Assessing convergent and discriminant validity in the ADHD-R IV rating scale:
User-written commands for Average Variance Extracted (AVE), Composite Reliability (CR), and Heterotrait-Monotrait ratio of correlations (HTMT).

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Overview

Construct Validity

Campbell and Fiske (1959) proposed two aspects to asses the construct validity of a test:

1. **Convergent validity**: is the degree of confidence we have that a trait is well measured by its indicators.

2. **Discriminant validity**: is the degree to which measures of different traits are unrelated.

In structural equation modelling, Confirmatory Factor Analysis has been usually used to asses construct validity (Jöreskog, 1969).

Example: Two-factor CFA model

In a **Confirmatory Factor Analysis** convergent and discriminant validity examine the extent to which measures of a latent variable shared their variance and how they are different from others.
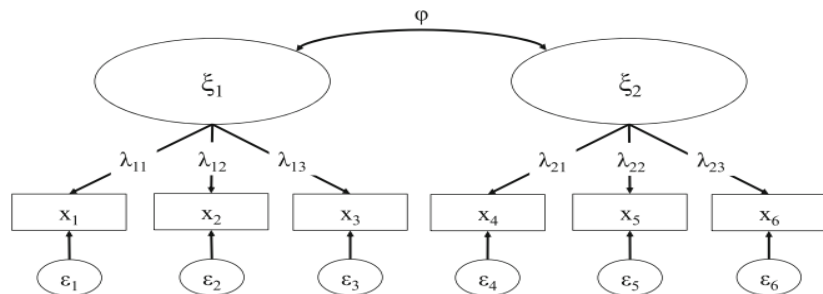

Figure 1: Example of two-factor CFA model.

Convergent Validity

The criterion of Fornell-Larcker (1981) has been commonly used to assess the degree of shared variance between the latent variables of the model.

According to this criterion, the *convergent validity* of the measurement model can be assessed by the Average Variance Extracted (AVE) and Composite Reliability (CR).

- **AVE** measures the level of variance captured by a construct versus the level due to measurement error, values above 0.7 are considered very good, whereas, the level of 0.5 is acceptable.

- **CR** is a less biased estimate of reliability than Chonbachs Alpha, the acceptable value of CR is 0.7 and above.

Average Variance Extracted (AVE)

The **Average Variance Extracted (AVE)** for construct ξ_j is defined as follows:

$$AVE\xi_j = \frac{\displaystyle\sum_{k=1}^{K_j} \lambda_{j_k}^2}{\left(\displaystyle\sum_{k=1}^{K_j} \lambda_{j_k}^2\right) + \Theta_{j_k}}$$

Where:

K_j is the number of indicators of construct ξ_j.

λ_{j_k} are factor loadings

Θ_{j_k} is the error variance of the kth indicator ($k = 1, ..., K_j$) of constuct ξ_j

$$\Theta_{j_k} = \sum_{k=1}^{K_j} 1 - \lambda_{j_k}^2$$

Composite Reliability (CR)

The **Composite Reliability (CR)** for construct ξ_j is defined as follows:

$$\rho_{c\xi j} = \frac{\left(\sum_{k=1}^{K_j} \lambda_{j_k}\right)^2}{\left(\sum_{k=1}^{K_j} \lambda_{j_k}\right)^2 + \Theta_{j_k}}$$

Where:

K_j is the number of indicators of construct ξ_j.

λ_{j_k} are factor loadings

Θ_{j_k} is the error variance of the kth indicator ($k = 1, ..., K_j$) of constuct ξ_j

$$\Theta_{j_k} = \sum_{k=1}^{K_j} 1 - \lambda_{j_k}^2$$

Discriminant validity

According to the Fornell-Larcker testing system, **discriminant validity** can be assessed by comparing the amount of the variance capture by the construct ($AVE\xi_j$) and the shared variance with other constructs (ϕ_{i_j}).

- Thus, the levels of square root of the AVE for each construct should be greater than the correlation involving the constructs.

$$\sqrt{AVE\xi_j} \geq \phi_{i_j} \ \forall i \neq j$$

- Otherwise, the levels of the AVE for each construct should be greater than the squared correlation involving the constructs.

$$AVE\xi_j \geq \phi_{i_j}^2 \ \forall i \neq j$$

Heterotrait-Monotrait ratio

Recently, it has been proposed the **Heterotrait-monotrait ratio of the correlations (HTMT)** approach to assess discriminant validity (Henseler, Ringle & Sarstedt, 2015).

HTMT is the average of the heterotrait-heteromethod correlations relative to the average of the monotrait-heteromethod correlations.

$$HTMT_{i_j} = \cfrac{\cfrac{1}{K_i K_j} \sum_{g=1}^{K_i} \sum_{h=1}^{K_j} r_{i_g, j_h}}{\cfrac{2}{K_i(K_i-1)} \sum_{g=1}^{K_i-1} \sum_{h=g+1}^{K_i} r_{i_g, i_h} \cfrac{2}{K_j(K_j-1)} \sum_{g=1}^{K_j-1} \sum_{h=g+1}^{K_j} r_{j_g, j_h}}$$

Heterotrait-Monotrait ratio

The HTMT derives from the classical multitrait-multimethod (MTMM) matrix (Campbell & Fiske, 1959).

Figure 2: Example of MTMT matrix.

Heterotrait-Monotrait ratio

The HTMT is an estimate of the correlation between the constructs ξ_i and ξ_j:

- HTMT values smaller than 1 show that the true correlation between the two constructs should differ.

As a criterion HTMT values are compared with a predefined threshold:

- If the value of the HTMT is higher than this threshold, there is a lack of discriminant validity.
- Some authors suggest a threshold of 0.85 (Kline 2011), whereas others propose a value of 0.90 (Teo et al. 2008).

Otherwise, the bootstrapping procedure allows for constructing confidence intervals for the HTMT:

- This test the null hypothesis (H 0: HTMT $\geq$ 1) against the alternative hypothesis (H 1: HTMT $<$ 1)
- A confidence interval containing the value 1 indicates a lack of discriminant validity.

Objetives

1. The present work presents a series of user-written commands to assess **convergent and discriminant validity** for confirmatory factor analysis models.

2. This commands compute AVE, CR and HTMT ratio; and their confidence intervals are estimated using the bootstrap method.

3. To demonstrate the use of these commands we use data from a sample of high school students who have been administered the ADHD-R IV rating scale.

avecr: AVE & CR

```
help avecr
```

_____

<u>Title</u>

    avecr—   Average Variance Extracted (AVE) and Composite Reliability (CR)

<u>Syntax</u>

        avecr [, ci(*opt*) reps(*integer*) seed(*integer*) iter(*integer*)]

<u>Description</u>

    avecr According to the criterion of Fornell-Larcker (1981) this command computes
    indices to assess the degree of shared variance between the latent variables of a
    CFA model. The convergent validity of the measurement model can be assessed by the
    Composite Reliability (CR) and the *Average Variance Extracted (AVE)*. AVE measures
    the level of variance captured by a construct versus the level due to measurement
    error, values above 0.7 are considered very good, whereas, the level of 0.5 is
    acceptable. CR is a less biased estimate of reliability than Chonbach□s Alpha, the
    acceptable value of CR is 0.7 and above. Discriminant validity can be assessed by
    comparing the AVE values with the square correlation between constructs. This
    command display a matrix with correlation coefficients and square root of AVE as
    diagonal. □ The bootstrapping procedure allows for constructing confidence intervals
    for AVE and CR indices.

Figure 3: avecr.sthlp

Options

ci(*opt*) specifies if the bootstrap confidence intervals are computed, *ci* must be one of the following options: "norm", "all"". It is optional.

reps(*integer*) if bootstrap confidence intervals have been required, specifies the number of bootstrap repetions. It is optional (by defect value is 100).

seed(*integer*) if bootstrap confidence intervals have been required, specifies the seed of the bootstrap analysis. It is optional (by defect value is 1).

iter(*integer*) if bootstrap confidence intervals have been required, specifies the maximum limit to break the a bootstrap repetion analysis. It is optional (by defect value is not limited).

ci_options	Description
Confidence Intervals	
norm	normal confidence interval (N)
all	normal (N), percentile (P) and bias-corrected (BC) confidence intervals

Remarks

This command computes **Post-estimation analyses**, remember to run previously the SEM Model. Weight and groups analysis are allowed in the SEM Model.

Figure 4: avecr.sthlp

avecr: AVE & CR

Examples

```
.  avecr
.  avecr , ci(norm)  reps(50)
.  avecr , ci(all)  reps(200) seed(4235)
.  avecr , seed(6889)
.  avecr , ci(norm)  reps(200) seed(4235) iter(500)
.  avecr , iter(2000)
```

Saved results

avecr saves the following in **r()**:

r(avecr)   AVE and CR coefficients

Reference

Fornell, C. & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and
measurement error. *Journal of Marketing Research*, 18, 39□50.

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Also see

Online: htmt

Figure 5: avecr.sthlp

htmt: Heterotrait-Monotrait ratio

```
help htmt
```

Title

    htmt—   Heterotrait-Monotrait ratio of the correlations (HTMT)

Syntax

        htmt [if] [in] [weight] [, ci(opt) reps(integer) seed(integer)

    if exp command, see if. in exp command, see in. fweights and aweights are allowed;
    see weight.

Description

    htmt The heterotrait-monotrait ratio of the correlations (HTMT) assess discriminant
    validity (Henseler, Ringle \& Sarstedt, 2015). The HTMT derives from the classical
    multitrait-multimethod (MTMM) matrix (Campbell \& Fiske, 1959). HTMT is the average
    of the heterotrait-heteromethod correlations relative to the average of the
    monotrait-heteromethod correlations. HTMT values smaller than 1 show that the true
    correlation between the two constructs should differ. As a criterion HTMT values are
    compared with a predefined threshold (e.g. .85 or .90, and if the value of the HTMT
    is higher than this threshold, there is a lack of discriminant validity. The
    bootstrapping procedure allows for constructing confidence intervals for the HTMT
    ratio.

Figure 6: htmt.sthlp

htmt: Heterotrait-Monotrait ratio

Options

    ci(*opt*) specifies if the bootstrap confidence intervals are computed, *ci* must be one
       of the following options: "norm", "all"". It is optional.

    reps(*integer*) if bootstrap confidence intervals have been required, specifies the
       number of bootstrap repetions. It is optional (by defect value is 100).

    seed(*integer*) if bootstrap confidence intervals have been required, specifies the
       seed of the bootstrap analysis. It is optional (by defect value is 1).

ci_options	Description
Confidence Intervals	
norm	normal confidence interval (N)
all	normal (N), percentile (P) and bias-corrected (BC) confidence intervals

Remarks

    This command computes **Post-estimation analyses**, remember to run previously the SEM
    Model. To compare between groups use the 'if' expression on the htmt command.

Figure 7: htmt.sthlp

htmt: Heterotrait-Monotrait ratio

<u>Examples</u>
```
. htmt
. htmt, ci(all) seed(1687)
. htmt  if edad >12 in 1/200 , ci(norm)
. htmt  in 1/200  [w=edad], ci(all) reps(50) seed(256)
```

<u>Saved results</u>

htmt saves the following in r():

r(htmt)   htmt coefficients

<u>Reference</u>

Campbell, D.T., & FiskeD.W. (1959) Convergent and discriminant validation by the
    multitrait-multimethod matrix. *Psychological Bulletin*, 56, 81-105
Henseler, J.; Ringle, C. M.; Sarstedt, M. (2015). A new criterion for assessing
    discriminant validity in variance-based structural equation modeling. *Journal
    of the Academy of Marketing Science*, 43 (1), 115-135,

<u>Author</u>

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<u>Also see</u>

Online: **avecr**

Example: Assessing convergent and discriminant validity in the ADHD-R IV rating scale

The ADHD-R IV rating scale assess 18 symptoms of diagnosis of the disorder for deficit of attention / hyperactivity (ADHD) given in the DSM-V.

Usually, the ratters are parents and teachers. However, it has not been proven if teenagers affected with ADHD can reliably self-report on these symptoms.

The objective of this example is to check the convergent and discriminant validity of the ADHD-R IV scale administered to different three ratters (teachers, parents and teenagers).

Method

Participants:

On an approximate population of 1500 students between 12 and 15 years, 300 subjects were randomly selected, of whom we attempted to obtain scores on the ADHD-RS-IV scale from their teachers, parents and students themselves.

- In total, complete three scales were obtained from 203 students.

- Participants were distributed uniformly by gender (102 women) and age groups (M=13,35; DT=1,07).

ADHD-R IV rating scale

The ADHD RS-IV scale consists of 18 items fully consistent with the list of symptoms of ADHD criterion on the DSM-IV.

- 9 items assess inattention (INAT. subscale, odd items).
- 9 items assess hyperactivity/impulsivity (HYPER. subscale, even items).

Each item was scored on a Likert scale of 0 "never or rarely" to 3 "Very often".

To avoid identification problems we use item parcelling in the CFA Models:

Three parcels were created for inattention and hyperactivity factors composed by each three consecutive items (Gomez, Burns, Walsh, & De Moura, 2003).

Confirmatory Factor Analysis Nested Models

- Model 0: Two-factor model with correlated factors (Jöreskog, 1967).

- Model 1: Two-factor model with correlated uniqueness (Kenny & Kashy, 1992).

- Model 2: Multitrait-multimethod model (Jöreskog, 1974).

Model 0: Two-factor model with correlated factors
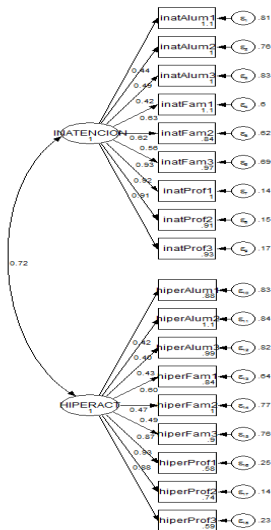
Model 1: Two-factor model with correlated factors and correlated uniqueness

Models Estimation and Fit
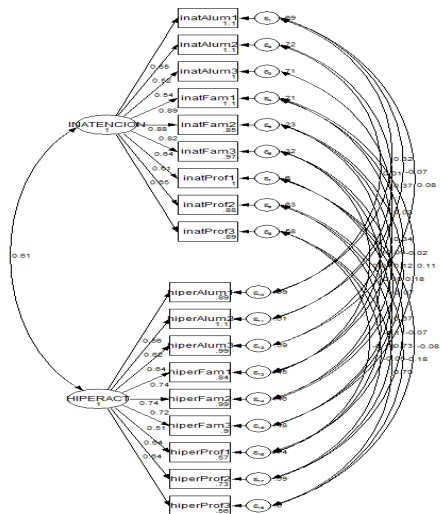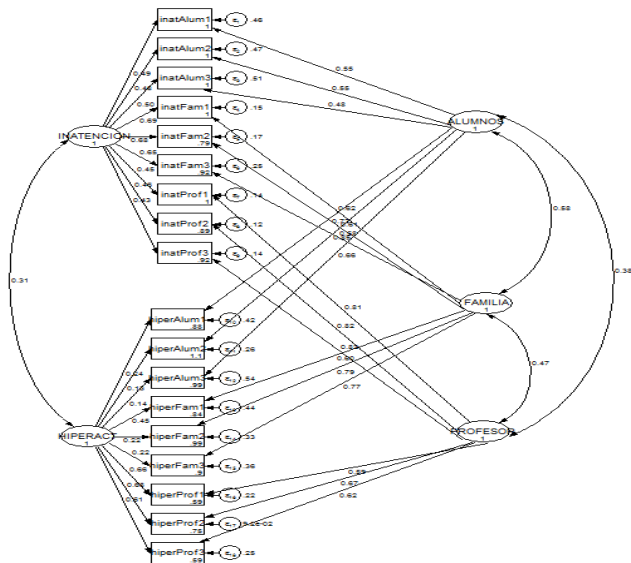
Table 1: Model Test and Fit indices

Model	χ^2 (df)	RMSEA	CFI	TLI	$\Delta\ \chi^2$
Model 1: CFA	1209.44* (134)	0.199	0.625	0.571	—
Model 2: Corr. Uniq.	1015.51* (110)	0.201	0.684	0.560	193.92*
Model 3: MTMM**	310.78* (113)	0.093	0.931	0.907	704.73*

*Prob > chi2 = 0.0000

Root mean squared error of approximation (RMSEA)

Comparative fit index (CFI)

Tucker-Lewis index (TLI)

Models Differences χ^2 Test

**MTMM was the best model to explain ADHD-R IV scale measures.

avecr for Model 2: Multitrait-multimethod model (MTMM)

Figure 10: avecr, ci(norm) seed(425)


```
. avecr
file framew.ster saved
    --------------
Number of Groups: 1

    --------------
Group Number: 1

%%% Factor loadings %%%

e(Group_1_coeffs)[18,5]
                     latent:     latent:     latent:     latent:     latent:
                  INATENCION    HIPERACT     ALUMNOS     FAMILIA    PROFESOR
 observed:inatAlum1    0.486       0.000       0.550       0.000       0.000
 observed:inatAlum2    0.481       0.000       0.548       0.000       0.000
 observed:inatAlum3    0.502       0.000       0.484       0.000       0.000
  observed:inatFam1    0.686       0.000       0.000       0.617       0.000
  observed:inatFam2    0.676       0.000       0.000       0.611       0.000
  observed:inatFam3    0.647       0.000       0.000       0.575       0.000
 observed:inatProf1    0.455       0.000       0.000       0.000       0.810
 observed:inatProf2    0.462       0.000       0.000       0.000       0.818
 observed:inatProf3    0.425       0.000       0.000       0.000       0.823
observed:hiperAlum1    0.000       0.239       0.726       0.000       0.000
observed:hiperAlum2    0.000       0.135       0.851       0.000       0.000
observed:hiperAlum3    0.000       0.139       0.664       0.000       0.000
 observed:hiperFam1    0.000       0.448       0.000       0.599       0.000
 observed:hiperFam2    0.000       0.218       0.000       0.786       0.000
 observed:hiperFam3    0.000       0.219       0.000       0.770       0.000
observed:hiperProf1    0.000       0.661       0.000       0.000       0.589
observed:hiperProf2    0.000       0.675       0.000       0.000       0.672
observed:hiperProf3    0.000       0.607       0.000       0.000       0.616
```

avecr for Model 2: Multitrait-multimethod model (MTMM)

```
%%% Lambdas %%%

e(Group_1_means)[5,3]
                lambda   lambda2   1-lambda2
INATENCION       4.820     2.667       6.333
  HIPERACT       3.341     1.652       7.348
   ALUMNOS       3.824     2.530       3.470
   FAMILIA       3.959     2.655       3.345
  PROFESOR       4.328     3.181       2.819

%%% AVE Sqrt(AVE) CR %%%

e(Group_1_result)[5,3]
                 AVE    Sqrt(AVE)        CR
INATENCION      0.296      0.544      0.786
  HIPERACT      0.184      0.428      0.603
   ALUMNOS      0.422      0.649      0.808
   FAMILIA      0.443      0.665      0.824
  PROFESOR      0.530      0.728      0.869

%%% Sqrt(AVE) vs Covariances %%%

symmetric e(Group_1_correl)[5,5]
            INATENCION   HIPERACT    ALUMNOS    FAMILIA    PROFESOR
INATENCION      0.544
  HIPERACT      0.311      0.428
   ALUMNOS      0.000      0.000      0.649
   FAMILIA      0.000      0.000      0.581      0.665
  PROFESOR      0.000      0.000      0.381      0.467      0.728
```
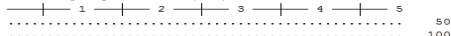
avecr for Model 2: Multitrait-multimethod model (MTMM)

```
%%% HTMT Confindence Intervals: normal%%%
(running avecrci on estimation sample)

Bootstrap replications (100)
  ----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
..................................................     50
..................................................    100

Bootstrap results                        Number of obs    =       203
                                         Replications     =       100
```

	Observed Coef.	Bootstrap Std. Err.	z	P>|z|	Normal-based [95% Conf. Interval]	
Group_1_AVE_INATENCION	.296341	.1607048	1.84	0.065	-.0186347	.6113166
Group_1_sqrtAVE_INATENCION	.5443721	.1470716	3.70	0.000	.2561171	.8326271
Group_1_CR_INATENCION	.7858067	.2170286	3.62	0.000	.3604384	1.211175
Group_1_AVE_HIPERACT	.1835948	.0663856	2.77	0.006	.0534814	.3137083
Group_1_sqrtAVE_HIPERACT	.4284797	.0690126	6.21	0.000	.2932175	.5637418
Group_1_CR_HIPERACT	.6030429	.1307266	4.61	0.000	.3468235	.8592624
Group_1_AVE_ALUMNOS	.4217481	.0572085	7.37	0.000	.3096216	.5338746
Group_1_sqrtAVE_ALUMNOS	.6942214	.0462599	14.04	0.000	.5587537	.7400891
Group_1_CR_ALUMNOS	.8082361	.0479518	16.86	0.000	.7142524	.9022199
Group_1_AVE_FAMILIA	.4425162	.069811	6.34	0.000	.3056893	.5793432
Group_1_sqrtAVE_FAMILIA	.6652189	.0554438	12.00	0.000	.5565511	.7738868
Group_1_CR_FAMILIA	.8240939	.0587798	14.02	0.000	.7088876	.9393002
Group_1_AVE_PROFESOR	.5301302	.0896686	5.91	0.000	.3543829	.7058775
Group_1_sqrtAVE_PROFESOR	.7281004	.0617209	11.80	0.000	.6071296	.8490712
Group_1_CR_PROFESOR	.8691915	.0444834	19.54	0.000	.7820055	.9563774
Group_1_INATENCION_HIPERACT	.3112848	5.43e+10	0.00	1.000	-1.06e+11	1.06e+11
Group_1_INATENCION_ALUMNOS	0	(omitted)				
Group_1_INATENCION_FAMILIA	0	(omitted)				
Group_1_INATENCION_PROFESOR	0	(omitted)				
Group_1_HIPERACT_ALUMNOS	0	(omitted)				
Group_1_HIPERACT_FAMILIA	.5810655	.1205214	4.82	0.000	.344848	.817283
Group_1_HIPERACT_PROFESOR	0	(omitted)				
Group_1_ALUMNOS_FAMILIA	0	(omitted)				
Group_1_ALUMNOS_PROFESOR	.3811549	.1305633	2.92	0.004	.1252555	.6370543
Group_1_FAMILIA_PROFESOR	.4673913	.109814	4.26	0.000	.2521598	.6826227

avecr for Model 2: Multitrait-multimethod model (MTMM)

```
. avecr
file framew.ster saved
  --------------
Number of Groups: 2


_____


Group Variable: sexalumn
sexalumn:
          1 Hombre
          2 Mujer


  --------------
Group Number: 1

%%% Factor loadings %%%
```

AVECR

Table 2: AVECR INDECES SUMMARIZED BY MODEL

Model	AVE*	CR	$\sqrt{AVE}$	INAT.	HYPER.	STUD.	FAM.	TEACH.
Model 1: CFA								
INATTENTION	0.470	0.880	0.685	0.685				
HYPERACTIVITY	0.414	0.851	0.643	0.719	0.643			
Model 2: Corr. Uniq.								
INATTENTION	0.479	0.888	0.692	0.692				
HYPERACTIVITY	0.423	0.867	0.650	0.612	0.650			
Model 3: MTMM**								
INATTENTION	0.296	0.786	0.544	0.544				
HYPERACTIVITY	0.184	0.603	0.428	0.311	0.428			
STUDENTS	0.422	0.808	0.649			0.649		
FAMILY	0.443	0.824	0.665			0.581	0.665	
TEACHERS	0.530	0.869	0.728			0.381	0.467	0.728

*There was a lack of convergent validity on inattention and hyperactivity latent variables.
**MTMM model discriminate better the shared variance between the latent variables.

Figure 11: htmt, ci(all) seed(425)

```
. htmt
file framew.ster saved

         %%% Factor loadings %%%

gfactors[18,5]
                       latent:       latent:       latent:       latent:       latent:
                    INATENCION      HIPERACT       ALUMNOS        FAMILIA       PROFESOR
  observed:inatAlum1   .48583804            0     .54989506             0             0
  observed:inatAlum2   .48083789            0     .54843821             0             0
  observed:inatAlum3   .50151816            0     .48436449             0             0
   observed:inatFam1   .68635685            0             0     .61681285             0
   observed:inatFam2   .67590258            0             0     .61067413             0
   observed:inatFam3   .64718869            0             0     .57518772             0
  observed:inatProf1    .4548988            0             0             0     .81003854
  observed:inatProf2    .4624416            0             0             0     .81758496
  observed:inatProf3   .42513104            0             0             0      .8233302
 observed:hiperAlum1           0    .23900886     .72578856             0             0
 observed:hiperAlum2           0     .1346096     .85137047             0             0
 observed:hiperAlum3           0    .13923064     .66416102             0             0
  observed:hiperFam1           0    .44808687             0     .59908755             0
  observed:hiperFam2           0    .21775011             0     .78633888             0
  observed:hiperFam3           0    .21877495             0     .77048091             0
 observed:hiperProf1           0    .66112265             0             0     .58853672
 observed:hiperProf2           0    .67500901             0             0     .67245719
 observed:hiperProf3           0    .60740726             0             0     .61621981


%%% Heterotrait-Monotrait ratio of correlations (HTMT) %%%

htmt[5,5]
               INATENCION      HIPERACT       ALUMNOS        FAMILIA       PROFESOR
INATENCION             0             0             0             0             0
  HIPERACT     .67701975             0             0             0             0
   ALUMNOS     .77826298     .80510899             0             0             0
   FAMILIA     .83988445     .84308738     .66152435             0             0
  PROFESOR      .7645685     .79037317     .51350816     .60832417             0
```

```
   %%% HTMT Confindence Intervals: all %%%
(running calhtmtci on estimation sample)

Bootstrap replications (100)
    ├─── 1 ───┼─── 2 ───┼─── 3 ───┼─── 4 ───┼─── 5
.................................................       50
.................................................      100

Bootstrap results                          Number of obs      =        203
                                           Replications       =        100
```

	Observed Coef.	Bootstrap Std. Err.	z	P>|z|	Normal-based [95% Conf. Interval]	
r(INATENCION_HIPERACT)	.6770198	.0566021	11.96	0.000	.5660817	.7879578
r(INATENCION_ALUMNOS)	.778263	.040018	19.45	0.000	.6998291	.8566968
r(INATENCION_FAMILIA)	.8398845	.0341433	24.60	0.000	.7729648	.9068041
r(INATENCION_PROFESOR)	.7645685	.0369829	20.67	0.000	.6920833	.8370537
r(HIPERACT_ALUMNOS)	.805109	.045789	17.58	0.000	.7153643	.8948537
r(HIPERACT_FAMILIA)	.8430874	.0388354	21.71	0.000	.7669715	.9192033
r(HIPERACT_PROFESOR)	.7903732	.04313	18.33	0.000	.70584	.8749064
r(ALUMNOS_FAMILIA)	.6615244	.0518783	12.75	0.000	.5598447	.763204
r(ALUMNOS_PROFESOR)	.5135082	.0597051	8.60	0.000	.3964883	.6305281
r(FAMILIA_PROFESOR)	.6083242	.0660273	9.21	0.000	.478913	.7377353

```
Bootstrap results                          Number of obs      =        203
                                           Replications       =        100
```

	Observed Coef.	Bias	Bootstrap Std. Err.	[95% Conf. Interval]	
r(INATENCI~)	.67701975	.0060582	.05660209	.5660817	.7879578	(N)
				.5477567	.7767437	(P)
				.5428485	.762126	(BC)
r(INATENCI~)	.77826298	.0006222	.040018	.6998291	.8566968	(N)
				.7110114	.861037	(P)
				.7159721	.8612623	(BC)
r(INATENCI~)	.83988445	−.0004004	.03414329	.7729648	.9068041	(N)

Figure 12: htmt if sexalumn==2, ci(all) seed(425)

```
%%% Heterotrait-Monotrait ratio of correlations (HTMT) %%%
-------------------------
GROUP analysis by if sexalumn==2
-------------------------


htmt[5,5]
            INATENCION    HIPERACT     ALUMNOS     FAMILIA    PROFESOR
INATENCION           0           0           0           0           0
  HIPERACT   .68066563           0           0           0           0
   ALUMNOS   .72840092   .81355768           0           0           0
   FAMILIA   .83669734   .77564584   .71834944           0           0
  PROFESOR   .71554588   .73165642   .39907633   .41242113           0
```

Table 3: Heterotrait-Monotrait ratio of correlations (HTMT)

FACTOR	INAT.	HYPER.	STUD.	FAM.	TEACH.
INATTENTION					
HYPERACTIVITY	.677				
STUDENTS	.778	.805			
FAMILY	.839	.843	.661		
TEACHERS	.764	.790	.513	.608	

The ADHD-R IV scores are biased by the rating method.

Teacher ratings on ADHD symptoms are more discriminant and less biased than the other methods

Conclusions

avecr and htmt commands asses CFA construct validity

- Convergent validity can be assessed by AVE and CR.
- Discriminant validity can be assessed by AVE vs factor correlation parameters.
- HTMT ratio of correlations assesses discriminant validity.

avecr and htmt commands remarks

- Help files describes options and functionalities.
- Analysis are optimized with mata for matrix algebra operations.
- Confidence intervals are computed by bootstrap method.
- Weight and groups analysis are allowed.

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Thank you!

Assessing convergent and discriminant validity in the ADHD-R IV rating scale:
User-written commands for Average Variance Extracted (AVE), Composite Reliability (CR), and Heterotrait-Monotrait ratio of correlations (HTMT).

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