Memory Functioning Questionnaire (MFQ):

Replication and Exploration of Factor Solutions in Older Adults.

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Poster presented at the 54th Annual Scientific Meeting of the Gerontological Society of America, Chicago, IL, November 16, 2001. This research was supported by a grant from the National Institute on Aging (R37 AG08055) to K. Warner Schaie. The data from which this study was prepared was obtained with permission from The Seattle Longitudinal Study (SLS) for this purpose. We gratefully acknowledge the enthusiastic cooperation of the members and staff of the Group Health Cooperative of Puget Sound. Correspondence concerning this article should be addressed to: Andrew J. Revell, Laboratory of Adult Cognitive Development, Department of Human Development and Family Studies, The Pennsylvania State University, 113 Henderson South Building, University Park, PA 16802-6504. Email: ajr213@psu.edu

Abstract

The Memory Functioning Questionnaire, a 64-item measure of self perception of everyday memory abilities, has been reported as having a three-factor (Gilewski & Zelinski, 1988) or four-factor solution (Gilewski et al., 1990) in samples aged 16-89 and 29-87, respectively. The four factors were General Frequency of Forgetting, Seriousness of Forgetting, Retrospective Functioning, and Mnemonics Usage, with the last two factors collapsed in the three-factor solution. We attempted to replicate these factor structures in a sample of 367 community-dwelling older adults, ages 60-95 (M=71.83, SD=8.07), from the Seattle Longitudinal Study (SLS). A principal axis factor analysis of the MFQ item-level data supported the three-factor solution, but not the four-factor solution. A 6-factor solution was also examined that accounted for 69% of the total variance, compared to 45% with the three-factor solution. Although the six-factor solution accounted for more variance than the three-factor solution, not all the factors had multiple markers. Hence, invariance by age, education level, and sex, was studied and found in the three-factor model.

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The Memory Functioning Questionnaire (MFQ) was designed as a self-report measure of everyday memory functioning in adults (Gilewski, Zelinksi, & Schaie, 1990). It is the result of extensive factor analyses on the larger Metamemory Questionnaire (MQ; Zelinski, Gilewski, & Thompson, 1980) to identify a shorter version of the measure and determine whether the factor structure indicated a unidimensional construct or whether multiple dimensions of memory were involved. The retained factor structure for the MFQ has been replicated as having either three or four factors (Gilewski, Zelinski, 1988; Gilewski, Zelinski, & Schaie, 1990, respectively). The four-factor structure has additionally been replicated between younger (ages 16-54) and older adults (55-89) and longitudinally over three years in a sample of adults ages 29-87 (N=264).

Research to date has suggested that the MFQ is invariant over age (Hertzog, 1989; Gilewski, Zelinski, & Schaie, 1990). The objectives of the current study were to replicate these previous findings with another, larger sample of adults ages 60 and over, yet within narrower age ranges, and further test whether the proposed factor structures were invariant with respect to age, education, and sex groups. Differences by educational level and sex have not been investigated in previous research.

Method

Participants

The sample for this investigation is comprised of community-dwelling older adults (N=367) ages 60-95 (M=71.83, SD=8.07) from the larger Seattle Longitudinal Study (SLS; Schaie, 1996) who volunteered to complete a series of neuropsychological assessments in addition to their participation in at least one wave of SLS. The neuropsychological assessments were administered in order to study cognitive change in later adulthood with specific interest in detecting the early precursors to cognitive impairment. In this investigation, the sample includes only individuals from the first wave of neuropsychological assessment data collection, tested between 1997 and 1998, who completed the Memory Functioning Questionnaire (MFQ; Gilewski & Zelinski, 1988).

Measures

The measure of interest in this investigation is the Memory Functioning Questionnaire (MFQ), a 64-item self perception measure of everyday memory functioning (Gilewski & Zelinski, 1988). This self-report measure includes 7 scales, which include a General Rating of Memory, Retrospective Functioning, Frequency of Forgetting, Frequency of Forgetting while Reading, Remembering Past Events, Seriousness of Forgetting, and Mnemonics Usage. The items are Likert scaled from 1 to 7, with the higher number representing a more positive response in all but one scale, where the lower number represents a more positive response. A high total score over all scales would indicate a high level of self-reported memory functioning (Scale 1: General Rating of Memory), with fewer problem incidents (Scale 2: Seriousness of Forgetting), little trouble remembering reading material (Scales 3 and 4: Frequency of Forgetting while reading), ability to remember past events well (Scale 5: Remembering Past Events), less serious incidents of forgetting (Scale 6: Seriousness of Forgetting), improved memory ability as compared to an earlier time period (Scale 7: Retrospective Functioning), and little use of mnemonic aids (Scale 8: Mnemonics Usage; Zelinski, Gilewski, & Anthony-Bergstone, 1990).

The MFQ has been reported as having either a three-factor (Gilewski & Zelinski, 1988) or four-factor solution (Gilewski, Zelinski, & Schaie, 1990) in samples of adults ages 16-89 and 29-87, respectively. The four factors proposed by Gilewski and colleagues (1990) included factor

names similar to the scales, which included General Frequency of Forgetting, Seriousness of Forgetting, Retrospective Functioning, and Mnemonics Usage. General Frequency of Forgetting (Factor 1), was made up of four scales: General Rating of Memory (1 item), Frequency of Forgetting (18 items), Frequency of Forgetting While Reading (10 items), and Remembering Past Events (4 items). The remaining three factors were composed of only one scale each. These factors were Seriousness of Forgetting (Factor 2, 18 items), Retrospective Functioning (Factor 3, 5 items), and Mnemonics Usage (Factor 4, 8 items). The three-factor solution grouped the last two factors together but was otherwise identical.

Statistical Analyses

Exploratory factor analysis was conducted for the total sample using principal axis factoring of item-level data with Promax rotation. In addition, to the proposed three and six factor solutions, all possible solutions up to six factors were investigated. The simple structure solutions (the three and the six factor) were then tested by groups (two age groups: 60-75 years, Over 75 years; two education groups: Under a 4-year degree, 4-year degree or higher; and two sex groups: male, female). The three and six factor solutions accounted for the highest total variance and since the three factor was most parsimonious with multiple indicator factors, it was assessed for factorial invariance between age, education, and sex groups.

Factorial invariance was assessed in the three factor solution using the Amos statistical package (Arbuckle, 1994; Arbuckle & Wothke, 1999) to test whether the General Frequency of Forgetting factor and Retrospective Functioning/Mnemonics factors were comparable with respect to age, education, and sex. These two factors were analyzed for factorial invariance, since both had multiple markers, unlike the third factor, seriousness of forgetting, which is a single-indicator factor (see Figure 1).

The General Frequency of Forgetting factor has been shown to represent the items from four scales of the MFQ, which include General Rating of Memory, Frequency of Forgetting, Frequency of Forgetting while Reading, and Remembering Past Events (Gilewski & Zelinski, 1988; Gilewski, Zelinski, & Schaie, 1990). Gilewski and colleagues (1990) found that the General Frequency of Forgetting factor, made up of 33 of the 64 total items, accounted for 23.7% of the variance in responses, with an eigenvalue of 21.81. Since both research studies have found that these same four scales load on this one factor, it seemed reasonable to investigate whether there was evidence of factorial invariance based on a similar, but different sample of older adults, between multiple groups. The Retrospective Functioning/Mnemonics factor is composed of the Retrospective Functioning Scale and the Mnemonics Usage scale, with five and eight items, respectively. The total raw scores for each scale, for both factors, were standardized between groups at the onset of this investigation to the T-score metric (M=50, SD=10), as suggested by Hofer (1999).

The evaluation of factorial invariance between the groups involves a nested sequence of increasingly stringent models. For example, a more stringent model would have the same free parameters as the model before it, but also have a subset of parameters that were fixed or constrained. The nested sequence allows the models to be compared for overall fit.

In accordance with the research of Meredith (1993), a hierarchy of factorial invariance constraints was applied to test a nested sequence of models. The lowest or least stringent form of invariance is aptly called weak factorial invariance where constraints are equal on the factor-variable regressions between the three groups and where the factor variances and covariances are free to vary. Meeting the condition of weak factorial invariance is necessary for establishing evidence for invariant measurement operations between groups (Hofer, 1999). The second, and

more stringent form of factorial invariance is called strong factorial invariance and requires the added equality constraints between corresponding mean intercepts and between the groups. In this analysis, the factor mean in the reference group outcome was set to zero, so that the mean differences are expressed at the factor level for the unconstrained factor means (see Table 3). If group differences in unique means are found at the factor level, then the presence of bias, above and beyond the weak model, are indicated. The third, and most stringent form of factorial invariance is called strict factorial invariance, which requires invariance among unique variances, in addition to the constraints added in prior steps of the hierarchy (i.e., unique means and factor loadings). This additional constraint assesses possible differences in the proportion of residual to true variance by forcing equivalence of random and specific error variances between the three groups. Differences in variance are then expressed at the factor level. Configural variance allows a qualitative assessment of the similarity between groups with the use of relaxed constraints, with the same number and pattern of factor loadings and is used as a baseline model.

Evaluating Goodness of Fit.

The sequence of nested models was first assessed with the chi square statistic. A difference between each of the models was then computed, as was the difference in degrees of freedom. A comparison of these difference chi square statistics allowed direct comparison of model fit. Since the chi square statistic will likely be affected by our moderately-sized sample (N=367), the differences between alternative models are better assessed by comparing the models' fit indices (Hu & Bentler, 1995). Four fit indices were calculated for each full model (i.e., configural, weak, strong, strict) and also for each difference model (i.e., weak, strong, strict). Fit indices, as discussed extensively by Hu and Bentler (1995), were designed to quantify variations in the data for a particular model and further reduce some degree of interpretation difficulty of the chi square statistic. While Amos does provide fit indices with the model output, those indices are based on the default independence model, which does not include the means. In order to compare the results from all the models, the means must be included in the independence model, allowing a more appropriate null hypothesis comparison, without constraints on the parameters of the independence model.

For this set of analyses, the incremental fit indices include the Normed Fit Index (NFI; Bentler & Bonett, 1980), the Tucker-Lewis Index (TLI; Tucker & Lewis, 1973), the Comparative Fit Index (CFI; Bentler, 1990), and the root mean square error of approximation (RMSEA; Steiger, 1990). The first and third of these indices are on a 0 to 1 scale, such that values above .90 in comparison to the null model are considered a good fit, though the higher the better. The second, the TLI, while considered robust to variations in sample size, is not scaled between 0 and 1, making it more difficult to interpret (Maruyama, 1998). The fourth, the RMSEA, is considered good if below .05 and acceptable up to .10. Hu and Bentler (1995) discuss the advantages and disadvantages of the various incremental and absolute fit indices using the types discussed by Marsh, Balla, and McDonald (1988). Given the moderately-sized sample in these analyses (N=367), any of the incremental fit indices should provide valid indications of model fit. However, past research has indicated that Type 2 and Type 3 indices (i.e.,TLI, CFI, respectively) tend to be less biased (Hu & Bentler, 1995; Marsh et al., 1988; Maruyama, 1998).

Model Evaluation.

There was also an evaluation of the regression weights for the parameters or specified relations for each model of invariance. Unstandardized parameter estimates, standard errors, and standardized parameter weights were assessed in the model, which appear to be the best fit.

Meredith and Horn (2001) state that when factors are correlated, as they often are, and invariance is evaluated among groups, that the standardized weights of a factor in one group should be proportional to the standardized weights of that factor in another group. In this case, since the first and third factors of the MFQ are being primarily explored, patterns among the scales for these factors are assessed between the groups. If the same pattern in terms of weights, variances, and covariances were found among each of the groups, then factorial invariance for the first and third factors would be supported in this population.

Since the Seriousness of Forgetting Factor had only a single indicator, the means, variances, and intercepts of the residuals and manifest variables were set to zero and the regression weights were set to one for this factor. The factor variances of the other factors were also set to zero, though the regression weights were free to vary, as were the factor means, indicator intercepts, and covariances (see Figure 2). This allowed the variance explained by this single-indicator factor to be forced to the right side of the model and the means and variances of the latent variable to represent the Seriousness of Forgetting factor in relation to the other factors among the covariances.

Results

Exploratory factor analyses of the three and six factor solutions accounted for the highest total variances. A simple structure supporting the seven subscales reported by Gilewski and Zelinski (1988) was replicated. When examined by age, education level, and sex groups, the three factor solution accounted for 41% - 49% of the total variance, whereas the six factor solution accounted for 62% - 75% of the total variance. Since the three factor solution was more parsimonious than the six factor solution, factorial invariance analyses were conducted for the three factor structure, using the seven subscale scores.

The evaluation of factorial invariance provided chi square values and corresponding degrees of freedom for each of the models tested between the groups of age, education, and sex. The sample sizes per group are noted as follows: For age groups, young-old (n=177), oldest-old (n=190); for education groups, under a 4 year degree (n=199), a 4 year degree and above (n=168); for sex groups, male (n=158), and female (n=209). Missing data is assumed to be missing at random (MAR). The chi square statistics, differences in degrees of freedom and difference chi squares, as well as fit indices are presented for all the groups and models in Table 1. For both age groups, the chi square statistic was statistically significant for the configural, weak, strong, and strict models of factorial invariance ($p < .001$). The difference in chi square statistics between the four models was non-significant in all cases. Based on the fit statistics, one could arguably choose the strict model as the best fitting due to the minimal changes among indices despite a somewhat lower and thus better RMSEA index score. Therefore, the strict model of factorial invariance was selected as having the best fit.

For both education groups, the chi square statistic was statistically significant for the configural, weak, strong, and strict models of factorial invariance ($p < .001$). The difference chi square statistics revealed non-significance between the configural-weak and weak-strong chi square statistics, and strong-strict models. The fit indices also clearly indicate the appropriate choice, as the indices for the strict model are somewhat better than those for the strong model. Once again, the strict model of factorial invariance appears to be the most reasonable choice for both education groups.

This previous pattern of factorial invariance did not hold for the male and female groups. For both sex groups, high statistical significance was found across all overall chi square statistics for the configural, weak, strong, and strict models ($p < .01$). Non-significance was found in

difference chi squares for the configural-weak and weak-strong combinations, and strong-strict combinations. Model choice would appear to be easy at this point, that is, until one views the fit indices. The fit indices present a pattern where the fit begins relatively well, but drops across the board from weak to strong and strict to strict. It is much more difficult to judge the appropriate direction as the absolute statistics contradict the relative statistics. The conservative choice taken here was to select weak factorial invariance, as it presented the best outcome for both types of statistics, including all the fit statistics, for the male and female groups.

Between all groups of estimates for the covariances among latent variables, the same three relationships are the largest in degree of association. These three relationships are as follows (in descending order): 1) The effect of Retrospective Functioning on Seriousness of Forgetting; 2) The effect of Seriousness of Forgetting on General Frequency of Forgetting; and 3) The effect of Retrospective Functioning on General Frequency of Forgetting.

There was a difference in association level when comparing the young-old to the oldest-old groups for the covariances of the latent constructs (see Table 2). In the young-old group, the highest degree of covariance was found between the effect of retrospective functioning on seriousness. Similarly, the old adult group had the highest covariances estimates for the effect of retrospective functioning on seriousness of forgetting, yet both this effect and the second highest covariance, that of Seriousness on General Frequency, were nearly double the size as the estimates for the young-old group. Both of these two effects also have the highest covariances in the sex groups, though the difference between the two is much less in the female group. These two effects also have the highest covariances in the education groups, though the differences between groups was hardly noticeable.

A further issue is which of the scales, which have been shown to load highly on either the first factor (General Frequency of Forgetting) or the third factor (Retrospective/Mnemonics) are accounting for the highest regression weights and most likely driving the relationships between the groups. For both the age and education groups, the highest and most significant regression weights were found for (in this order): 1) Frequency of Forgetting Scale (from factor 1), and 2) Retrospective Functioning Scale (from factor 3). For the sex groups, the highest regression weight was also the Frequency of Forgetting Scale, though the second highest was the Remembering Past Events Scale (both of factor 1).

Discussion

Previous research by Gilewski, Zelinski, and Schaie (1990) has found that the 64-item Memory Functioning Questionnaire (MFQ) was stable over young (ages 16-54) and older (55-89) adults and that the same scales loaded on each of the four factors. The objective of this study was to replicate these previous findings with another, larger sample of adults ages 60 and over and further test whether the factor structure was invariant over education and sex groups, in addition to assessing age based on groups of young-old and oldest-old individuals.

Following exploratory factor analysis, three and six factor solutions were found to account for the highest percentages of variance. The six factor solution was not parsimonious and was thus dropped in favor of the three, for which more multiple-indicator factors were present. Factorial invariance between the groups was performed using the three factor solution.

These analyses indicate that strict factorial invariance was present between the groups of age and education and weak factorial invariance was present for male and female groups. This conclusion is supported by the absolute and incremental indices of fit, which include chi square statistics, difference chi squares, and various fit indices, particularly those fit indices that are

most robust to sample size and less biased – Type 2 and Type 3 indices (i.e., TLI and CFI, respectively; Hu & Bentler, 1995; Marsh et al., 1988; Maruyama, 1998). This finding confirms the previous work of Gilewski and colleagues (1990) that the MFQ is invariant over age groups. It also extends beyond their work to suggest that education groups and sex groups appear to be invariant based on the loadings on the first and third factors.

This investigation also uncovered some important differences among groups for the third factor, as revealed by the variation in the covariances of the latent variable. The most startling difference was the strength of the covariance estimates between the young-old and old adult groups. The effect of retrospective functioning on seriousness of forgetting in the old adult group was twice as large as the same effect in the young-old group. It may be that the old adults in this sample are more effected by how "serious" their memory changes are as evidenced by the research showing that the greatest declines in cognitive ability occur after age 80 (Schaie, 1996). Thus, it may be that the old adults are more concerned with the seriousness of their forgetting and then tend to score much differently on that scale as compared to the scales of the other factors. This might then have some implications for how the covariance estimates are heightened for factors where seriousness of forgetting is the outcome of the effect being tested (i.e., seriousness ← retrospective functioning).

The limitations of these findings are also noteworthy. First, factorial invariance of the MFQ was not measurable among the third factor of this instrument due to the lack of multiple scales or markers composing each. The second limitation of this investigation is the absence of Time 2 data for these individuals on this assessment tool. This will soon be resolved, as a more significantly-sized sample will be available within the next year. The third limitation of this investigation may be the moderately-sized sample. The results of this study may be more significant if the sample size was closer to a thousand individuals. Still, this sample is nearly double that of the earlier paper that assessed invariance over time (i.e., Gilewski, Zelinski, and Schaie, 1990), which is also the only published paper to date on this topic.

In conclusion, the presence of strict factorial invariance on this sample between the age and education groups tested is truly a step forward for those that administer this assessment and those who conduct and publish secondary analyses on MFQ scaled score results. This finding provides researchers in the field of cognitive aging with necessary evidence that the assessment tool can be administered to populations similar in age, education, and sex, and be confident that the hypothesized factor structures will remain the same. Whether the structure remains invariant longitudinally, is not yet known, but will be undertaken in a follow-up investigation.

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Author Note

This research was supported by a grant from the National Institute on Aging (R37 AG08055) to K. Warner Schaie. The data from which this study was prepared was obtained with permission from The Seattle Longitudinal Study (SLS) for this purpose. We gratefully acknowledge the enthusiastic cooperation of the members and staff of the Group Health Cooperative of Puget Sound. I would also like to thank those who participated in reviewing prior drafts of this manuscript including K. Warner Schaie, Sherry L. Willis, Grace I. L. Caskie, and Scott M. Hofer.

Table 1

Fit Indices for Nested Sequence of Models (N=367) between Multiple Groups

Group	Model	df	χ^2	df_{diff}	χ^2_{diff}	NFI	TLI	CFI	RMSEA
Age									
	Null	42	565.841	--	--	--	--	--	--
	Configural	24	51.373	--	--	0.909	0.909	0.948	0.056
	Weak	28	56.394	4	2.014	0.900	0.919	0.946	0.053
	Strong	32	61.988	4	1.937	0.890	0.925	0.943	0.051
	Strict	38	70.752	6	1.862	0.875	0.931	0.937	0.048
Education									
	Null	42	609.504	--	--	--	--	--	--
	Configural	24	60.325	--	--	0.901	0.888	0.936	0.064
	Weak	28	65.961	4	2.356	0.892	0.900	0.933	0.061
	Strong	32	74.065	4	2.315	0.878	0.903	0.926	0.060
	Strict	38	82.560	6	2.173	0.865	0.913	0.921	0.057
Sex									
	Null	42	565.841	--	--	--	--	--	--
	Configural	24	48.488	--	--	0.914	0.918	0.953	0.064
	Weak	28	57.108	4	2.040	0.899	0.917	0.944	0.053
	Strong	32	70.781	4	2.212	0.875	0.903	0.926	0.057
	Strict	38	80.135	6	2.109	0.858	0.911	0.920	0.055

Note. Null is the independence model with the means. NFI=normed fit index (Bentler & Bonett, 1980). TLI=Tucker-Lewis Index (Tucker & Lewis, 1973). CFI=comparative fit index (Bentler, 1990). RMSEA=root mean square error of approximation (Steiger, 1990).

Table 2

Covariances among Latent Variables of the MFQ Factors from Strict (Age, Education) and Weak Models (Males, Females)

Group	Regression	B	SE
Young-Old	Gen Freq of Forget ← Seriousness	1.788*	0.794
	Seriousness ← Retrospective	3.057*	1.244
	Gen Freq of Forget ← Retrospective	0.576	0.162
Oldest-Old			
	Gen Freq of Forget ← Seriousness	3.543*	0.962
	Seriousness ← Retrospective	6.910*	2.184
	Gen Freq of Forget ← Retrospective	0.800	0.263
< 4-year degree			
	Gen Freq of Forget ← Seriousness	2.910*	0.724
	Seriousness ← Retrospective	4.640*	1.057
	Gen Freq of Forget ← Retrospective	0.598	0.109
≥ 4-year degree			
	Gen Freq of Forget ← Seriousness	1.559*	0.751
	Seriousness ← Retrospective	3.875*	1.178
	Gen Freq of Forget ← Retrospective	0.405	0.117
Male			
	Gen Freq of Forget ← Seriousness	3.006*	0.781
	Seriousness ← Retrospective	4.492*	1.441
	Gen Freq of Forget ← Retrospective	0.705*	0.179
Female			
	Gen Freq of Forget ← Seriousness	1.864*	0.748
	Seriousness ← Retrospective	6.932*	2.224
	Gen Freq of Forget ← Retrospective	0.694	0.229

*$p < .05$.

Table 3

Means among Latent Variables of the MFQ Factors from Strict (Age, Education) and Weak Models (Males, Females)

Group	Latent Variable	Estimate	S.E.
Young-Old	v_gen	0.000	
	v_seri	48.898	0.735
	v_retrom	0.000	
Old-old	v_gen	0.000	
	v_seri	50.111	0.739
	v_retrom	0.000	
< 4-year degree	v_gen	0.000	
	v_seri	50.266	0.697
	v_retrom	0.000	
≥ 4-year degree	v_gen	0.000	
	v_seri	49.702	0.785
	v_retrom	0.000	
Male	v_gen	0.000	
	v_seri	50.494	0.754
	v_retrom	0.000	
Female	v_gen	0.000	
	v_seri	49.641	0.716
	v_retrom	0.000	

Note. The mean of the latent variable representing the second factor (Seriousness of Forgetting or v_seri) was set to zero for all groups in order to test the factorial invariance and as such, has a mean estimate standardized to the T-score metric. The means of the other latent variables were investigated and thus appear as zero in the table.

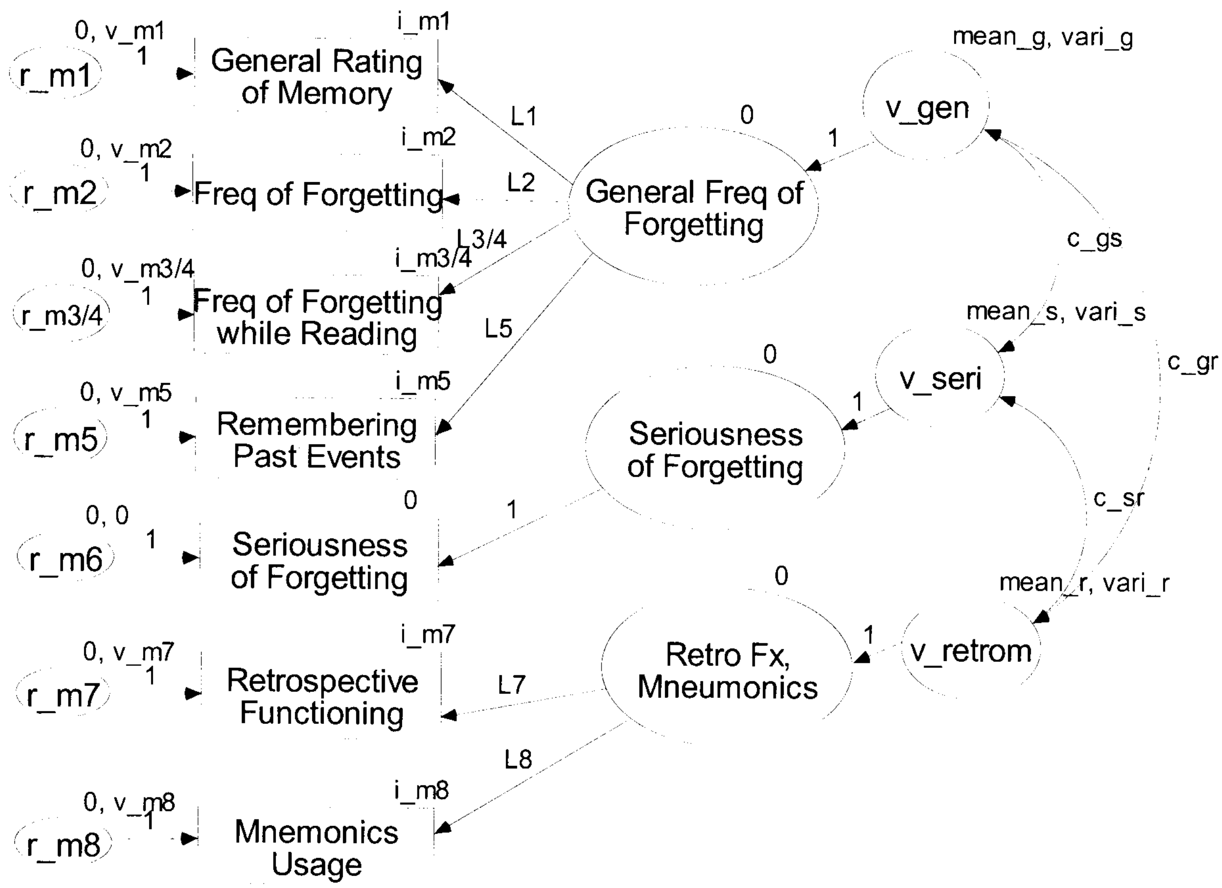

Figure 2. The three factor model of the Memory Functioning Questionnaire with labeled parameter estimates.

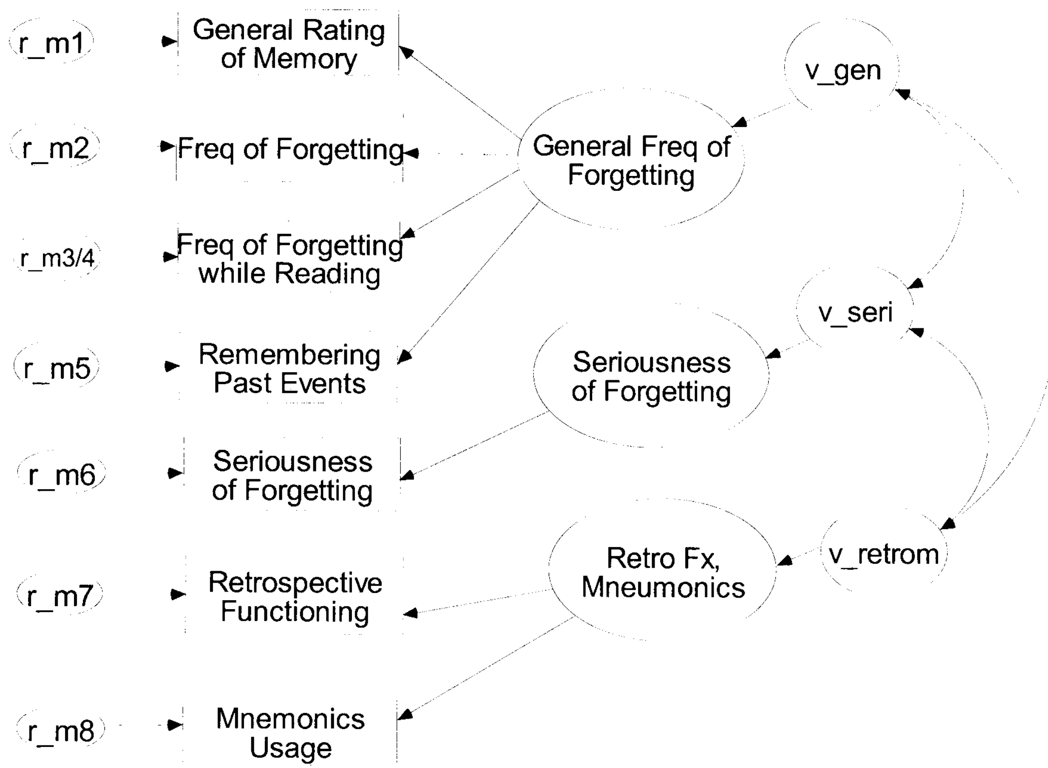

Figure 1. <u>The three factor model of the Memory Functioning Questionnaire (MFQ).</u>