allows us to perform a number of important and routine tasks daily. Although our memory system is typically very efficient, sometimes failures occur that have both minor and major consequences. For example, have you ever forgotten the name of the person you were just introduced to at an important meeting? Have you ever forgotten the login information for your email? Most of us will likely answer *yes* to these questions. These memory failures reflect failures of our retrospective memory system which is important for remembering information from our past. An important reason for examining retrospective memory failures is that not only does the frequency of these failures likely vary as a function of neuropsychological disorders, age, and individual differences but these failures also have real world consequences. For example, students with poor retrospective memory abilities will likely have difficulties learning and retrieving information in educational contexts leading to poor exam scores.

Despite the importance of everyday retrospective memory failures to a number of areas, there has been relatively little work examining these failures (relative to experimental studies of laboratory tasks) due to the difficulties inherent in recording memory failures. One method that has been used successfully to assess everyday memory failures is diary studies. In these studies individuals are required to carry a diary for some amount of time and record their various memory failures. These studies provide important information about broad classifications of memory failures. For example, Crovitz and Daniel (1984) had participants record their memory failures over the course of a week. Crovitz and Daniel found that participants reported a number of different retrospective and prospective memory failures. Ranking the failures in terms of frequency of occurrence, Crovitz and Daniel found that the most frequently occurring memory failure by far was a retrospective memory error (i.e., forgetting someone's name). Additional retrospective memory failures included forgetting phone numbers, conversations, locations of items, as well as forgetting what one was saying or doing. Likewise, Terry (1988) examining memory failures in participants over several weeks found that participants had a number of different types of retrospective memory failures including forgetting names, forgetting locations, as well as forgetting facts pertaining to friends and relatives (such as birthdays). Although these results suggest that diary studies provide important information on everyday retrospective memory failures, more work is needed to better examine the occurrence of different retrospective memory failures in everyday life.

Recently we (Unsworth, Brewer, & Spillers, 2012) have begun to examine some of these questions in a large-scale diary study. In this study, participants carried diaries for one week in which they recorded their various cognitive failures (i.e., attention, retrospective memory, and prospective memory failures). Similar to prior work (Reason, 1984) we examined relatively broad categories of retrospective memory failures broken down into short-term memory failures, personal memory failures, and fact based memory

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failures. Like Reason (1984) these results provided evidence for the relative frequency of broad classes of failures, but the results do not provide more fine grained estimates of the relative frequency of more specific retrospective memory failures. Thus, one goal of the current study was to better examine the relative frequency of specific retrospective memory failures in order to gauge which types of failures occur most frequently (Crovitz & Daniel, 1984; Terry, 1988). Examining the frequency of different retrospective memory failures is important in order to understand what types of memory problems are typically faced in everyday life.

In addition to examining frequency estimates of various retrospective memory failures, another goal of the current study was to examine individual differences in everyday retrospective memory failures. In particular, are certain individuals more likely to experience everyday retrospective memory failures than others? Theoretically, one might assume that individuals with poor retrospective memory (RM) abilities should be more likely to experience everyday memory failures than individuals high in RM abilities. While such statements seem relatively straightforward and intuitive, it should be noted that relatively little work has directly examined these types of claims in which laboratory assessments of RM have been linked to everyday memory failures. In particular, although there have been several studies that have examined the relations between laboratory assessments of RM and everyday memory failures as assessed by various memory questionnaires (Herrmann, 1982), little work has directly examined the relation between laboratory RM measures and everyday memory failures measured by diaries.

In our recent diary study of cognitive failures we (Unsworth et al., 2012) found that individual differences in working memory capacity (WMC) and RM abilities predicted individual differences in the total number of retrospective memory failures as well as the broad three classes of failures. Consistent with theories that link individual differences in WMC to differences in RM (Unsworth & Engle, 2007; Unsworth, Brewer, & Spillers, 2009) this work suggests that individual differences in WMC and RM abilities as assessed in the laboratory predict individual differences in everyday memory failures. Despite this initial evidence, however, it is not clear that individual differences in WMC and RM should predict individual differences in all memory failures. In particular, individual differences indexed in the laboratory might only be related to everyday memory failures that require the use of particular encoding strategies or to everyday memory failures that are of a consequential nature such that certain memory failures could have more impactful consequences (failing an exam) than others (forgetting the name of someone you were just introduced to). It is possible that individual differences in WMC and RM will be related to some, but not all memory failures based on the consequentially of the failure. Our prior work suggests that WMC and RM are related to broad classes of retrospective memory failures, but this work does not indicate how these laboratory measures are related to specific types of memory failures. Thus, a novel aspect to the current study is the examination of specific types of memory failures rather than just broad classes of failures. Furthermore, according to our prior work examining the relation between WMC and RM abilities (Unsworth, Brewer, et al., 2009), the relation between individual differences in WMC and everyday memory failures should be due to RM abilities. This is because according to our model, differences in WMC are due to both differences in attention control and differences in memory abilities. Thus, the relation between WMC and retrospective memory failures should be due to the shared variance between WMC and RM. This means that variation in RM abilities should fully mediate the relation between WMC and everyday failures. In our prior work (Unsworth et al., 2012) we only examined the overall relations among constructs and did not specifically test whether the relation between WMC and retrospective memory failures would be mediated by RM.

Finally, assuming that there is a relation between individual differences in the laboratory measures of WMC and RM with everyday memory failures, one can ask whether the variation in retrospective memory failures partially accounts for the relation between WMC and RM with scholastic abilities and intelligence as measured by the SAT (Frey & Detterman, 2004). Specifically, prior research has found that variation in WMC strongly predicts SAT scores (Engle, Tuholski, Laughlin, & Conway, 1999) and this relation is theoretically partially due to variation in RM abilities (Unsworth, Brewer, et al., 2009). Thus, one might suspect that individuals with lower RM abilities who also experience more memory failures should also have lower scholastic abilities, as an inability to effectively retrieve information from memory while taking a test could potentially lead to a lower than normal score. Thus, the shared variance between RM abilities and everyday memory failures should predict SAT scores and might partially account for the relation between WMC and SAT.

To examine the nature of individual differences in everyday retrospective memory failures we used a novel combination of diary and cognitive ability methods. In particular, we examined four questions of primary interest. (1) What are the most common retrospective memory failures in a sample of undergraduate students? (2) How are different everyday retrospective memory failures related to laboratory assessments of WMC and RM? (3) Do individual differences in RM abilities mediate the relation between WMC and everyday retrospective memory failures? (4) Do individual differences in everyday retrospective memory failures partially account for the relations between RM and WMC with scholastic abilities as measured by the SAT?

To address these questions we a tested a large number of participants on several laboratory tasks thought to measure WMC and RM. Participants also agreed to carry diaries for a week in which they recorded any retrospective memory failures (as well as other cognitive failures not discussed in the current study) they experienced each day (Unsworth, Brewer, & Spillers, 2012). Finally, we obtained verbal and quantitative SAT scores for each participant via self-report. To examine the relations between the laboratory cognitive ability measures and everyday retrospective memory failures we used a latent variable approach. By examining a large number of participants and a large and diverse number of measures we should be able to better examine individual differences in everyday retrospective failures and address our four questions of primary interest. The current work significantly extends prior research by examining specific types of retrospective memory failures and how they relate to cognitive abilities.

1. Method

1.1. Participants

A total of 100 participants (66% female) were recruited from the subject-pool at the University of Georgia. Participants were between the ages of 18 and 35 (M = 19.33, SD = 1.35).

1.2. WMC tasks

1.2.1. Operation span

Participants solved a series of math operations while trying to remember a set of unrelated letters. At recall, letters from the current set were recalled in the correct order by clicking on the appropriate letters (Unsworth, Heitz, Schrock, & Engle, 2005). For all of the WMC measures, items were scored if the item was correct and in the correct position. The score was the number of correct items in the correct position.

1.2.2. Symmetry span

Participants were required to recall sequences of red squares within a matrix while performing a symmetry-judgment task. In the symmetry-judgment task participants were shown an 8 × 8 matrix with some squares filled in black. Participants decided whether the design was symmetrical about its vertical axis. The pattern was symmetrical half of the time. At recall, participants recalled the sequence of red-square locations in the preceding displays, in the order they appeared by clicking on the cells of an empty matrix (Unsworth, Redick, Heitz, Broadway, Engle, 2009).

1.2.3. Reading span

Participants were required to read sentences while trying to remember a set of unrelated letters. At recall, letters from the current set were recalled in the correct order by clicking on the appropriate letters (Unsworth, Redick et al., 2009).

1.3. RM tasks

1.3.1. Free recall

Participants were given 2 lists of 10 words each. All words were common nouns that were presented for 1.5 s each. After the list presentation participants saw ???, which indicated that they should type as many words as they could remember from the current list in any order they wished. Participants had 45 s for recall. A participant's score was the total number of items recalled correctly.

1.3.2. Paired associates recall

Participants were given 3 lists of 10 word pairs each. All words were common nouns and the word pairs were presented vertically for 2 s each. Participants were told that the cue would always be the word on top and the target would be on bottom. After the presentation of the last word participants saw the cue word and ??? in place of the target word. Participants were instructed to type in the target word from the current list that matched cue. Cues were randomly mixed so that the corresponding target words were not recalled in the same order as they were presented. Participants had 5 s to type in the corresponding word. A participant's score was proportion correct.

1.3.3. Picture source-recognition

Participants were presented with a picture (30 total pictures) in one of the four different quadrants onscreen for 1 s. Participants were explicitly instructed to pay attention to both the picture and the quadrant it was located in. At test participants were presented with 30 old and 30 new pictures individually in the center of the screen. Participants indicated if the picture was new or old and, if old, what quadrant it was presented in via key press. Participants had 5 s to press the appropriate key to enter their response. A participant's score was proportion correct.

1.4. SAT

Quantitative and verbal SAT scores for each individual were obtained via self-report. It was not possible to obtain SAT scores from university records.

1.5. Diary

Participants were given a booklet and asked to keep a diary of their retrospective memory failures over the course of one week. Participants were told to indicate their various failures by writing a brief description of the failure and recording when it occurred. Participants were encouraged to document the failures as soon as they happened or soon after they happened. Participants were given detailed instructions about how to record responses in the diary and examples were provided to assist them (see also Unsworth et al., 2012). Diary responses were coded by two raters who classified each response into their respective categories. Inter-rater agreement was high (>96%), and disagreements were resolved.

Table 1
Descriptive statistics and rankings of most frequent everyday retrospective memory failures.

Retrospective memory failure	*M*	*SD*	Sum	Range
1. Forgot information for an exam or homework	1.75	1.73	175	9
2. Forgot someone's name	0.90	1.05	90	5
3. Forgot login or ID information	0.86	1.08	86	6
4. Forgot relative or friend information	0.41	0.68	41	4
5. Forgot directions to destination	0.25	0.79	25	5
6. Forgot a fact outside of school	0.23	0.69	23	5
7. Forgot what one was doing or looking for	0.14	0.38	14	2
8. Forgot what one was going to tell someone	0.12	0.38	12	2

2. Results and discussion

A total of 674 retrospective memory failures with a mean of 6.74 (*SD* = 4.68) failures per person were reported. Of these, 466 memory failures fell into one of the eight specific types of failures. The other failures were either relatively idiosyncratic failures or were not specified enough to be placed into one of the specific types. The major types of retrospective memory failures are listed in Table 1 in descending order of frequency. The most frequently occurring memory failure was forgetting information for an exam or homework. Examples of these failures were things such as forgetting information that was read in a class textbook the previous night, forgetting information provided by the professor to solve certain types of problems, as well as forgetting vocabulary terms learned in a foreign language class. These failures were followed by memory failures due to forgetting someone's name, forgetting login or ID information, and forgetting information pertaining to friends and relatives such as their birthdays or phone numbers. Given the composition of the current sample, it is interesting that the majority of retrospective memory failures that typical college students experience are related to educational contexts. These results point to the importance of an efficient memory system in educational contexts and suggest that despite the fact that these participants can be considered somewhat high functioning they are likely to experience memory failures related to academics in the course of a typical week.

We used confirmatory factor analysis to examine how each of the memory failures listed in Table 1 were related to individual differences in WMC, RM, and SAT scores. Latent factors were created based on the inter-relations among variables. Building latent variables based on the co-variation among measures is standard practice in studies using confirmatory factor analytic techniques. First, we examined a base measurement model of the WMC, RM, and SAT. Three latent variables were constructed based on their respective tasks. The descriptive statistics for the cognitive ability measures are shown in Table 2. The fit of the model was acceptable, $\chi^2(17) = 23.31$, $p > .13$, RMSEA = .06, SRMR = .07, NNFI = .95, CFI = .97, suggesting that the specified model provided a good description to the underlying pattern of data. The resulting model is shown in Fig. 1. Each of the tasks loaded significantly on their respective constructs and all of the latent constructs were moderately to strongly correlated with one another.

Next, we included the eight specific retrospective memory failures (total number of each for each participant) into the model to see how WMC, RM, and SAT would relate with each type of

Table 2
Descriptive statistics and reliability estimates for laboratory cognitive ability measures.

Measure	*M*	*SD*	Skew	Kurtosis	Reliability
Ospan	61.78	10.25	−1.01	0.59	.84
Rspan	60.16	11.35	−.92	0.52	.79
Symspan	30.14	6.59	−.86	0.92	.76
Free recall	6.92	1.72	−.12	−0.01	.68
PA recall	0.49	0.25	.29	−0.90	.74
Picture source	0.69	0.20	−1.19	0.85	.84
VSAT	608.25	56.59	−.14	1.39	NA
QSAT	606.85	67.80	−.89	−0.92	NA

Note. Ospan = operation span; Rspan = reading span; Symspan = symmetry span; PA recall = paired associates recall; Picture source = Picture-source recognition; VSAT = verbal SAT; QSAT = quantitative SAT. The standard error of skew for each measure was .24 and the standard error of kurtosis for each measure was 0.48.

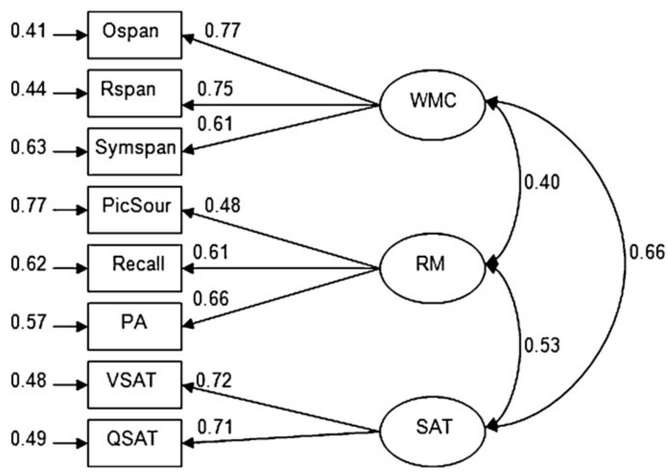

Fig. 1. Confirmatory factor analysis for working memory capacity (WMC), retrospective memory (RM), and SAT. Paths connecting latent variables (circles) to each other represent the correlations between the constructs, the numbers from the latent variables to the manifest variables (squares) represent the loadings of each task onto the latent variable, and numbers appearing next to each manifest variable represent error variance associated with each task. All loadings and paths are significant at the $p < .05$ level.

Table 3
Latent correlations of everyday retrospective memory failures with working memory capacity (WMC), retrospective memory (RM) and SAT.

Memory failure	WMC	RM	SAT
1. Forgot information for an exam or homework	−.30*	−.62*	−.29*
2. Forgot someone's name	−.08	−.14	.05
3. Forgot login or ID information	−.20*	−.29*	−.31*
4. Forgot relative or friend information	−.02	−.44*	−.16
5. Forgot directions to destination	.06	−.18	.17
6. Forgot a fact outside of school	.13	.07	.16
7. Forgot what one was doing or looking for	−.08	−.04	−.01
8. Forgot what one was going to tell someone	.01	.12	.00

* $p < .05$.

failure.[1] The fit of the model was acceptable, $\chi^2(57) = 72.42$, $p > .08$, RMSEA = .05, SRMR = .06, NNFI = .87, CFI = .94. The resulting correlations are shown in Table 3. As can be seen, three of the four most common retrospective memory failures were significantly related to the cognitive ability measures. In particular, forgetting information pertaining to an exam or homework as well as forgetting login or ID information was related with WMC, RM, and SAT. These

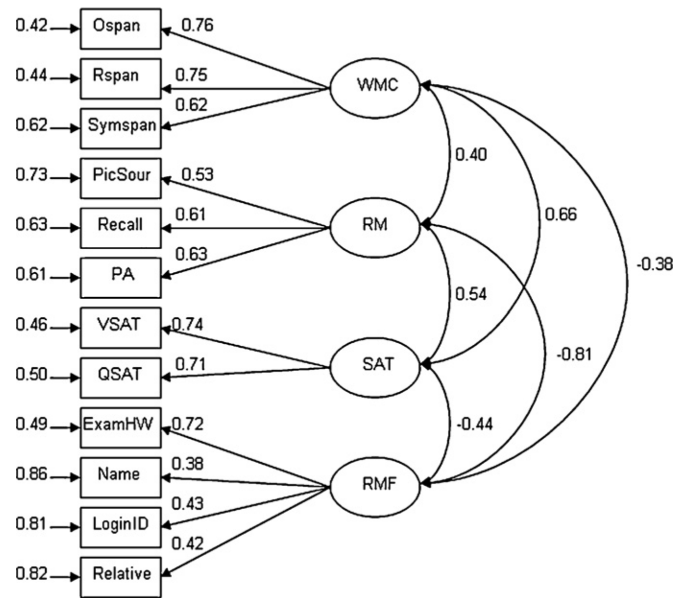

Fig. 2. Confirmatory factor analysis for working memory capacity (WMC), retrospective memory (RM), SAT, and everyday retrospective memory failures (RMF). Paths connecting latent variables (circles) to each other represent the correlations between the constructs, the numbers from the latent variables to the manifest variables (squares) represent the loadings of each task onto the latent variable, and numbers appearing next to each manifest variable represent error variance associated with each task. All loadings and paths are significant at the $p < .05$ level.

results suggest that the importance of the information matters to the extent that forgetting critical information (such as an answer to an exam question or your pin number for your debit card) can have important consequences. It is these types of failures, rather than failures associated with more minor consequences (forgetting the name of an actor in a movie), that are related to cognitive abilities assessed in the laboratory.

To examine these issues more thoroughly, we specified another confirmatory factor analysis model in which the four most common memory failures formed a single latent factor and were added to the base model from Fig. 1. This model examines the extent to which the four most common memory failures would load on the same factor and how this factor would be related to cognitive abilities. That is, this model examines the extent to which the four most common memory failures share common variance (rather than having only unique variance) and whether this common variance is related to cognitive abilities. The four most common memory failures were chosen in order to ensure that there would be enough variability among the measures to form a latent variable. Indeed the four most common memory failures were all inter-related (*M* correlation = 0.26), whereas the remaining memory failures were not correlated with one another (*M* correlation = 0.05) or with the most common memory failures (*M* correlation = 0.08). The fit of the model was acceptable, $\chi^2(48) = 64.25$, $p > .05$, RMSEA = .06, SRMR = .08, NNFI = .91, CFI = .93. The resulting model is shown in Fig. 2. As can be seen, the four most common retrospective memory failures all loaded significantly on the same retrospective memory failure (RMF) factor. This factor represents the shared variance among the four specific retrospective memory failures. Furthermore, this factor was moderately to strongly related to the cognitive ability factors. This provides important ecological validity for WMC and RM laboratory measures and suggests that individual differences in RM indexed in the laboratory are strongly related with individual differences in everyday retrospective memory failures.

For our final set of analyses we used structural equation modeling (SEM) to better examine how the laboratory measures of

[1] Note that given that many of the distributions of memory failures were positively skewed we applied a square root transformation to each memory failure and reanalyzed the data. All of the results were virtually identical to those reported.

WMC and RM would predict everyday retrospective memory failures and to examine the extent to which individual differences in everyday retrospective memory failures account for the relations between WMC and RM with SAT. In the first SEM analysis we examined whether the relation between WMC and memory failures would be mediated by individual differences in RM. To examine this we specified a model in which WMC predicted both RM and retrospective memory failures, and RM predicted retrospective memory failures. The resulting model is shown in Fig. 3. The fit of the model was acceptable, $\chi^2(32) = 50.72$, $p > .18$, RMSEA = .08, SRMR = .08, NNFI = .90, CFI = .90. As can be seen, WMC significantly predicted RM, and RM predicted retrospective memory failures, but

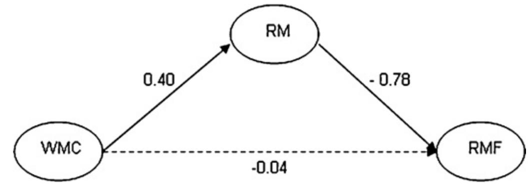

Fig. 3. Structural equation model for working memory capacity (WMC), retrospective memory (RM), and everyday retrospective memory failures (RMF). Single-headed arrows connecting latent variables (circles) to each other represent standardized path coefficients indicating the unique contribution of the latent variable. Solid lines are significant at the $p < .05$ level and dotted lines are not significant at the $p < .05$ level.

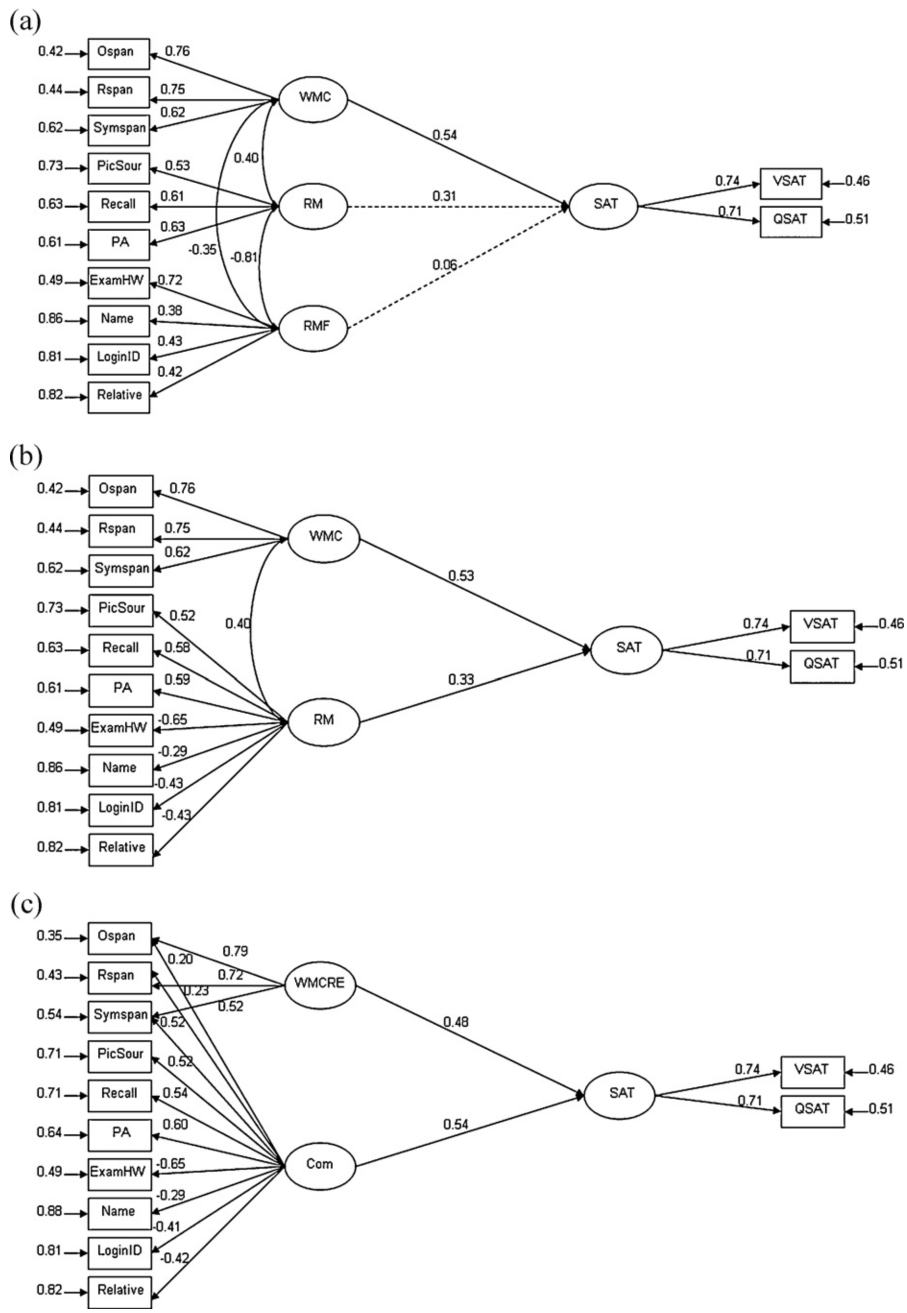

Fig. 4. (a) Structural equation model for working memory capacity (WMC), retrospective memory (RM), and everyday retrospective memory failures (RMF) predicting SAT. (b) Structural equation model for working memory capacity (WMC), and a combined retrospective memory and everyday retrospective memory failures latent variable (RM) predicting SAT. (c) Structural equation model for the common variance shared across all the memory tasks (Com) and the residual variance common to only the working memory capacity tasks (WMCRE) predicting SAT. Single-headed arrows connecting latent variables (circles) to each other represent standardized path coefficients indicating the unique contribution of the latent variable. Solid lines are significant at the $p < .05$ level and dotted lines are not significant at the $p < .05$ level.

the direct path from WMC to retrospective memory failures was not significant. The indirect path from WMC to retrospective memory failures was significant (indirect effect = −.28, $p < .05$) suggesting that RM mediated the relation between WMC and retrospective memory failures. Indeed, fixing the path from WMC to retrospective memory failures to zero, did not significantly change the fit of the model, $\Delta\chi^2(1) = .16$, $p > .68$. These results are consistent with the notion that the relation between WMC and retrospective memory failures will be accounted for by shared variance with RM.

In our next set of SEM analyses we examined how WMC, RM, and retrospective memory failures would account for SAT scores. Specifically, as shown in Fig. 2 all three constructs were significantly related to SAT scores, but it is not known if these relations are due to shared variance among all three constructs, unique variance associated with each construct or some combination. To examine this we specified a model in which WMC, RM, and retrospective memory failures were all allowed to predict SAT scores. Shown in Fig. 4a is the resulting model. The fit of the model was acceptable, $\chi^2(48) = 64.25$, $p > .05$, RMSEA = .06, SRMR = .08, NNFI = .91, CFI = .93. As can be seen, although WMC, RM, and RMF were all significantly correlated with one another only WMC significantly predicted SAT scores. Thus, this model suggests that WMC, but neither RM or RMF account for unique variance in SAT scores. However, as can be seen, the path from RM to SAT was moderate, yet not significant likely due to the strong correlation between RM and RMF leading to a large standard error around the parameter estimate. Given that RM and RMF are strongly related, it is possible that the shared variance between these two constructs is related to SAT scores, but that the unique variance associated with each is not. To examine this we specified a new model in which the three RM measures and the four RMF measures all loaded onto a single factor. This factor was allowed to correlate with WMC and both WMC and this factor were allowed to predict SAT scores. Shown in Fig. 4b is the resulting model. The fit of the model was acceptable, $\chi^2(51) = 67.82$, $p > .05$, RMSEA = .06, SRMR = .08, NNFI = .92, CFI = .93. As can be seen, in this revised model now both WMC and RM (composed of both RM and RMF measures) predict unique variance in SAT scores. In fact, collectively these factors account for 53% of the variance in SAT scores (WMC = 27% unique, RM = 11% unique). Thus, WMC and the shared variance between RM laboratory measures and retrospective memory failures accounted for a substantial portion of the variance in SAT scores.

For our final SEM analysis we examined whether WMC would still predict SAT scores once the common variance shared with RM was taken into account. That is, as shown in Fig. 3b, WMC and RM were moderately related and thus, some of the variance predicted in SAT scores is likely shared by WMC and RM. Furthermore, prior work has suggested that the reason WMC predicts scores on measures of higher-order cognition is because of differences in RM abilities (Mogle et al., 2008). If this is true, then we should see that the shared variance between WMC, RM, and RMF measures accounts for significant variance in SAT scores, but any residual variance from WMC does not. If, however, WMC is related to SAT scores due to variation in both attentional abilities and RM abilities as other work suggests then the common variance shared amongst all tasks should predict SAT scores and the residual variance specific to WMC should also account for unique variance in WMC (Unsworth, Brewer, et al., 2009). To examine this we specified a model in which all of the measures were allowed to load on one common factor, and the WMC factor was composed of the common variance shared between the WMC measures, independent of the shared variance with the memory measures. The correlation between these two factors was constrained to zero, and both were allowed to predict SAT. Shown in Fig. 4c is the resulting model. The fit of the model was acceptable, $\chi^2(49) = 55.68$, $p > .23$, RMSEA = .04, SRMR = .06, NNFI = .96, CFI = .97. As can be seen, both the common factor and the residual WMC factor accounted for unique variance in SAT. Specifically, both factors accounted for 53% of the variance in SAT (WMC residual = 24% unique, common factor = 29% unique). The current results suggest that at least part of the relation between WMC and SAT is due to differences in RM abilities (Unsworth, Brewer, et al., 2009) which are manifested in everyday memory failures as well as possibly differences in attention control (Unsworth & Spillers, 2010).

3. Conclusions

In a unique approach to studying everyday retrospective memory failures we combined laboratory assessments of cognitive abilities with diary methods. We found in a sample of undergraduate students that the most frequently reported retrospective memory failures were forgetting information pertaining to exams and homework, forgetting someone's name, forgetting login or ID information, and forgetting information pertaining to friends and relatives. Individual differences analyses suggested that measures of RM and WMC were significantly related to some, but not all, of the reported everyday retrospective memory failures. In particular, variation in memory failures related to educational contexts were consistently related with the cognitive ability assessments, whereas forgetting someone's name was not. These results tentatively suggest that everyday retrospective memory failures associated with consequential outcomes (such as doing poorly on an exam) are consistently related with laboratory cognitive ability measures.

It was also found that the most common retrospective memory failures were all related and formed a single latent variable which was strongly related to WMC, RM, and SAT scores, thereby providing important ecological validity to laboratory assessments of WMC, RM, and scholastic abilities and intelligence. This is important given prior debates on the ecological validity of laboratory measures of memory and their relation to everyday memory problems (Banaji & Crowder, 1989; Hintzman, 2011; Neisser, 1978; Roediger, 1991). In particular, the current results suggest that individual differences in laboratory measures of RM abilities strongly predict individual differences in everyday memory failures. Thus, memory measured in the laboratory is strongly related to memory in the real world. Furthermore, these results suggest that there are strong relations among different everyday memory failures suggesting that there is a common mechanism underlying these failures rather than multiple mechanisms. That is, everyday memory failures are not simply due to idiosyncratic factors, but rather reflect breakdowns in a more general memory system.

Further examination of these memory failures suggested that the relation between WMC and retrospective memory failures was fully mediated by individual differences in RM consistent with dual-component model of WMC (Unsworth & Engle, 2007). Additionally, the structural equation models suggested that the both WMC and the shared variance between RM abilities and retrospective memory failures accounted for unique variance in SAT scores. These results suggest that the ability to encode, store, and retrieve target information is an important predictor of everyday memory failures and a major source of individual differences in scholastic abilities and intelligence as measured by the SATs. As such the current results point to the importance of studying retrospective memory failures both inside and outside of the laboratory in order to better understand what types of failures individuals experience on a daily basis as well as who is most likely to experience various different types of retrospective memory failures. Combining laboratory assessments of cognitive abilities with assessments of everyday memory failures is a promising avenue for future research.

3.1. Practical applications

The findings reported here provide important information on the types of memory failures that healthy undergraduate students likely experience on a daily basis. The finding that most of these students' memory failures are related to school work suggests that low ability participants are likely having the most difficulties in school. Much prior work has shown that testing can improve retention in both laboratory and classroom studies (Roediger, Putnam, & Smith, 2011), and that prior laboratory work has shown that low ability participants are the most likely to benefit from testing (Brewer & Unsworth, 2012). The current work suggests a promising means by which low ability participants can be identified and can be potentially helped via changes in curriculum that allow for more testing as well as instruction on how to utilize study strategies that emphasize self-testing (Hartwig & Dunlosky, 2012).

References

Banaji, M. R., & Crowder, R. G. (1989). The bankruptcy of everyday memory. *American Psychologist*, *44*, 1185–1193.

Brewer, G. A., & Unsworth, N. (2012). Individual differences in the effects of retrieval from long-term memory. *Journal of Memory and Language*, *66*, 407–415.

Crovitz, H. F., & Daniel, W. F. (1984). Measurements of everyday memory: Toward the prevention of forgetting. *Bulletin of the Psychonomic Society*, *22*, 413–414.

Engle, R. W., Tuholski, S. W., Laughlin, J. E., & Conway, A. R. A. (1999). Working memory short-term memory and general fluid intelligence: A latent-variable approach. *Journal of Experimental Psychology: General*, *128*, 309–331.

Frey, M. C., & Detterman, D. K. (2004). Scholastic assessment or g? The relationship between the scholastic assessment test and general cognitive ability. *Psychological Science*, *15*, 373–378.

Hartwig, M. K., & Dunlosky, J. (2012). Study strategies of college students: Are self-testing and scheduling related to achievement. *Psychonomic Bulletin & Review*, *19*, 126–134.

Herrmann, D. J. (1982). Know thy memory: The use of questionnaires to assess and study memory. *Psychological Bulletin*, *92*, 434–452.

Hintzman, D. L. (2011). Research strategy in the study of memory: Fads, fallacies and the search for the coordinates of truth. *Perspectives on Psychological Science*, *6*, 253–271.

Mogle, J. A., Lovett, B. J., Stawski, R. S., & Sliwinski, M. J. (2008). What's so special about working memory? An examination of the relationship among working memory, secondary memory, and fluid intelligence. *Psychological Science*, *19*, 1071–1077.

Neisser, U. (1978). Memory: What are the important questions? In M. M. Gruneberg, E. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory* (pp. 3–24). San Diego, CA: Academic Press.

Reason, J. T. (1984). Lapses of attention in every day life. In R. Parasuraman, & D. R. Davies (Eds.), *Varieties of attention*. Orlando, FL: Academic Press.

Roediger, H. L. (1991). They read an article? A comment on the everyday memory controversy. *American Psychologist*, *46*, 37–40.

Roediger, H. L., Putnam, A. L., & Smith, M. A. (2011). Ten benefits of testing and their applications to educational practice. In J. Mestre, & B. Ross (Eds.), *Psychology of learning and motivation: Cognition in education* (pp. 1–36). Oxford: Elsevier.

Terry, W. S. (1988). Everyday forgetting: Data from a diary study. *Psychological Reports*, *62*, 299–303.

Unsworth, N., Brewer, G. A., & Spillers, G. J. (2009). There's more to the working memory-fluid intelligence relationship than just secondary memory. *Psychonomic Bulletin & Review*, *16*, 931–937.

Unsworth, N., Brewer, G. A., & Spillers, G. J. (2012). Variation in cognitive failures: An individual differences investigation of everyday attention and memory failures. *Journal of Memory & Language*, *67*, 1–16.

Unsworth, N., & Engle, R. W. (2007). The nature of individual differences in working memory capacity: Active maintenance in primary memory and controlled search from secondary memory. *Psychological Review*, *114*, 104–132.

Unsworth, N., Heitz, R. P., Schrock, J. C., & Engle, R. W. (2005). An automated version of the operation span task. *Behavior Research Methods*, *37*, 498–505.

Unsworth, N., Redick, T. S., Heitz, R. P., Broadway, J., & Engle, R. W. (2009). Complex working memory span tasks and higher-order cognition: A latent variable analysis of the relationship between processing and storage. *Memory*, *17*, 635–654.

Unsworth, N., & Spillers, G. J. (2010). Working memory capacity: Attention, memory, or both? A direct test of the dual-component model. *Journal of Memory and Language*, *62*, 392–406.