

Silent and spoken intervals in naming: Descriptives

Athanassios Protopapas

27 January 2023

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```
library(psych)
library(mice)
library(lattice)
require(nlme)
require(multcomp)
```

1 Introduction

In this document we present the variables used in the analyses and their basic descriptive statistics, as well as intercorrelations and graphs displaying them in ways facilitating comparisons in the context of their respective distributions.

2 Read in data

```
tasks <- c("digit", "numword", "word", "dice", "object")
tcols <- c("#D55E00", "#E69F00", "#009E73", "#0180C7", "#884584")
```

```
read.table("read_discrete_serial_data.txt",stringsAsFactors=TRUE) -> rsdw
str(rsdw, list.len=ncol(rsdw))
```

```
## 'data.frame':   298 obs. of  171 variables:
## $ sID           : Factor w/ 298 levels "S1101","S1102",...: 1 2 3 4 5 6 7 8 9 10 ...
## $ grade         : Factor w/ 3 levels "G1","G3","G5": 1 1 1 1 1 1 1 1 1 1 ...
## $ sex           : Factor w/ 2 levels "F","M": 2 2 2 NA 1 1 1 1 2 1 ...
## $ graden        : int   1 1 1 1 1 1 1 1 1 1 ...
## $ agemonths     : int   NA 87 84 NA 83 88 81 81 81 81 ...
## $ wrdacc        : int   74 72 78 NA 60 61 76 62 73 77 ...
## $ pwracc        : int   19 20 22 NA 20 19 29 20 24 22 ...
## $ wflut         : int   24 34 36 NA 31 22 40 20 33 29 ...
## $ pwflu         : int   14 22 24 NA 19 17 21 15 19 16 ...
## $ logwacc       : num   1.921 1.697 2.614 NA 0.909 ...
## $ sqpwacc       : num   0.528 0.641 0.877 NA 0.641 ...
## $ acc.dice      : num   1 1 1 1 1 1 1 1 1 1 ...
## $ RT.dice       : num  1227 1193 1130 1595 1191 ...
## $ onsRT.dice    : num   852 685 641 958 681 ...
## $ artic.dice    : num   359 502 485 621 504 ...
## $ invRT.dice    : num   0.815 0.838 0.885 0.627 0.839 ...
## $ invonsRT.dice : num   1.17 1.46 1.56 1.04 1.47 ...
## $ invartic.dice : num   2.79 1.99 2.06 1.61 1.98 ...
## $ logRT.dice    : num   7.11 7.08 7.03 7.37 7.08 ...
## $ logonsRT.dice : num   6.75 6.53 6.46 6.86 6.52 ...
## $ logartic.dice : num   5.88 6.22 6.18 6.43 6.22 ...
## $ acc.digit     : num   1 1 1 1 1 ...
## $ RT.digit      : num  1197 1068 1139 1257 1081 ...
## $ onsRT.digit   : num   785 572 621 633 572 ...
## $ artic.digit   : num   402 491 514 614 499 ...
## $ invRT.digit   : num   0.835 0.937 0.878 0.796 0.925 ...
## $ invonsRT.digit : num   1.27 1.75 1.61 1.58 1.75 ...
## $ invartic.digit : num   2.48 2.04 1.95 1.63 2.01 ...
## $ logRT.digit   : num   7.09 6.97 7.04 7.14 6.99 ...
## $ logonsRT.digit : num   6.67 6.35 6.43 6.45 6.35 ...
## $ logartic.digit : num   6 6.2 6.24 6.42 6.21 ...
## $ acc.numword   : num   1 0.972 1 1 1 ...
## $ RT.numword    : num  1123 992 1231 1387 1060 ...
## $ onsRT.numword : num   759 608 678 743 597 ...
## $ artic.numword : num   353 377 549 635 456 ...
## $ invRT.numword : num   0.89 1.008 0.813 0.721 0.943 ...
## $ invonsRT.numword : num   1.32 1.65 1.47 1.35 1.67 ...
## $ invartic.numword : num   2.83 2.65 1.82 1.57 2.19 ...
## $ logRT.numword : num   7.02 6.9 7.12 7.23 6.97 ...
## $ logonsRT.numword : num   6.63 6.41 6.52 6.61 6.39 ...
## $ logartic.numword : num   5.87 5.93 6.31 6.45 6.12 ...
## $ acc.object    : num   1 1 1 0.972 0.944 ...
## $ RT.object     : num  1759 1429 1482 1579 1412 ...
## $ onsRT.object  : num  1093 902 886 954 855 ...
## $ artic.object  : num   571 467 575 648 534 ...
## $ invRT.object  : num   0.568 0.7 0.675 0.633 0.708 ...
## $ invonsRT.object : num   0.915 1.109 1.129 1.049 1.17 ...
## $ invartic.object : num   1.75 2.14 1.74 1.54 1.87 ...
## $ logRT.object  : num   7.47 7.27 7.3 7.36 7.25 ...
## $ logonsRT.object : num   7 6.8 6.79 6.86 6.75 ...
```

```

## $ logartic.object : num 6.35 6.15 6.35 6.47 6.28 ...
## $ acc.word : num 0.806 1 1 1 0.944 ...
## $ RT.word : num 2231 1568 1502 2302 1728 ...
## $ onsRT.word : num 1604 737 845 1203 1171 ...
## $ artic.word : num 561 789 637 969 517 ...
## $ invRT.word : num 0.448 0.638 0.666 0.434 0.579 ...
## $ invonsRT.word : num 0.623 1.356 1.183 0.832 0.854 ...
## $ invartic.word : num 1.78 1.27 1.57 1.03 1.94 ...
## $ logRT.word : num 7.71 7.36 7.31 7.74 7.45 ...
## $ logonsRT.word : num 7.38 6.6 6.74 7.09 7.07 ...
## $ logartic.word : num 6.33 6.67 6.46 6.88 6.25 ...
## $ tottim.dice : num 33.5 27 23.8 40.6 36.4 ...
## $ adjtim.dice : num 33.5 26.5 23.7 39.3 36.4 ...
## $ incN.dice : int 0 0 0 0 0 0 1 0 0 0 ...
## $ totcor.dice : int 36 36 36 36 36 36 35 36 36 36 ...
## $ invraw.dice : num 1.075 1.334 1.512 0.886 0.989 ...
## $ invadj.dice : num 1.075 1.36 1.522 0.917 0.989 ...
## $ artN.dice : int 28 7 15 24 26 14 15 35 18 16 ...
## $ arttot.dice : num 21.7 23.5 19.1 26.8 20.4 ...
## $ artNE.dice : int 28 7 15 23 26 14 15 32 18 16 ...
## $ arttotE.dice : num 21.7 23.3 18.9 25.6 20.4 ...
## $ pauN.dice : int 27 6 14 23 25 13 14 34 17 15 ...
## $ pauNE.dice : int 27 5 14 22 25 13 13 31 17 15 ...
## $ pautot.dice : num 10.45 2.25 3.81 12.22 12.07 ...
## $ pautotE.dice : num 10.45 1.96 3.81 12.06 12.07 ...
## $ itmarttE.dice : num 0.602 0.647 0.526 0.71 0.567 ...
## $ logarttE.dice : num -0.508 -0.436 -0.642 -0.342 -0.568 ...
## $ invarttE.dice : num 1.66 1.55 1.9 1.41 1.76 ...
## $ itmpautE.dice : num 0.2902 0.0543 0.1057 0.3351 0.3353 ...
## $ logpautE.dice : num -1.24 -2.91 -2.25 -1.09 -1.09 ...
## $ invpautE.dice : num 3.45 18.4 9.46 2.98 2.98 ...
## $ itmadj.dice : num 0.93 0.735 0.657 1.091 1.011 ...
## $ logadj.dice : num -0.0727 -0.3077 -0.4199 0.0868 0.0109 ...
## $ tottim.digit : num 33.3 22.3 23.7 25.8 21.7 ...
## $ adjtim.digit : num 33.3 21.7 23.1 25.8 21.7 ...
## $ incN.digit : int 0 0 0 0 0 0 0 0 NA 1 ...
## $ totcor.digit : int 36 36 36 36 36 36 36 36 NA 35 ...
## $ invraw.digit : num 1.08 1.62 1.52 1.39 1.66 ...
## $ invadj.digit : num 1.08 1.66 1.56 1.39 1.66 ...
## $ artN.digit : int 26 5 9 12 13 12 10 24 NA 9 ...
## $ arttot.digit : num 22.8 18.8 20 19.1 16.7 ...
## $ artNE.digit : int 26 5 9 12 13 12 10 24 NA 8 ...
## $ arttotE.digit : num 22.8 18.3 19.5 19.1 16.7 ...
## $ pauN.digit : int 25 4 8 11 12 11 9 23 NA 8 ...
## $ pauNE.digit : int 25 4 8 11 12 11 9 23 NA 7 ...
## $ pautot.digit : num 8.77 1.95 2.7 5.89 3.72 ...
## $ pautotE.digit : num 8.77 1.95 2.7 5.89 3.72 ...
## $ itmarttE.digit : num 0.634 0.508 0.54 0.532 0.465 ...
## $ logarttE.digit : num -0.456 -0.678 -0.615 -0.632 -0.767 ...
## $ invarttE.digit : num 1.58 1.97 1.85 1.88 2.15 ...
## $ itmpautE.digit : num 0.244 0.054 0.075 0.164 0.103 ...
## $ logpautE.digit : num -1.41 -2.92 -2.59 -1.81 -2.27 ...
## $ invpautE.digit : num 4.1 18.51 13.34 6.12 9.67 ...
## $ itmadj.digit : num 0.925 0.603 0.642 0.718 0.603 ...

```

```

## $ logadj.digit : num -0.0784 -0.5065 -0.4426 -0.3315 -0.5059 ...
## $ tottim.numword : num 37.8 27.5 23.2 29.2 24.4 ...
## $ adjtim.numword : num 34 27.5 23.2 29.2 24.4 ...
## $ incN.numword : int 0 0 0 0 0 0 0 0 0 0 ...
## $ totcor.numword : int 36 36 36 36 36 36 36 36 36 36 ...
## $ invraw.numword : num 0.952 1.307 1.552 1.232 1.473 ...
## $ invadj.numword : num 1.06 1.31 1.55 1.23 1.47 ...
## $ artN.numword : int 28 10 12 18 22 11 14 25 5 16 ...
## $ arttot.numword : num 24.7 23.5 18.9 23.4 18.5 ...
## $ artNE.numword : int 24 10 12 18 22 10 14 25 5 16 ...
## $ arttotE.numword : num 22.6 23.5 18.9 23.4 18.5 ...
## $ pauN.numword : int 27 9 11 17 21 10 13 24 4 15 ...
## $ pauNE.numword : int 23 9 11 17 21 9 13 24 4 15 ...
## $ pautot.numword : num 11.41 2.98 3.41 4.87 5.09 ...
## $ pautotE.numword : num 9.62 2.98 3.41 4.87 5.09 ...
## $ itmarttE.numword : num 0.629 0.653 0.525 0.65 0.513 ...
## $ logarttE.numword : num -0.464 -0.426 -0.643 -0.431 -0.667 ...
## $ invarttE.numword : num 1.59 1.53 1.9 1.54 1.95 ...
## $ itmpautE.numword : num 0.2671 0.0828 0.0948 0.1352 0.1414 ...
## $ logpautE.numword : num -1.32 -2.49 -2.36 -2 -1.96 ...
## $ invpautE.numword : num 3.74 12.08 10.55 7.4 7.07 ...
## $ itmadj.numword : num 0.944 0.765 0.645 0.811 0.679 ...
## $ logadj.numword : num -0.0572 -0.2676 -0.4392 -0.209 -0.3876 ...
## $ tottim.object : num 63.8 58.7 59.9 41 53.2 ...
## $ adjtim.object : num 52.2 57.7 58.4 39.6 48.4 ...
## $ incN.object : int 0 0 0 0 1 7 1 1 0 1 ...
## $ totcor.object : int 36 36 36 36 35 29 35 35 36 35 ...
## $ invraw.object : num 0.564 0.613 0.601 0.878 0.677 ...
## $ invadj.object : num 0.69 0.624 0.616 0.908 0.723 ...
## $ artN.object : int 36 18 27 18 28 26 36 29 28 29 ...
## $ arttot.object : num 25.4 31.8 26.8 30 23.7 ...
## $ artNE.object : int 33 18 26 17 24 18 32 29 26 21 ...
## $ arttotE.object : num 24.8 31 26.1 29 21.8 ...
## $ pauN.object : int 35 17 26 17 27 25 35 28 27 28 ...
## $ pauNE.object : int 32 16 25 16 23 15 30 28 25 19 ...
## $ pautot.object : num 36.82 25.14 31.89 9.65 28.2 ...
## $ pautotE.object : num 25.79 24.9 31.02 9.27 25.36 ...
## $ itmarttE.object : num 0.689 0.86 0.726 0.807 0.622 ...
## $ logarttE.object : num -0.372 -0.151 -0.321 -0.215 -0.475 ...
## $ invarttE.object : num 1.45 1.16 1.38 1.24 1.61 ...
## $ itmpautE.object : num 0.716 0.692 0.862 0.257 0.724 ...
## $ logpautE.object : num -0.333 -0.369 -0.149 -1.357 -0.322 ...
## $ invpautE.object : num 1.4 1.45 1.16 3.89 1.38 ...
## $ itmadj.object : num 1.45 1.6 1.62 1.1 1.38 ...
## $ logadj.object : num 0.3714 0.4717 0.4837 0.0964 0.3242 ...
## $ tottim.word : num 97.7 53.2 36.6 50.9 58.1 ...
## $ adjtim.word : num 59.4 46 33.8 45.4 46.4 ...
## $ incN.word : int 9 2 2 1 2 9 1 3 2 3 ...
## $ totcor.word : int 27 34 34 35 34 27 35 33 34 33 ...
## $ invraw.word : num 0.368 0.677 0.985 0.707 0.62 ...
## $ invadj.word : num 0.455 0.738 1.007 0.771 0.733 ...
## $ artN.word : int 67 29 18 36 41 47 33 42 32 34 ...
## $ arttot.word : num 49.6 40.2 28.5 37.2 30.8 ...
## $ artNE.word : int 40 26 18 32 34 33 31 36 27 28 ...

```

```

## $ arttotE.word      : num  30.8 35 26.1 34 25.2 ...
## $ pauN.word         : int   66 28 17 35 40 46 32 41 31 33 ...
## $ pauNE.word        : int   38 23 16 31 32 29 30 35 26 25 ...
## $ pautotE.word      : num   45.97 11.53 6.67 11.96 25.72 ...
## $ pautotE.word      : num   26.42 9.66 6.23 9.69 19.66 ...
## $ itmarttE.word     : num   1.141 1.028 0.769 0.972 0.742 ...
## $ logarttE.word     : num   0.1318 0.0281 -0.2628 -0.028 -0.2987 ...
## $ invarttE.word     : num   0.876 0.972 1.301 1.028 1.348 ...
## $ itmpautE.word     : num   0.978 0.284 0.183 0.277 0.578 ...
## $ logpautE.word     : num  -0.0218 -1.2584 -1.6967 -1.2838 -0.5476 ...
## $ invpautE.word     : num   1.02 3.52 5.46 3.61 1.73 ...
## $ itmdadj.word      : num   2.198 1.354 0.993 1.297 1.365 ...
## $ logadj.word       : num   0.7877 0.30326 -0.00685 0.26036 0.31128 ...

```

3 Description of variables

The data set contains the following variables:

A. Demographics

sID : Participant ID

grade : Grade (G1, G3, or G5)

sex : Sex (F or M)

graden : Grade as a number (1, 3, 5)

agemonths : Age in months

B. Reading tests

wrddacc : Word reading accuracy (number of correct words out of X)

pwrddacc : Pseudoword reading accuracy (number of correct pseudowords out of X)

wflut : Word list reading fluency (words correct per minute, including correct stress)

pwflu : Pseudoword list reading fluency (pseudowords correct per minute, ignoring stress)

logwacc : Log-transformed word reading accuracy

sqpwacc : Square-root-transformed word reading accuracy

C. Discrete naming

acc. : Proportion of correct items (out of 36)

RT. : Geometric mean of total response time over correct items (ms) (includes onset latency and articulation)

onsRT. : Geometric mean of onset latency over correct items (ms)

artic. : Geometric mean of articulation time over correct items (ms)

invRT. : Inverse-transformed total response time of correct items (rate; items per second)

invonsRT. : Inverse-transformed onset latency of correct items (rate; items per second)

invartic. : Inverse-transformed articulation time of correct items (rate; items per second)

logRT. : Log-transformed total response time of correct items

logonsRT. : Log-transformed onset latency of correct items

logartic. : Log-transformed articulation time of correct items

These four metrics apply for the following five types of content:

- **dice** : Dice faces (2, 3, 5, 6)
- **digit** : Digits (2, 3, 5, 6)
- **numword** : Number words (the words two, three, five, six in Greek: δύο, τρία, πέντε, έξι)
- **object** : Pictures of clock(time), ship, ball, gun (in Greek: ρολόι, πλοίο, μπάλα, όπλο)
- **word** : Familiar two-syllable words

D. Serial naming

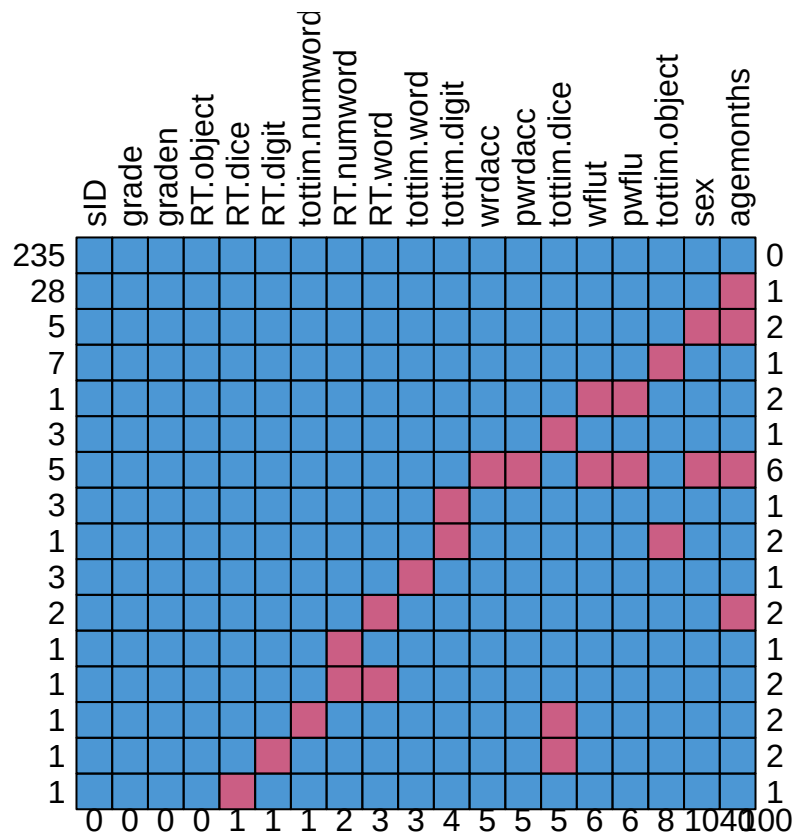
`tottim.` : Total response time, from display onset to articulation offset of the last item, in seconds.
`adjtim.` : Adjusted time, that is, total time minus intervals removed due to errors
`incN.` : Number of incorrect items, out of 36
`totcor.` : Number of correct items, out of 36
`invraw.` : Inverse-transformed total time, i.e., response rate as items per second, ignoring errors
`invadj.` : Inverse-transformed adjusted time, interpretable as response rate for correct items
`artN.` : Number of articulation (spoken) intervals
`artNE.` : Adjusted number of articulation intervals, after removing error intervals
`arttot.` : Total duration of articulation intervals, in seconds (including errors)
`arttotE.` : Adjusted total duration of articulation intervals, after removing error intervals
`pauN.` : Number of pause (silent) intervals
`pauNE.` : Adjusted number of silent intervals, after removing pauses preceding errors
`pautot.` : Total duration of silent intervals, in seconds
`pautotE.` : Adjusted total duration of silent intervals, after removing pauses preceding errors
`itmarttE.` : Mean duration of adjusted articulation interval per correct item ($\text{arttotE}/\text{totcor}$)
`logarttE.` : Log-transformed adjusted articulation duration per correct item, $\log(\text{itmarttE})$
`invarttE.` : Inverse-transformed adjusted articulation duration per correct item ($\text{totcor}/\text{arttotE}$)
`itmpautE.` : Mean duration of adjusted pause interval per correct item ($\text{pautotE}/\text{totcor}$)
`logpautE.` : Log-transformed adjusted pause duration per correct item, $\log(\text{itmpautE})$
`invpautE.` : Inverse-transformed adjusted pause duration per correct item ($\text{totcor}/\text{pautotE}$)
`itmadj.` : Mean adjusted time per correct item ($\text{adjtim}/\text{totcor}$); includes both silent and speech intervals (excluding errors)
`logadj.` : Log-transformed adjusted time per correct item, $\log(\text{itmadj})$

These metrics apply for the same five types of content as defined above (the only difference being a different set of 36 familiar two-syllable words).

4 Missing data report

Because many different variables are produced by each task, we restrict the analysis to one variable per task to reduce clutter in the graph. Because all variables are derived from the same trials, this accurately represents missing values across variables.

```
dvar <- grep("^RT\\.", names(rsdw))
svar <- grep("^tottim\\.", names(rsdw))
md.pattern(rsdw[,c(1:9, dvar, svar)], rotate.names=T)
```



##	sID	grade	graden	RT.object	RT.dice	RT.digit	tottim.numword	RT.numword	RT.word	tottim.word
## 235	1	1	1	1	1	1		1	1	1
## 28	1	1	1	1	1	1		1	1	1
## 5	1	1	1	1	1	1		1	1	1
## 7	1	1	1	1	1	1		1	1	1
## 1	1	1	1	1	1	1		1	1	1
## 3	1	1	1	1	1	1		1	1	1
## 5	1	1	1	1	1	1		1	1	1
## 3	1	1	1	1	1	1		1	1	1
## 1	1	1	1	1	1	1		1	1	1
## 3	1	1	1	1	1	1		1	1	0
## 2	1	1	1	1	1	1		1	0	1
## 1	1	1	1	1	1	1		1	0	1
## 1	1	1	1	1	1	1		1	0	1
## 1	1	1	1	1	1	1		0	1	1
## 1	1	1	1	1	1	0		1	1	1
## 1	1	1	1	1	0	1		1	1	1
##	0	0	0	0	1	1		1	2	3

##	tottim.digit	wrdacc	pwracc	tottim.dice	wflut	pwflu	tottim.object	sex	agemonths
## 235	1	1	1		1	1	1	1	0
## 28	1	1	1		1	1	1	1	1
## 5	1	1	1		1	1	1	0	2
## 7	1	1	1		1	1	1	0	1
## 1	1	1	1		1	0	0	1	2
## 3	1	1	1		0	1	1	1	1
## 5	1	0	0		1	0	0	1	6

```
## 3      0      1      1      1      1      1      1      1      1      1
## 1      0      1      1      1      1      1      0      1      1      2
## 3      1      1      1      1      1      1      1      1      1      1
## 2      1      1      1      1      1      1      1      1      0      2
## 1      1      1      1      1      1      1      1      1      1      1
## 1      1      1      1      1      1      1      1      1      1      2
## 1      1      1      1      0      1      1      1      1      1      2
## 1      1      1      1      0      1      1      1      1      1      2
## 1      1      1      1      1      1      1      1      1      1      1
##      4      5      5      5      6      6      8     10     40    100
```

5 Descriptive statistics of all variables per grade

```
desclist <- describeBy(rsdw,rsdw$grade)
for (grd in levels(rsdw$grade)) {
  cat(paste("\n\n#####\nDescriptives for grade",grd))
  print(desclist[[grd]][,-c(1,6,7,10,13)])
}
```

```
##
##
## #####
## Descriptives for grade G1
## =====
##      n      mean      sd  median      min      max  skew  kurtosis
## sID*      99    50.00  28.72   50.00     1.00    99.00  0.00   -1.24
## grade*     99     1.00   0.00     1.00     1.00     1.00  NaN    NaN
## sex*       97     1.45   0.50     1.00     1.00     2.00  0.18   -1.99
## graden     99     1.00   0.00     1.00     1.00     1.00  NaN    NaN
## agemonths  81    82.74   3.39   83.00    77.00    89.00  0.07   -1.09
## wrdacc     97    69.36   7.09   71.00    46.00    80.00 -0.92    0.60
## pwracc     97    23.60   4.74   23.00    15.00    37.00  0.65    0.24
## wflut      97    30.71  10.25   30.00    11.00    62.00  0.91    1.27
## pwflu      97    18.14   5.18   18.00     6.00    34.00  0.23    0.43
## logwacc    97     1.63   0.60     1.60     0.42     3.31  0.42   -0.14
## sqpwacc    97     1.14   0.69     1.00     0.10     3.59  1.34    2.31
## acc.dice   99     0.99   0.02     1.00     0.89     1.00 -2.11    4.12
## RT.dice    99  1324.84  289.32 1266.22  841.08  2541.52  1.41    2.69
## onsRT.dice 99   845.14  198.47  806.61  550.00  1594.23  1.36    2.22
## artic.dice 99   461.66  127.62  442.88  246.09   872.32  0.92    0.89
## invRT.dice 99     0.79   0.15     0.79     0.39     1.19 -0.11    0.01
## invonsRT.dice 99    1.24   0.25     1.24     0.63     1.82 -0.18   -0.42
## invartic.dice 99    2.32   0.61     2.26     1.15     4.06  0.56    0.16
## logRT.dice 99    7.17   0.20     7.14     6.73     7.84  0.72    0.65
## logonsRT.dice 99    6.72   0.21     6.69     6.31     7.37  0.72    0.32
## logartic.dice 99    6.10   0.27     6.09     5.51     6.77  0.16   -0.13
## acc.digit  99     0.99   0.02     1.00     0.86     1.00 -5.22   33.54
## RT.digit   99  1159.76  211.90 1138.58  754.36  1989.37  1.04    2.05
## onsRT.digit 99   683.85  129.96  658.58  481.97  1179.40  1.36    2.45
## artic.digit 99   463.50  119.91  462.26  231.48   983.05  0.85    2.12
## invRT.digit 99     0.89   0.15     0.88     0.50     1.33  0.22    0.16
## invonsRT.digit 99    1.51   0.25     1.52     0.85     2.07 -0.19   -0.01
## invartic.digit 99    2.30   0.60     2.16     1.02     4.32  0.76    0.39
```

## logRT.digit	99	7.04	0.17	7.04	6.63	7.60	0.36	0.49
## logonsRT.digit	99	6.51	0.18	6.49	6.18	7.07	0.75	0.76
## logartic.digit	99	6.11	0.26	6.14	5.44	6.89	-0.07	-0.03
## acc.numword	98	0.99	0.02	1.00	0.89	1.00	-3.46	13.16
## RT.numword	98	1217.34	254.83	1172.02	809.63	2475.08	1.52	4.64
## onsRT.numword	98	722.09	164.20	697.21	489.45	1547.68	1.84	5.49
## artic.numword	98	484.39	135.95	469.66	247.95	901.13	0.71	0.61
## invRT.numword	98	0.85	0.16	0.85	0.40	1.24	-0.03	-0.22
## invonsRT.numword	98	1.44	0.27	1.43	0.65	2.04	-0.30	-0.17
## invartic.numword	98	2.23	0.64	2.13	1.11	4.03	0.77	0.20
## logRT.numword	98	7.09	0.19	7.07	6.70	7.81	0.63	0.83
## logonsRT.numword	98	6.56	0.20	6.55	6.19	7.34	0.93	1.30
## logartic.numword	98	6.14	0.28	6.15	5.51	6.80	-0.07	-0.24
## acc.object	99	0.98	0.03	1.00	0.86	1.00	-1.51	2.12
## RT.object	99	1551.64	230.95	1545.81	1033.68	2205.96	0.26	-0.04
## onsRT.object	99	1012.84	165.25	970.59	727.52	1572.60	0.55	-0.08
## artic.object	99	496.12	128.25	483.09	244.66	886.73	0.72	0.65
## invRT.object	99	0.66	0.10	0.65	0.45	0.97	0.61	0.49
## invonsRT.object	99	1.01	0.16	1.03	0.64	1.37	0.06	-0.90
## invartic.object	99	2.15	0.56	2.07	1.13	4.09	0.80	0.74
## logRT.object	99	7.34	0.15	7.34	6.94	7.70	-0.16	-0.06
## logonsRT.object	99	6.91	0.16	6.88	6.59	7.36	0.22	-0.72
## logartic.object	99	6.17	0.26	6.18	5.50	6.79	-0.04	-0.04
## acc.word	96	0.95	0.06	0.97	0.75	1.00	-1.43	1.58
## RT.word	96	1837.85	508.89	1724.88	1063.58	3481.27	1.08	1.03
## onsRT.word	96	1109.62	349.83	1025.64	600.01	2265.61	1.08	0.95
## artic.word	96	682.32	203.04	625.90	374.14	1580.40	1.40	3.01
## invRT.word	96	0.58	0.14	0.58	0.29	0.94	0.13	-0.51
## invonsRT.word	96	0.98	0.27	0.98	0.44	1.67	0.17	-0.69
## invartic.word	96	1.58	0.41	1.60	0.63	2.67	0.17	-0.36
## logRT.word	96	7.48	0.26	7.45	6.97	8.16	0.44	-0.28
## logonsRT.word	96	6.97	0.29	6.93	6.40	7.73	0.41	-0.44
## logartic.word	96	6.49	0.27	6.44	5.92	7.37	0.50	0.07
## tottim.dice	97	33.63	8.74	32.12	20.40	64.47	1.18	1.51
## adjtim.dice	97	31.76	7.29	30.64	20.05	59.46	1.11	1.61
## incN.dice	97	0.25	0.52	0.00	0.00	2.00	1.98	3.04
## totcor.dice	97	35.75	0.52	36.00	34.00	36.00	-1.98	3.04
## invraw.dice	97	1.13	0.26	1.12	0.56	1.76	0.13	-0.30
## invadj.dice	97	1.18	0.25	1.16	0.61	1.80	0.18	-0.27
## artN.dice	97	25.39	8.40	26.00	7.00	44.00	-0.04	-0.58
## arttot.dice	97	21.03	3.77	20.03	14.18	34.99	1.10	1.97
## artNE.dice	97	24.12	7.67	24.00	7.00	41.00	-0.09	-0.58
## arttotE.dice	97	20.16	3.29	19.72	13.93	30.95	0.92	1.41
## pauN.dice	97	24.39	8.40	25.00	6.00	43.00	-0.04	-0.58
## pauNE.dice	97	22.74	7.75	23.00	5.00	39.00	-0.10	-0.58
## pautot.dice	97	10.95	6.17	9.80	2.05	32.65	1.13	1.25
## pautotE.dice	97	9.93	5.46	8.75	1.84	28.83	1.28	1.97
## itmarttE.dice	97	0.56	0.09	0.55	0.39	0.86	0.86	1.31
## logarttE.dice	97	-0.59	0.16	-0.59	-0.95	-0.15	0.30	0.30
## invarttE.dice	97	1.82	0.28	1.81	1.16	2.58	0.21	0.06
## itmpautE.dice	97	0.28	0.15	0.25	0.05	0.82	1.28	2.03
## logpautE.dice	97	-1.43	0.56	-1.40	-2.98	-0.19	-0.39	0.24
## invpautE.dice	97	4.93	3.37	4.04	1.21	19.61	2.28	6.22
## itmadj.dice	97	0.89	0.21	0.86	0.56	1.65	1.08	1.53

## logadj.dice	97	-0.14	0.22	-0.15	-0.59	0.50	0.40	0.06
## tottim.digit	96	27.34	5.89	26.10	17.00	48.27	0.92	0.91
## adjtim.digit	96	26.62	5.25	25.89	17.00	43.02	0.78	0.42
## incN.digit	96	0.05	0.27	0.00	0.00	2.00	5.48	31.81
## totcor.digit	96	35.95	0.27	36.00	34.00	36.00	-5.48	31.81
## invraw.digit	96	1.37	0.27	1.38	0.75	2.12	0.11	-0.45
## invadj.digit	96	1.40	0.26	1.39	0.84	2.12	0.13	-0.43
## artN.digit	96	21.16	8.54	21.00	4.00	41.00	0.25	-0.73
## arttot.digit	96	18.74	2.93	18.18	13.64	27.09	0.72	0.20
## artNE.digit	96	20.56	8.32	20.00	4.00	41.00	0.26	-0.70
## arttotE.digit	96	18.42	2.69	17.84	13.02	24.76	0.47	-0.40
## pauN.digit	96	20.16	8.54	20.00	3.00	40.00	0.25	-0.73
## pauNE.digit	96	19.43	8.33	19.00	3.00	40.00	0.27	-0.70
## pautot.digit	96	7.44	4.27	6.15	1.63	21.03	0.87	0.21
## pautotE.digit	96	7.04	3.89	5.96	1.63	18.52	0.80	0.05
## itmarttE.digit	96	0.51	0.07	0.50	0.36	0.69	0.45	-0.42
## logarttE.digit	96	-0.68	0.14	-0.70	-1.02	-0.37	0.13	-0.47
## invarttE.digit	96	1.99	0.29	2.02	1.45	2.76	0.22	-0.25
## itmpautE.digit	96	0.20	0.11	0.17	0.05	0.51	0.79	0.03
## logpautE.digit	96	-1.79	0.58	-1.80	-3.09	-0.66	-0.19	-0.80
## invpautE.digit	96	7.08	4.37	6.04	1.94	22.06	1.28	1.20
## itmadj.digit	96	0.74	0.15	0.72	0.47	1.20	0.77	0.37
## logadj.digit	96	-0.32	0.19	-0.33	-0.75	0.18	0.31	-0.38
## tottim.numword	98	30.95	8.61	28.39	17.12	68.42	1.35	2.49
## adjtim.numword	98	30.22	7.53	28.28	17.12	58.42	1.07	1.18
## incN.numword	98	0.01	0.10	0.00	0.00	1.00	9.60	91.06
## totcor.numword	98	35.99	0.10	36.00	35.00	36.00	-9.60	91.06
## invraw.numword	98	1.24	0.30	1.27	0.53	2.10	0.13	-0.04
## invadj.numword	98	1.26	0.28	1.27	0.62	2.10	0.23	0.03
## artN.numword	98	24.26	8.73	25.00	5.00	44.00	0.09	-0.68
## arttot.numword	98	20.77	3.74	20.20	13.79	32.13	0.64	0.27
## artNE.numword	98	23.73	8.36	24.50	5.00	44.00	0.05	-0.63
## arttotE.numword	98	20.43	3.40	20.20	13.79	30.19	0.49	0.08
## pauN.numword	98	23.26	8.73	24.00	4.00	43.00	0.09	-0.68
## pauNE.numword	98	22.66	8.34	23.00	4.00	43.00	0.06	-0.63
## pautot.numword	98	8.94	5.87	7.06	1.41	34.69	1.44	2.68
## pautotE.numword	98	8.54	5.24	7.06	1.41	27.97	1.14	1.07
## itmarttE.numword	98	0.57	0.09	0.56	0.38	0.84	0.48	0.08
## logarttE.numword	98	-0.58	0.16	-0.58	-0.96	-0.18	0.05	-0.32
## invarttE.numword	98	1.81	0.30	1.78	1.19	2.61	0.36	-0.25
## itmpautE.numword	98	0.24	0.15	0.20	0.04	0.78	1.14	1.07
## logpautE.numword	98	-1.62	0.62	-1.63	-3.24	-0.25	-0.13	-0.55
## invpautE.numword	98	6.13	4.13	5.10	1.29	25.48	1.74	4.16
## itmadj.numword	98	0.84	0.21	0.79	0.48	1.62	1.07	1.16
## logadj.numword	98	-0.20	0.24	-0.24	-0.74	0.48	0.42	-0.03
## tottim.object	98	51.08	10.73	51.05	32.79	85.93	0.47	0.03
## adjtim.object	98	44.87	8.62	43.60	27.65	74.97	0.54	0.34
## incN.object	98	0.88	1.39	0.00	0.00	7.00	2.57	7.44
## totcor.object	98	35.12	1.39	36.00	29.00	36.00	-2.57	7.44
## invraw.object	98	0.74	0.15	0.71	0.42	1.10	0.41	-0.69
## invadj.object	98	0.81	0.16	0.80	0.47	1.19	0.30	-0.32
## artN.object	98	32.10	6.05	32.00	18.00	51.00	0.07	0.50
## arttot.object	98	24.92	3.93	24.97	16.49	34.09	0.23	-0.70
## artNE.object	98	28.52	5.83	29.00	9.00	41.00	-0.34	0.28

```

## arttotE.object 98 22.67 3.39 22.12 14.41 32.74 0.52 0.29
## pauN.object 98 31.12 6.04 31.00 17.00 50.00 0.06 0.52
## pauNE.object 98 26.90 6.00 27.00 8.00 40.00 -0.25 0.01
## payout.object 98 24.48 9.71 24.83 8.68 55.52 0.54 0.04
## payoutE.object 98 20.53 8.39 19.55 6.79 54.17 0.78 1.16
## itmarttE.object 98 0.65 0.09 0.65 0.41 0.91 0.43 0.28
## logarttE.object 98 -0.45 0.15 -0.43 -0.89 -0.09 -0.02 0.10
## invarttE.object 98 1.58 0.23 1.54 1.10 2.43 0.50 0.65
## itmpautE.object 98 0.59 0.25 0.55 0.19 1.55 0.86 1.13
## logpautE.object 98 -0.62 0.43 -0.59 -1.66 0.44 -0.20 -0.54
## invpautE.object 98 2.04 0.92 1.81 0.65 5.27 1.10 0.85
## itmadj.object 98 1.28 0.26 1.25 0.84 2.14 0.73 0.56
## logadj.object 98 0.23 0.20 0.23 -0.17 0.76 0.19 -0.24
## tottim.word 99 64.39 29.49 58.06 26.08 175.94 1.34 1.74
## adjtim.word 99 51.12 18.42 46.42 24.68 110.76 0.98 0.51
## incN.word 99 2.83 2.30 2.00 0.00 12.00 1.55 2.85
## totcor.word 99 33.17 2.30 34.00 24.00 36.00 -1.55 2.85
## invraw.word 99 0.66 0.26 0.62 0.20 1.38 0.52 -0.35
## invadj.word 99 0.73 0.26 0.72 0.30 1.38 0.39 -0.58
## artN.word 99 39.90 10.95 40.00 14.00 69.00 0.07 0.66
## arttot.word 99 33.49 10.28 30.33 17.48 68.98 0.94 0.48
## artNE.word 99 32.69 7.23 34.00 13.00 57.00 -0.39 1.20
## arttotE.word 99 26.72 5.98 25.66 15.44 43.95 0.68 0.10
## pauN.word 99 38.90 10.95 39.00 13.00 68.00 0.07 0.66
## pauNE.word 99 31.31 7.33 33.00 12.00 56.00 -0.31 0.96
## payout.word 99 29.48 21.64 23.87 4.71 108.38 1.51 2.01
## payoutE.word 99 22.92 14.83 19.49 4.51 69.88 1.24 1.14
## itmarttE.word 99 0.81 0.19 0.77 0.49 1.26 0.59 -0.42
## logarttE.word 99 -0.24 0.23 -0.26 -0.72 0.23 0.16 -0.72
## invarttE.word 99 1.30 0.30 1.30 0.79 2.06 0.29 -0.53
## itmpautE.word 99 0.70 0.48 0.59 0.13 2.18 1.28 1.09
## logpautE.word 99 -0.56 0.66 -0.53 -2.08 0.78 0.00 -0.66
## invpautE.word 99 2.17 1.47 1.71 0.46 7.98 1.40 1.98
## itmadj.word 99 1.56 0.60 1.39 0.73 3.39 0.99 0.39
## logadj.word 99 0.38 0.37 0.33 -0.32 1.22 0.29 -0.66
##
##
## #####
## Descriptives for grade G3
## =====
##          n      mean      sd  median    min      max  skew kurtosis
## sID*      102  150.50  29.59  150.50 100.00  201.00  0.00  -1.24
## grade*    102   2.00   0.00   2.00   2.00   2.00   NaN   NaN
## sex*      95   1.44   0.50   1.00   1.00   2.00  0.23  -1.97
## graden    102   3.00   0.00   3.00   3.00   3.00   NaN   NaN
## agemonths  84  107.18   3.58  107.00 100.00  114.00 -0.02  -1.08
## wrdacc    99   75.19   4.91   77.00  55.00   80.00 -1.72   3.38
## pwrdacc   99   28.47   7.37   30.00  14.00   38.00 -0.20  -1.43
## wflut     98   55.79  11.57  55.50  27.00   84.00 -0.12  -0.08
## pwflu     98   28.74   6.67   29.00  14.00   49.00  0.17  -0.04
## logwacc   99   2.30   0.66   2.39   0.70   3.31 -0.18  -0.67
## sqpwacc   99   2.01   1.25   2.00   0.00   4.00  0.15  -1.43
## acc.dice  102   0.99   0.02   1.00   0.92   1.00 -1.89   3.30
## RT.dice   102 1045.51 180.52 1025.79 697.57 1661.44  0.74   0.90

```

## onsRT.dice	102	652.67	129.03	647.06	369.85	1179.88	0.93	2.49
## artic.dice	102	384.46	91.05	369.03	224.61	655.15	0.78	0.23
## invRT.dice	102	0.98	0.16	0.97	0.60	1.43	0.32	0.08
## invonsRT.dice	102	1.59	0.31	1.55	0.85	2.70	0.78	1.47
## invartic.dice	102	2.74	0.61	2.71	1.53	4.45	0.23	-0.46
## logRT.dice	102	6.94	0.17	6.93	6.55	7.42	0.19	0.09
## logonsRT.dice	102	6.46	0.19	6.47	5.91	7.07	0.03	0.88
## logartic.dice	102	5.93	0.23	5.91	5.41	6.48	0.27	-0.48
## acc.digit	101	0.99	0.02	1.00	0.83	1.00	-5.79	35.01
## RT.digit	101	915.25	138.40	914.89	609.18	1338.66	0.83	1.48
## onsRT.digit	101	531.39	81.69	521.93	307.61	816.86	0.40	0.99
## artic.digit	101	377.68	88.52	366.59	214.02	659.86	0.83	0.96
## invRT.digit	101	1.12	0.16	1.09	0.75	1.64	0.36	0.79
## invonsRT.digit	101	1.93	0.31	1.92	1.22	3.25	1.06	2.91
## invartic.digit	101	2.79	0.63	2.73	1.52	4.67	0.51	0.12
## logRT.digit	101	6.81	0.15	6.82	6.41	7.20	0.23	0.73
## logonsRT.digit	101	6.26	0.16	6.26	5.73	6.71	-0.28	1.16
## logartic.digit	101	5.91	0.23	5.90	5.37	6.49	0.13	-0.05
## acc.numword	101	1.00	0.02	1.00	0.89	1.00	-4.17	18.48
## RT.numword	101	906.30	146.51	894.06	586.09	1486.87	1.03	2.36
## onsRT.numword	101	518.69	76.33	512.68	319.75	711.61	0.34	0.33
## artic.numword	101	382.66	93.92	368.75	232.92	766.02	1.21	2.23
## invRT.numword	101	1.13	0.17	1.12	0.67	1.71	0.30	0.79
## invonsRT.numword	101	1.97	0.30	1.95	1.41	3.13	0.92	2.61
## invartic.numword	101	2.75	0.61	2.71	1.31	4.29	0.23	-0.17
## logRT.numword	101	6.80	0.16	6.80	6.37	7.30	0.34	0.93
## logonsRT.numword	101	6.24	0.15	6.24	5.77	6.57	-0.22	0.84
## logartic.numword	101	5.92	0.23	5.91	5.45	6.64	0.42	0.21
## acc.object	102	0.98	0.02	1.00	0.86	1.00	-1.90	4.76
## RT.object	102	1178.29	181.25	1141.37	818.80	1681.51	0.66	0.10
## onsRT.object	102	758.62	129.71	749.65	482.61	1227.14	0.83	1.29
## artic.object	102	402.04	98.83	381.84	212.33	806.32	1.03	1.74
## invRT.object	102	0.87	0.13	0.88	0.59	1.22	0.14	-0.02
## invonsRT.object	102	1.35	0.22	1.33	0.81	2.07	0.37	0.55
## invartic.object	102	2.63	0.61	2.62	1.24	4.71	0.50	0.57
## logRT.object	102	7.06	0.15	7.04	6.71	7.43	0.27	-0.17
## logonsRT.object	102	6.62	0.17	6.62	6.18	7.11	0.22	0.44
## logartic.object	102	5.97	0.24	5.94	5.36	6.69	0.24	0.15
## acc.word	102	0.98	0.03	1.00	0.83	1.00	-2.49	6.94
## RT.word	102	1100.13	237.58	1054.70	713.57	2008.78	1.46	2.81
## onsRT.word	102	622.04	167.01	584.42	366.61	1356.41	2.05	5.47
## artic.word	102	467.37	105.81	456.60	264.46	943.72	1.13	2.88
## invRT.word	102	0.94	0.18	0.95	0.50	1.40	-0.10	0.12
## invonsRT.word	102	1.70	0.36	1.71	0.74	2.73	-0.11	0.66
## invartic.word	102	2.24	0.48	2.19	1.06	3.78	0.41	0.16
## logRT.word	102	6.98	0.20	6.96	6.57	7.61	0.75	0.85
## logonsRT.word	102	6.40	0.23	6.37	5.90	7.21	1.03	1.86
## logartic.word	102	6.12	0.22	6.12	5.58	6.85	0.26	0.33
## tottim.dice	99	24.25	5.33	23.07	15.76	44.10	1.06	1.15
## adjtim.dice	99	23.45	4.51	22.52	15.76	38.95	0.88	0.65
## incN.dice	99	0.13	0.37	0.00	0.00	2.00	2.74	7.15
## totcor.dice	99	35.87	0.37	36.00	34.00	36.00	-2.74	7.15
## invraw.dice	99	1.55	0.31	1.56	0.82	2.28	0.01	-0.39
## invadj.dice	99	1.58	0.29	1.60	0.92	2.28	0.07	-0.34

## artN.dice	99	16.61	7.62	16.00	4.00	36.00	0.51	-0.51
## arttot.dice	99	17.69	2.62	17.65	12.93	24.84	0.31	-0.66
## artNE.dice	99	16.14	7.33	14.00	4.00	36.00	0.58	-0.29
## arttotE.dice	99	17.31	2.46	17.12	12.93	24.84	0.41	-0.31
## pauN.dice	99	15.60	7.62	15.00	3.00	35.00	0.51	-0.51
## pauNE.dice	99	14.86	7.18	13.00	3.00	35.00	0.63	-0.12
## pautot.dice	99	5.43	3.79	4.28	1.00	24.42	1.85	5.13
## pautotE.dice	99	5.01	3.27	3.98	1.00	20.89	1.76	4.61
## itmarttE.dice	99	0.48	0.07	0.48	0.36	0.69	0.38	-0.42
## logarttE.dice	99	-0.74	0.14	-0.74	-1.02	-0.37	0.09	-0.71
## invarttE.dice	99	2.11	0.30	2.10	1.45	2.78	0.18	-0.76
## itmpautE.dice	99	0.14	0.09	0.11	0.03	0.58	1.73	4.41
## logpautE.dice	99	-2.15	0.61	-2.20	-3.58	-0.54	0.09	-0.47
## invpautE.dice	99	10.25	6.33	9.03	1.72	35.82	1.37	2.22
## itmadj.dice	99	0.65	0.13	0.63	0.44	1.08	0.87	0.54
## logadj.dice	99	-0.44	0.19	-0.47	-0.83	0.08	0.39	-0.19
## tottim.digit	101	19.54	3.86	19.06	13.96	34.93	1.21	1.76
## adjtim.digit	101	19.13	3.46	18.68	13.23	29.59	0.99	0.88
## incN.digit	101	0.12	0.43	0.00	0.00	3.00	4.35	21.59
## totcor.digit	101	35.88	0.43	36.00	33.00	36.00	-4.35	21.59
## invraw.digit	101	1.91	0.33	1.89	1.03	2.58	-0.22	-0.49
## invadj.digit	101	1.93	0.32	1.92	1.21	2.72	-0.07	-0.36
## artN.digit	101	11.55	6.52	10.00	2.00	36.00	1.16	1.46
## arttot.digit	101	15.33	2.06	15.11	11.59	22.62	0.70	0.69
## artNE.digit	101	11.29	6.35	10.00	2.00	36.00	1.26	1.94
## arttotE.digit	101	15.11	1.87	15.07	11.23	20.25	0.39	-0.10
## pauN.digit	101	10.56	6.52	9.00	1.00	35.00	1.16	1.47
## pauNE.digit	101	10.18	6.30	9.00	1.00	35.00	1.30	2.11
## pautot.digit	101	3.32	2.55	2.49	0.54	15.36	2.10	5.69
## pautotE.digit	101	3.14	2.37	2.46	0.54	15.36	2.36	7.73
## itmarttE.digit	101	0.42	0.05	0.42	0.31	0.57	0.40	-0.01
## logarttE.digit	101	-0.87	0.12	-0.87	-1.16	-0.56	0.07	-0.24
## invarttE.digit	101	2.41	0.30	2.39	1.76	3.21	0.26	-0.16
## itmpautE.digit	101	0.09	0.07	0.07	0.02	0.43	2.34	7.56
## logpautE.digit	101	-2.66	0.66	-2.67	-4.19	-0.85	0.11	-0.23
## invpautE.digit	101	17.55	11.88	14.50	2.34	66.18	1.44	2.22
## itmadj.digit	101	0.53	0.10	0.52	0.37	0.83	0.98	0.89
## logadj.digit	101	-0.64	0.17	-0.65	-1.00	-0.19	0.51	0.01
## tottim.numword	102	19.39	3.99	18.55	13.35	34.53	1.48	2.58
## adjtim.numword	102	19.12	3.70	18.35	13.35	32.58	1.43	2.39
## incN.numword	102	0.03	0.17	0.00	0.00	1.00	5.49	28.41
## totcor.numword	102	35.97	0.17	36.00	35.00	36.00	-5.49	28.41
## invraw.numword	102	1.92	0.34	1.94	1.04	2.70	-0.33	-0.11
## invadj.numword	102	1.94	0.32	1.96	1.11	2.70	-0.32	-0.04
## artN.numword	102	11.32	6.95	10.00	2.00	36.00	1.22	1.78
## arttot.numword	102	15.45	2.06	15.38	11.75	21.82	0.73	0.41
## artNE.numword	102	11.14	6.77	10.00	2.00	36.00	1.25	2.03
## arttotE.numword	102	15.29	1.96	15.25	11.75	21.52	0.75	0.49
## pauN.numword	102	10.32	6.95	9.00	1.00	35.00	1.22	1.78
## pauNE.numword	102	10.06	6.75	9.00	1.00	35.00	1.26	2.07
## pautot.numword	102	3.08	2.63	2.46	0.44	16.30	2.84	10.20
## pautotE.numword	102	2.96	2.45	2.30	0.44	16.30	2.74	9.85
## itmarttE.numword	102	0.43	0.05	0.42	0.33	0.60	0.73	0.44
## logarttE.numword	102	-0.86	0.13	-0.86	-1.12	-0.51	0.39	-0.12

## invarttE.numword	102	2.39	0.29	2.36	1.67	3.06	-0.08	-0.40
## itmpautE.numword	102	0.08	0.07	0.06	0.01	0.45	2.74	9.83
## logpautE.numword	102	-2.74	0.70	-2.75	-4.40	-0.79	0.02	0.11
## invpautE.numword	102	19.75	15.02	15.65	2.21	81.82	1.73	2.93
## itmadj.numword	102	0.53	0.10	0.51	0.37	0.90	1.41	2.34
## logadj.numword	102	-0.65	0.18	-0.67	-0.99	-0.10	0.84	0.76
## tottim.object	100	35.64	6.96	34.74	23.39	55.64	0.57	-0.02
## adjtim.object	100	31.99	5.47	31.02	22.96	46.94	0.52	-0.22
## incN.object	100	0.71	1.08	0.00	0.00	6.00	2.08	5.55
## totcor.object	100	35.29	1.08	36.00	30.00	36.00	-2.08	5.55
## invraw.object	100	1.05	0.20	1.04	0.65	1.54	0.35	-0.26
## invadj.object	100	1.13	0.19	1.14	0.73	1.57	0.21	-0.53
## artN.object	100	25.97	7.02	26.00	11.00	46.00	0.07	-0.39
## arttot.object	100	22.03	2.94	21.99	15.73	30.72	0.52	0.22
## artNE.object	100	23.53	5.92	24.00	11.00	35.00	-0.14	-0.68
## arttotE.object	100	20.30	2.63	20.04	13.49	26.77	0.25	0.05
## pauN.object	100	24.99	7.03	25.00	10.00	45.00	0.08	-0.37
## pauNE.object	100	21.71	6.01	22.00	10.00	33.00	-0.04	-0.71
## pautot.object	100	12.30	5.80	11.88	3.38	31.09	0.87	0.63
## pautotE.object	100	10.43	4.80	10.09	3.38	25.24	0.77	0.21
## itmarttE.object	100	0.58	0.07	0.57	0.37	0.74	0.29	-0.04
## logarttE.object	100	-0.56	0.12	-0.57	-0.98	-0.30	-0.10	0.33
## invarttE.object	100	1.77	0.22	1.76	1.34	2.67	0.59	1.53
## itmpautE.object	100	0.30	0.14	0.28	0.09	0.74	0.83	0.34
## logpautE.object	100	-1.32	0.47	-1.26	-2.37	-0.30	-0.12	-0.77
## invpautE.object	100	4.21	2.06	3.52	1.35	10.66	0.94	0.13
## itmadj.object	100	0.91	0.15	0.87	0.64	1.38	0.54	-0.07
## logadj.object	100	-0.11	0.17	-0.13	-0.45	0.32	0.15	-0.50
## tottim.word	101	28.46	11.08	25.29	14.86	78.18	2.14	5.75
## adjtim.word	101	25.92	7.95	23.69	13.96	54.98	1.59	2.63
## incN.word	101	0.82	1.34	0.00	0.00	9.00	2.99	12.74
## totcor.word	101	35.18	1.34	36.00	27.00	36.00	-2.99	12.74
## invraw.word	101	1.40	0.40	1.42	0.46	2.42	-0.01	-0.04
## invadj.word	101	1.46	0.38	1.48	0.60	2.51	-0.01	-0.07
## artN.word	101	17.47	10.45	15.00	3.00	49.00	0.91	0.11
## arttot.word	101	20.48	4.87	19.03	12.59	38.75	1.35	1.76
## artNE.word	101	15.78	8.64	14.00	3.00	38.00	0.77	-0.24
## arttotE.word	101	18.95	3.45	18.20	12.11	28.74	0.84	0.27
## pauN.word	101	16.48	10.48	14.00	2.00	48.00	0.92	0.16
## pauNE.word	101	14.43	8.55	13.00	2.00	37.00	0.80	-0.12
## pautot.word	101	6.95	6.91	5.14	0.78	41.76	2.63	8.20
## pautotE.word	101	5.93	5.36	4.48	0.78	27.27	2.16	4.72
## itmarttE.word	101	0.54	0.11	0.51	0.35	0.86	0.93	0.30
## logarttE.word	101	-0.63	0.19	-0.68	-1.06	-0.15	0.52	-0.26
## invarttE.word	101	1.92	0.34	1.96	1.16	2.89	-0.09	-0.32
## itmpautE.word	101	0.17	0.16	0.13	0.02	0.85	2.22	5.17
## logpautE.word	101	-2.08	0.79	-2.03	-3.84	-0.16	0.15	-0.15
## invpautE.word	101	10.81	9.01	7.64	1.17	46.39	1.89	3.81
## itmadj.word	101	0.74	0.24	0.68	0.40	1.68	1.61	2.70
## logadj.word	101	-0.34	0.29	-0.39	-0.92	0.52	0.79	0.47
##								
##								
## #####								
## Descriptives for grade G5								

```

## =====
##          n      mean      sd  median   min      max  skew kurtosis
## sID*      97  250.00  28.15  250.00 202.00  298.00  0.00  -1.24
## grade*    97   3.00   0.00   3.00   3.00   3.00   NaN   NaN
## sex*      96   1.43   0.50   1.00   1.00   2.00  0.29  -1.94
## graden    97   5.00   0.00   5.00   5.00   5.00   NaN   NaN
## agemonths  93  130.00  3.33  130.00 124.00  136.00  0.05  -1.32
## wrdacc    97   78.19  2.69   79.00  67.00   80.00 -2.00   4.02
## pwrdacc   97   33.23  5.51   35.00  17.00   38.00 -1.29   0.76
## wflut     97   71.62 11.36   73.00  42.00   95.00 -0.30  -0.61
## pwflu     97   36.64  7.30   36.00  20.00   54.00 -0.01  -0.43
## logwacc   97    2.83  0.55    2.90  1.29    3.31 -0.97  -0.09
## sqpwacc   97    2.84  1.07    3.00  0.31    4.00 -0.69  -0.59
## acc.dice  96    0.99  0.02    1.00  0.89    1.00 -2.64   8.18
## RT.dice   96  971.39 135.17  945.60 669.12 1457.74  0.39   0.45
## onsRT.dice 96  583.98  78.19  578.77 422.06  773.13  0.29  -0.31
## artic.dice 96  380.37  95.34  358.41 213.52  706.74  0.57   0.00
## invRT.dice 96    1.05  0.15    1.06  0.69    1.49  0.43   0.12
## invonsRT.dice 96  1.74  0.23    1.73  1.29    2.37  0.38  -0.14
## invartic.dice 96  2.79  0.69    2.79  1.41    4.68  0.45  -0.40
## logRT.dice 96    6.87  0.14    6.85  6.51    7.28 -0.03  -0.07
## logonsRT.dice 96  6.36  0.13    6.36  6.05    6.65 -0.04  -0.35
## logartic.dice 96  5.91  0.25    5.88  5.36    6.56  0.04  -0.70
## acc.digit 97    0.99  0.03    1.00  0.75    1.00 -6.10  44.43
## RT.digit  97  850.09 127.02  833.66 598.29 1358.02  0.66   1.15
## onsRT.digit 97  475.79  62.60  466.44 367.58  677.42  0.90   0.74
## artic.digit 97  368.85  97.33  361.15 194.81  676.55  0.49  -0.20
## invRT.digit 97    1.20  0.18    1.20  0.74    1.67  0.25  -0.15
## invonsRT.digit 97  2.14  0.26    2.14  1.48    2.72 -0.23  -0.31
## invartic.digit 97  2.91  0.78    2.77  1.48    5.13  0.65   0.06
## logRT.digit 97    6.73  0.15    6.73  6.39    7.21  0.16   0.02
## logonsRT.digit 97  6.16  0.13    6.15  5.91    6.52  0.55   0.06
## logartic.digit 97  5.88  0.26    5.89  5.27    6.52 -0.08  -0.61
## acc.numword 97    1.00  0.02    1.00  0.92    1.00 -4.13  17.16
## RT.numword 97  859.55 131.10  850.76 598.47 1376.40  0.64   0.91
## onsRT.numword 97  469.77  62.57  457.96 365.41  668.86  0.84   0.58
## artic.numword 97  385.00  99.03  369.09 193.18  703.47  0.41  -0.25
## invRT.numword 97    1.19  0.18    1.18  0.73    1.67  0.19  -0.41
## invonsRT.numword 97  2.16  0.27    2.18  1.50    2.74 -0.23  -0.58
## invartic.numword 97  2.78  0.74    2.71  1.42    5.18  0.68   0.05
## logRT.numword 97    6.75  0.15    6.75  6.39    7.23  0.18  -0.19
## logonsRT.numword 97  6.14  0.13    6.13  5.90    6.51  0.51  -0.17
## logartic.numword 97  5.92  0.26    5.91  5.26    6.56 -0.14  -0.65
## acc.object 97    0.98  0.03    1.00  0.83    1.00 -2.42   6.66
## RT.object  97 1108.08 164.00 1101.09 752.55 1568.08  0.66   0.34
## onsRT.object 97  695.15 124.89  673.18 476.45 1082.32  1.10   1.01
## artic.object 97  398.20  92.55  381.50 203.14  705.56  0.47   0.10
## invRT.object 97    0.92  0.13    0.91  0.64    1.33  0.15  -0.05
## invonsRT.object 97  1.48  0.24    1.49  0.92    2.10 -0.20  -0.12
## invartic.object 97  2.65  0.64    2.62  1.42    4.92  0.82   0.87
## logRT.object 97    7.00  0.14    7.00  6.62    7.36  0.25  -0.08
## logonsRT.object 97  6.53  0.17    6.51  6.17    6.99  0.66   0.19
## logartic.object 97  5.96  0.23    5.94  5.31    6.56 -0.15  -0.21
## acc.word   97    0.99  0.02    1.00  0.83    1.00 -4.24  25.22

```

## RT.word	97	974.08	154.95	958.14	706.66	1497.47	0.79	0.87
## onsRT.word	97	512.56	77.52	496.14	383.03	816.28	1.07	1.38
## artic.word	97	454.91	109.12	452.25	230.38	831.82	0.62	1.06
## invRT.word	97	1.05	0.16	1.04	0.67	1.42	0.03	-0.53
## invonsRT.word	97	1.99	0.27	2.02	1.23	2.61	-0.30	-0.41
## invartic.word	97	2.33	0.57	2.21	1.20	4.34	0.76	0.44
## logRT.word	97	6.87	0.15	6.86	6.56	7.31	0.35	-0.13
## logonsRT.word	97	6.23	0.14	6.21	5.95	6.70	0.65	0.16
## logartic.word	97	6.09	0.24	6.11	5.44	6.72	-0.12	-0.16
## tottim.dice	97	21.88	4.87	21.54	13.85	42.84	1.57	4.62
## adjtim.dice	97	21.22	4.54	20.75	13.32	41.95	1.81	5.99
## incN.dice	97	0.05	0.22	0.00	0.00	1.00	3.99	14.10
## totcor.dice	97	35.95	0.22	36.00	35.00	36.00	-3.99	14.10
## invraw.dice	97	1.72	0.34	1.67	0.84	2.60	0.23	0.29
## invadj.dice	97	1.76	0.33	1.73	0.86	2.70	0.20	0.65
## artN.dice	97	15.62	8.19	15.00	2.00	36.00	0.82	0.31
## arttot.dice	97	16.43	2.34	16.32	11.36	22.50	0.29	-0.10
## artNE.dice	97	15.15	7.91	14.00	2.00	36.00	0.88	0.50
## arttotE.dice	97	16.05	2.20	15.99	10.65	21.98	0.29	0.36
## pauN.dice	97	14.62	8.19	14.00	1.00	35.00	0.82	0.31
## pauNE.dice	97	13.80	7.84	13.00	1.00	35.00	0.92	0.57
## pautot.dice	97	4.49	3.49	3.32	0.41	21.57	2.39	7.36
## pautotE.dice	97	4.21	3.32	3.26	0.41	20.63	2.51	8.25
## itmarttE.dice	97	0.45	0.06	0.45	0.30	0.61	0.29	0.31
## logarttE.dice	97	-0.82	0.14	-0.81	-1.19	-0.49	-0.19	0.38
## invarttE.dice	97	2.28	0.32	2.24	1.64	3.29	0.68	1.00
## itmpautE.dice	97	0.12	0.09	0.09	0.01	0.57	2.49	8.05
## logpautE.dice	97	-2.38	0.68	-2.40	-4.48	-0.56	-0.09	0.71
## invpautE.dice	97	13.72	12.11	11.03	1.74	88.02	3.49	16.20
## itmadj.dice	97	0.59	0.13	0.58	0.37	1.17	1.77	5.75
## logadj.dice	97	-0.55	0.20	-0.55	-0.99	0.15	0.66	1.75
## tottim.digit	97	17.65	4.04	16.88	12.37	33.41	2.00	4.75
## adjtim.digit	97	17.45	3.92	16.52	12.37	33.00	1.94	4.33
## incN.digit	97	0.03	0.23	0.00	0.00	2.00	7.62	59.79
## totcor.digit	97	35.97	0.23	36.00	34.00	36.00	-7.62	59.79
## invraw.digit	97	2.12	0.38	2.13	1.08	2.91	-0.58	0.43
## invadj.digit	97	2.14	0.38	2.18	1.09	2.91	-0.60	0.36
## artN.digit	97	10.10	7.48	8.00	2.00	36.00	1.70	2.51
## arttot.digit	97	14.29	2.27	13.71	10.13	22.58	0.98	0.93
## artNE.digit	97	9.97	7.38	8.00	2.00	36.00	1.76	2.79
## arttotE.digit	97	14.17	2.25	13.59	10.13	22.06	0.96	0.72
## pauN.digit	97	9.10	7.48	7.00	1.00	35.00	1.70	2.51
## pauNE.digit	97	8.87	7.38	7.00	1.00	35.00	1.77	2.81
## pautot.digit	97	2.60	2.38	1.84	0.39	13.37	2.46	6.75
## pautotE.digit	97	2.52	2.28	1.82	0.39	12.46	2.37	6.01
## itmarttE.digit	97	0.39	0.06	0.38	0.28	0.61	0.97	0.75
## logarttE.digit	97	-0.94	0.15	-0.97	-1.27	-0.49	0.59	-0.05
## invarttE.digit	97	2.60	0.37	2.65	1.63	3.55	-0.23	-0.37
## itmpautE.digit	97	0.07	0.06	0.05	0.01	0.35	2.36	5.93
## logpautE.digit	97	-2.95	0.74	-2.98	-4.52	-1.06	0.29	-0.03
## invpautE.digit	97	24.47	18.00	19.75	2.89	91.84	1.54	2.40
## itmadj.digit	97	0.49	0.11	0.46	0.34	0.92	1.93	4.28
## logadj.digit	97	-0.74	0.20	-0.78	-1.07	-0.09	1.23	1.79
## tottim.numword	97	17.34	3.68	16.65	12.16	32.18	1.70	3.90

## adjtim.numword	97	17.10	3.55	16.35	12.16	30.45	1.70	3.73
## incN.numword	97	0.05	0.22	0.00	0.00	1.00	3.99	14.10
## totcor.numword	97	35.95	0.22	36.00	35.00	36.00	-3.99	14.10
## invraw.numword	97	2.15	0.38	2.16	1.12	2.96	-0.31	0.01
## invadj.numword	97	2.18	0.37	2.19	1.15	2.96	-0.40	0.14
## artN.numword	97	9.89	7.54	8.00	2.00	35.00	1.75	2.84
## arttot.numword	97	14.28	2.20	13.88	10.79	22.66	0.93	0.97
## artNE.numword	97	9.74	7.48	8.00	2.00	35.00	1.79	3.04
## arttotE.numword	97	14.14	2.11	13.76	10.79	20.82	0.78	0.04
## pauN.numword	97	8.89	7.54	7.00	1.00	34.00	1.75	2.84
## pauNE.numword	97	8.62	7.46	6.00	1.00	34.00	1.83	3.15
## pautot.numword	97	2.32	2.04	1.65	0.22	11.10	2.33	5.96
## pautotE.numword	97	2.22	1.99	1.64	0.22	11.10	2.50	6.88
## itmarttE.numword	97	0.39	0.06	0.38	0.30	0.58	0.80	0.09
## logarttE.numword	97	-0.94	0.14	-0.96	-1.20	-0.55	0.50	-0.43
## invarttE.numword	97	2.60	0.36	2.61	1.73	3.34	-0.23	-0.71
## itmpauteE.numword	97	0.06	0.06	0.05	0.01	0.32	2.54	7.17
## logpautE.numword	97	-3.07	0.74	-3.09	-5.08	-1.15	0.10	0.23
## invpautE.numword	97	28.09	23.59	21.94	3.15	160.71	2.53	9.38
## itmadj.numword	97	0.48	0.10	0.46	0.34	0.87	1.76	4.06
## logadj.numword	97	-0.76	0.19	-0.79	-1.09	-0.14	1.02	1.48
## tottim.object	92	30.87	5.64	28.80	21.97	46.16	0.72	-0.37
## adjtim.object	92	27.18	4.27	26.43	19.64	37.92	0.67	-0.31
## incN.object	92	0.63	0.82	0.00	0.00	3.00	1.11	0.38
## totcor.object	92	35.37	0.82	36.00	33.00	36.00	-1.11	0.38
## invraw.object	92	1.20	0.20	1.25	0.78	1.64	-0.12	-0.80
## invadj.object	92	1.33	0.20	1.35	0.91	1.80	0.00	-0.52
## artN.object	92	22.97	7.68	21.00	9.00	39.00	0.29	-0.86
## arttot.object	92	21.06	3.58	20.35	14.80	32.25	0.93	0.63
## artNE.object	92	21.23	7.15	19.00	9.00	36.00	0.36	-0.93
## arttotE.object	92	19.00	2.44	18.84	14.38	25.72	0.47	-0.05
## pauN.object	92	21.96	7.70	20.00	8.00	38.00	0.28	-0.86
## pauNE.object	92	18.55	7.43	17.00	6.00	35.00	0.45	-0.91
## pautot.object	92	8.78	4.17	7.78	2.52	21.46	1.00	0.51
## pautotE.object	92	7.14	3.74	6.52	1.80	18.75	1.22	0.94
## itmarttE.object	92	0.54	0.07	0.54	0.41	0.73	0.47	-0.08
## logarttE.object	92	-0.63	0.13	-0.62	-0.90	-0.31	0.15	-0.38
## invarttE.object	92	1.89	0.24	1.86	1.36	2.45	0.16	-0.44
## itmpauteE.object	92	0.20	0.11	0.18	0.05	0.52	1.23	0.99
## logpautE.object	92	-1.72	0.50	-1.71	-3.00	-0.65	0.09	-0.27
## invpautE.object	92	6.31	3.23	5.52	1.92	19.99	1.40	2.97
## itmadj.object	92	0.77	0.12	0.74	0.56	1.09	0.63	-0.36
## logadj.object	92	-0.27	0.16	-0.30	-0.59	0.09	0.33	-0.56
## tottim.word	95	22.76	5.52	21.69	15.06	43.86	1.21	1.52
## adjtim.word	95	21.51	4.70	20.43	13.80	36.69	0.95	0.34
## incN.word	95	0.45	0.87	0.00	0.00	5.00	2.43	7.21
## totcor.word	95	35.55	0.87	36.00	31.00	36.00	-2.43	7.21
## invraw.word	95	1.66	0.35	1.66	0.82	2.39	-0.11	-0.56
## invadj.word	95	1.72	0.34	1.74	0.92	2.54	-0.15	-0.58
## artN.word	95	12.93	8.45	10.00	3.00	37.00	1.15	0.43
## arttot.word	95	17.91	3.17	17.31	12.51	27.36	0.77	0.35
## artNE.word	95	12.37	8.05	10.00	3.00	35.00	1.16	0.45
## arttotE.word	95	17.10	2.84	16.43	11.69	26.40	0.76	0.27
## pauN.word	95	11.93	8.45	9.00	2.00	36.00	1.15	0.43

## pauNE.word	95	10.95	7.96	8.00	2.00	34.00	1.22	0.65
## pautot.word	95	3.91	3.12	3.09	0.92	21.50	2.41	9.03
## pautotE.word	95	3.48	2.61	2.83	0.42	14.87	1.68	3.14
## itmarttE.word	95	0.48	0.08	0.47	0.33	0.73	0.70	0.09
## logarttE.word	95	-0.74	0.16	-0.75	-1.10	-0.31	0.32	-0.38
## invarttE.word	95	2.13	0.34	2.12	1.36	2.99	0.06	-0.43
## itmpautE.word	95	0.10	0.08	0.08	0.01	0.48	1.99	5.40
## logpautE.word	95	-2.56	0.68	-2.54	-4.39	-0.73	0.24	-0.36
## invpautE.word	95	16.03	11.20	12.72	2.08	80.76	2.28	9.89
## itmadj.word	95	0.61	0.14	0.58	0.39	1.09	1.10	0.94
## logadj.word	95	-0.52	0.21	-0.55	-0.93	0.08	0.60	-0.18

6 Discrete naming data

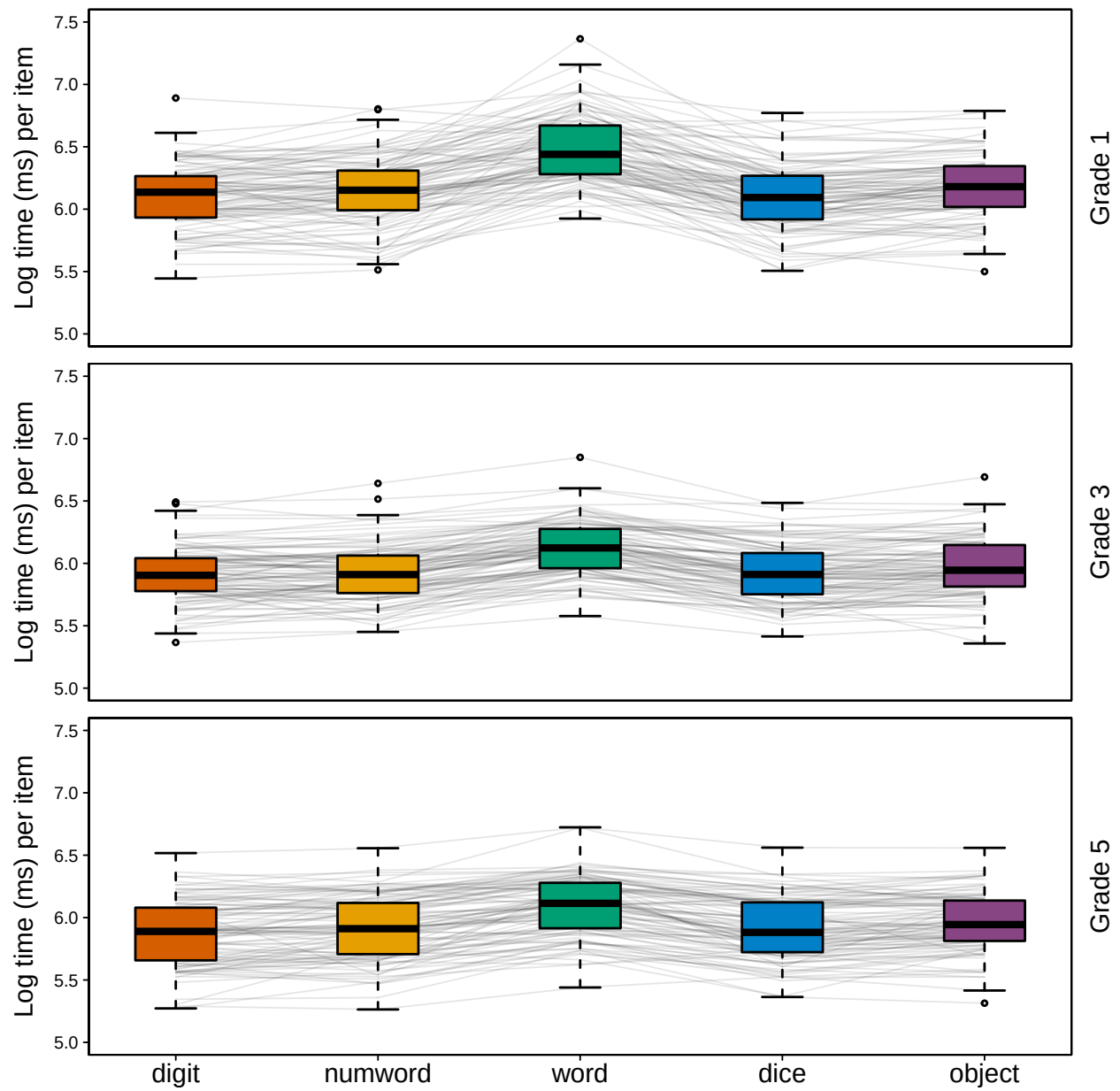
We begin with discrete naming response components, namely silent intervals (onset latency) and spoken intervals (articulation duration).

Note: In this and the following analyses of discrete and serial naming “components” we use log-transformed data as there were determined to produce acceptable distributions across variables, tasks, and grades. Rates (i.e., inverse-transformed data) lead to most normal-like distributions for total times, and have been the metric of choice in most past studies, but they lead to severely skewed distributions for serial pause times (i.e., silent intervals), perhaps because they shrink substantially toward zero with increasing skill. Thus, in order to keep all comparable metrics on a common scale, we use log-transformed times per item for all metrics below.

6.1 Spoken intervals (articulation duration) per task and grade

Here we plot the distribution of performance per task and grade on top of the individual participant data (each faint line joins the rates for one child).

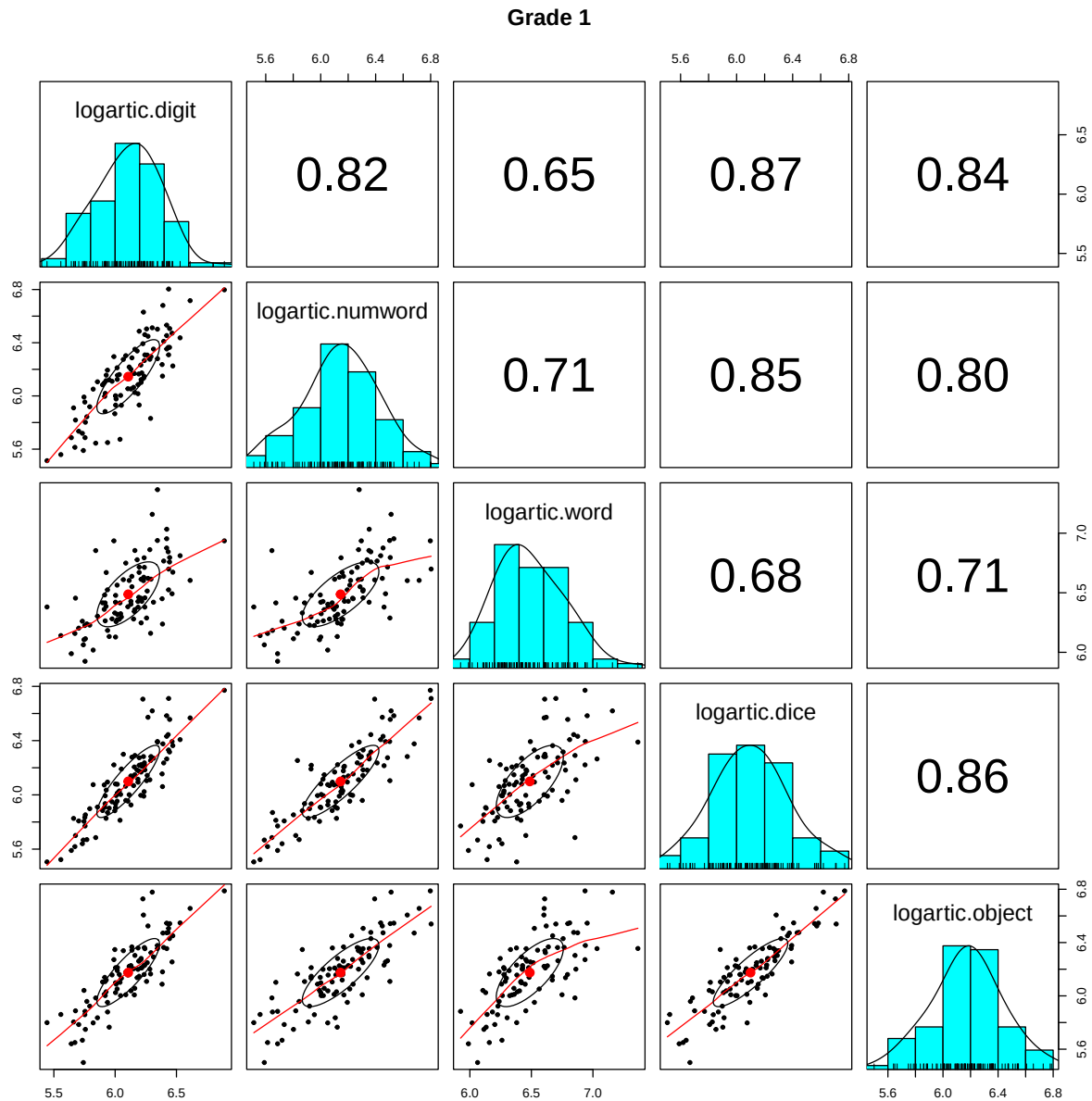
```
par(mfrow=c(3,1))
par(oma=c(2,3,0,2))
par(mai=c(0.1,0.1,0.01,0.01))
par(mgp=c(2,0.5,0))
par(tcl= -0.25)
for (grd in levels(rsdw$grade)) {
  plot(NA,NA,type="n",xlim=c(0.75,5.25),ylim=c(5,7.5),yaxt="n",xaxt="n",xlab="",ylab="")
  if (grd=="G5") {
    axis(1,at=1:length(tasks),labels=tasks,cex.axis=1.5,xpd=NA)
  }
  axis(2,at=0:5/2+5,las=1)
  mtext("Log time (ms) per item",2,line=2.5,xpd=NA)
  mtext(paste("Grade",substr(grd,2,2)),side=4,line=1,xpd=NA)
  for (itsk in 1:(length(tasks)-1) ) {
    for (ss in which(rsdw$grade==grd)) {
      lines(c(itsk,itsk+1),rsdw[ss,paste(c("logartic"),tasks[c(itsk,itsk+1)]),sep="."]),col="#30303020")
    }
  }
  for (itsk in 1:length(tasks)) {
    tsk <- tasks[itsk]
    boxplot(rsdw[rsdw$grade==grd,paste("logartic",tsk,sep=".")],at=itsk,add=T,col=tcols[itsk],lwd=1.5,y)
  }
}
```



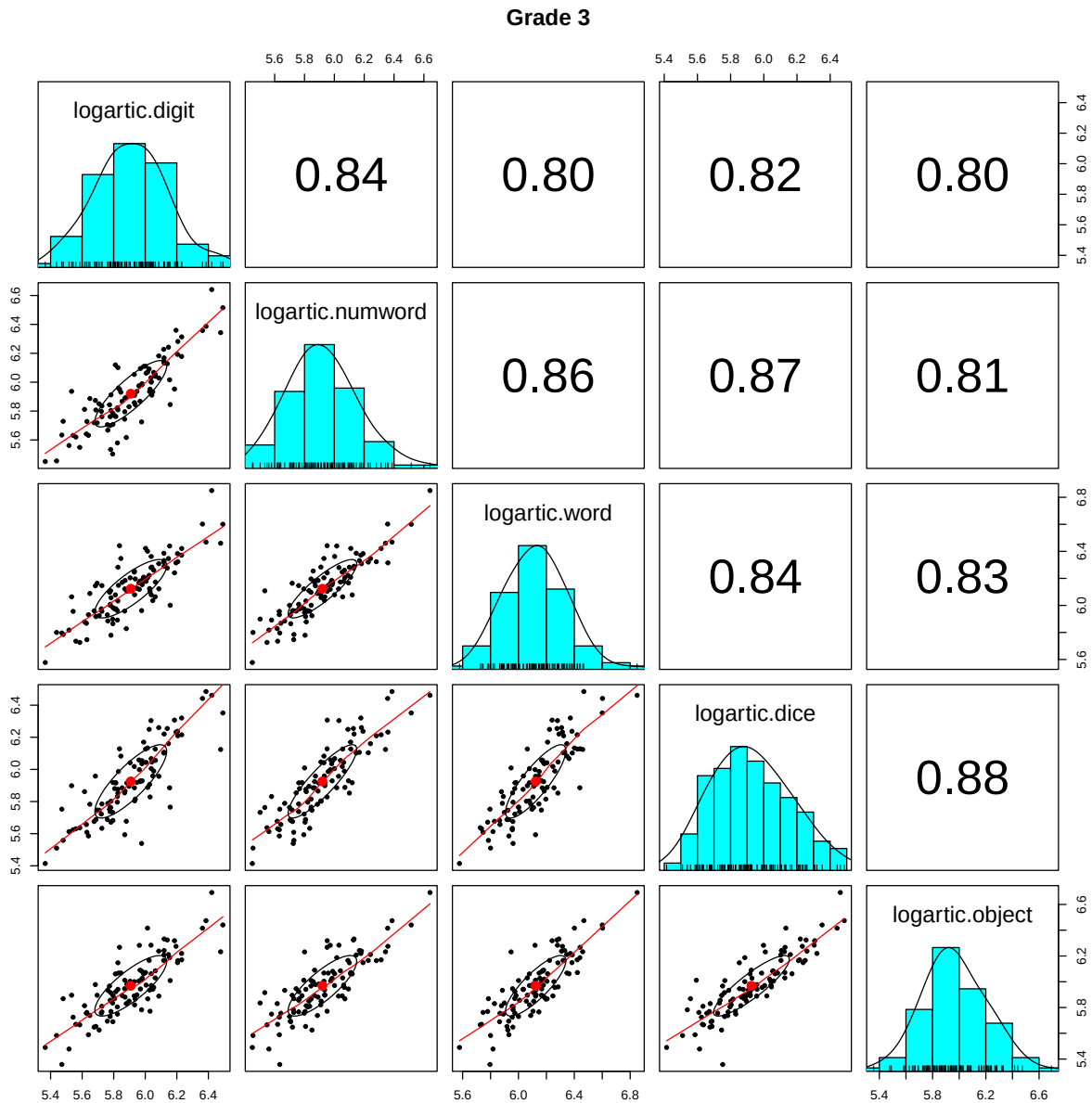
6.2 Intercorrelations among spoken intervals

The following graph shows the interrelations among the discrete articulation variables for each grade (nonparametric correlation coefficient, Spearman's)

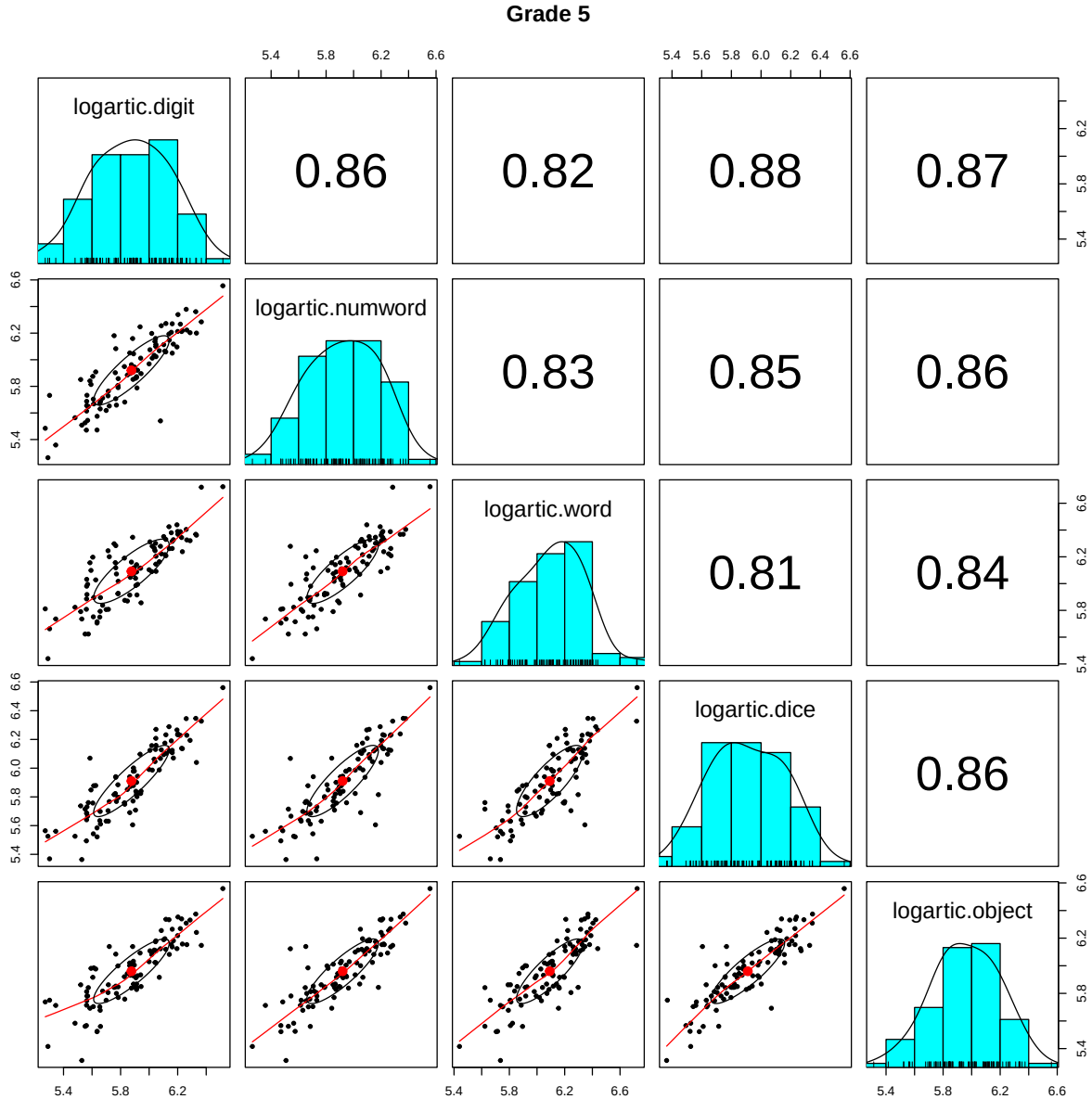
```
artnm <- paste("logartic",tasks,sep=".")
pairs.panels(rsdw[rsdw$grade=="G1",artnm],method="spearman",main="Grade 1")
```



```
pairs.panels(rsdw[rsdw$grade=="G3",artnm],method="spearman",main="Grade 3")
```



```
pairs.panels(rsdw[rsdw$grade=="G5",artnm],method="spearman",main="Grade 5")
```



We can see that articulation durations among all types of content are fairly highly correlated ($> .8$) except for words in Grade 1.

6.3 Silent intervals (onset latencies) per task and grade

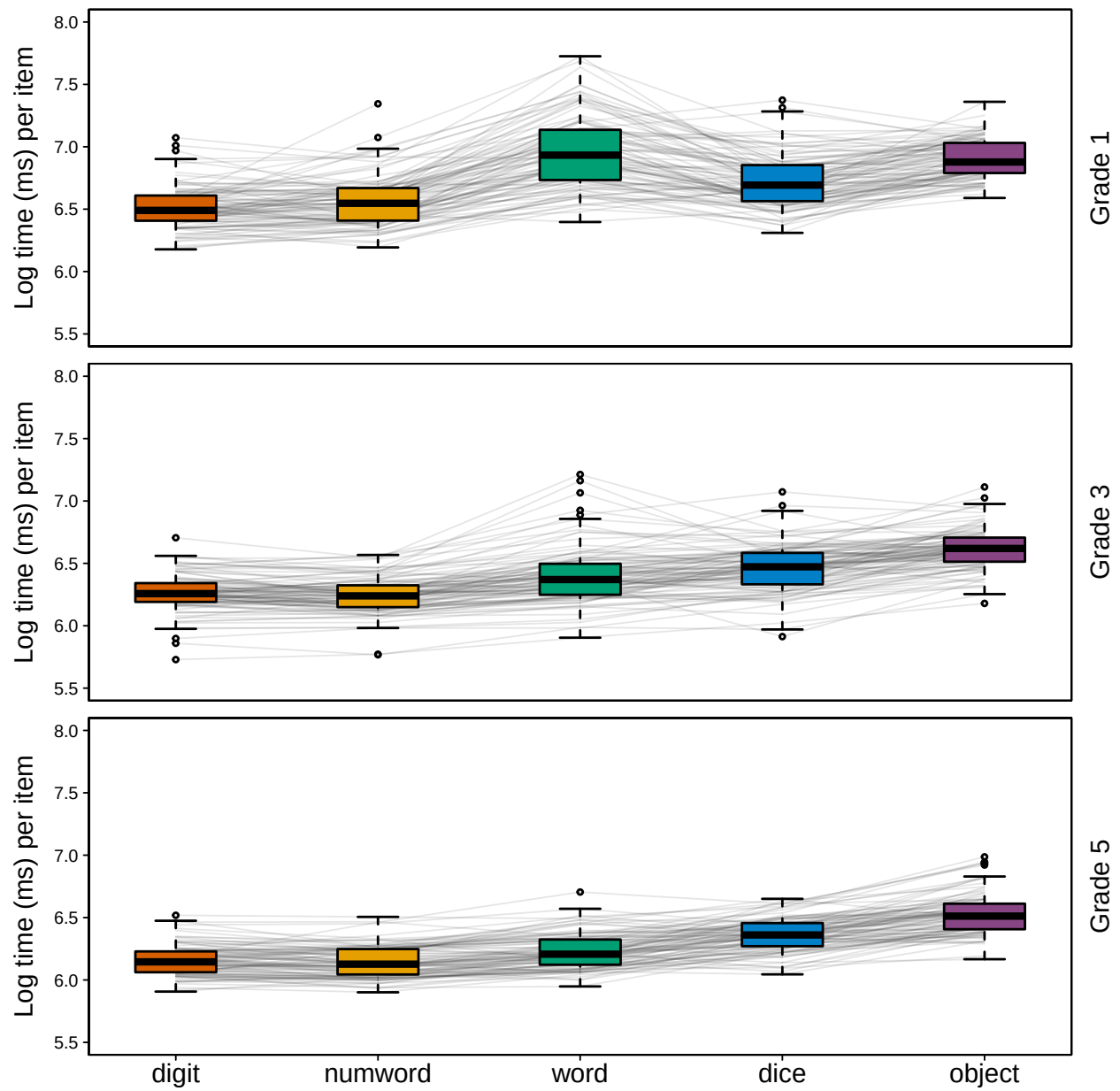
We now turn to onset latency and apply the same approach to plotting the distribution of performance per task and grade on top of the individual participant data, as done for articulation above.

```
par(mfrow=c(3,1))
par(oma=c(2,3,0,2))
par(mai=c(0.1,0.1,0.01,0.01))
par(mgp=c(2,0.5,0))
par(tcl= -0.25)
for (grd in levels(rsdw$grade)) {
  plot(NA,NA,type="n",xlim=c(0.75,5.25),ylim=c(5.5,8),yaxt="n",xaxt="n",xlab="",ylab="")
}
```

```

if (grd=="G5") {
  axis(1,at=1:length(tasks),labels=tasks,cex.axis=1.5,xpd=NA)
}
axis(2,at=0:5/2+5.5,las=1)
mtext("Log time (ms) per item",2,line=2.5,xpd=NA)
mtext(paste("Grade",substr(grd,2,2)),side=4,line=1,xpd=NA)
for (itsk in 1:(length(tasks)-1) ) {
  for (ss in which(rsdw$grade==grd)) {
    lines(c(itsk,itsk+1),rsdw[ss,paste(c("logonsRT"),tasks[c(itsk,itsk+1)],sep=".")],col="#30303020")
  }
}
for (itsk in 1:length(tasks)) {
  tsk <- tasks[itsk]
  boxplot(rsdw[rsdw$grade==grd,paste("logonsRT",tsk,sep=".")],at=itsk,add=T,col=tcols[itsk],lwd=1.5,y
}
}

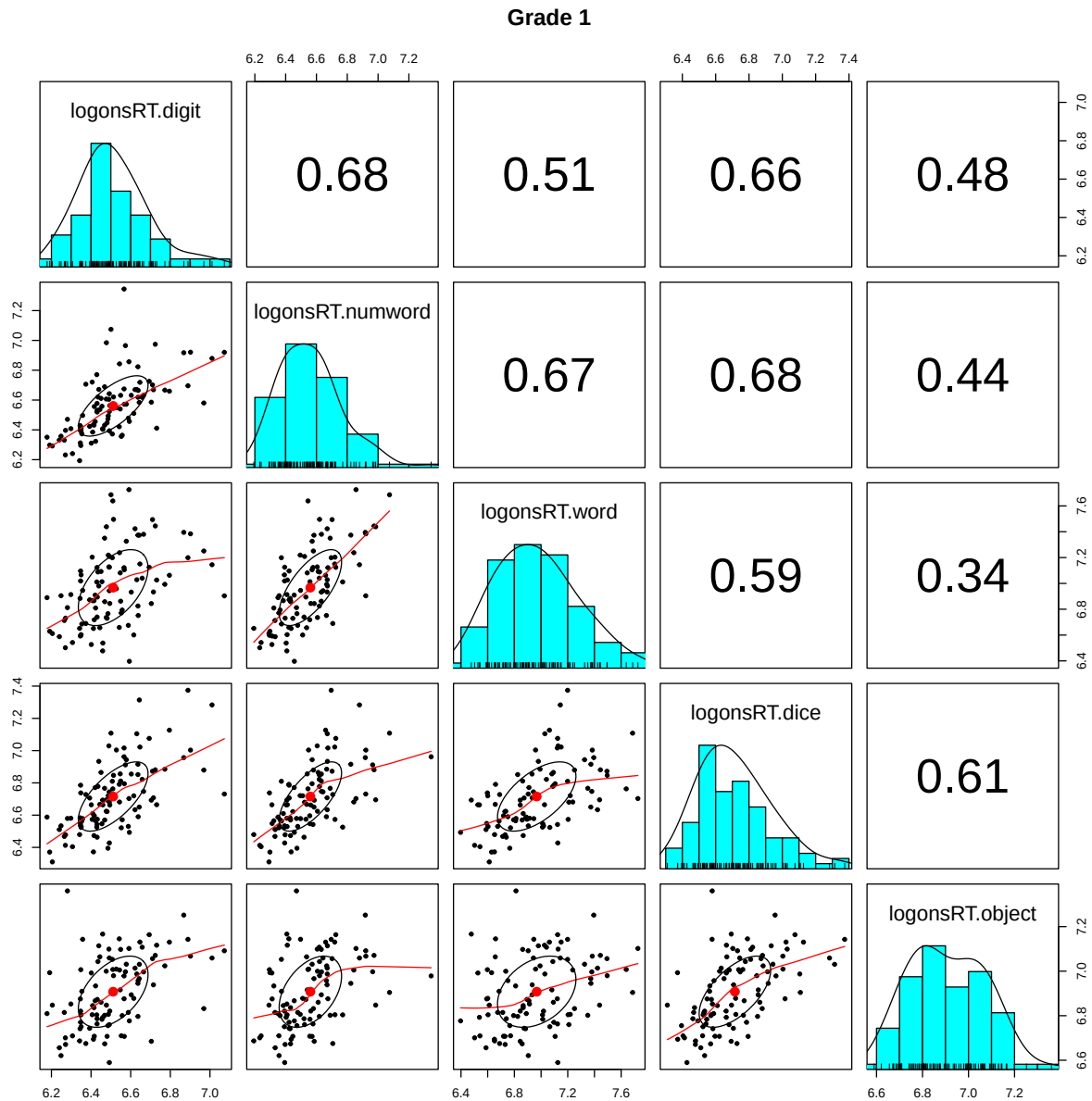
```



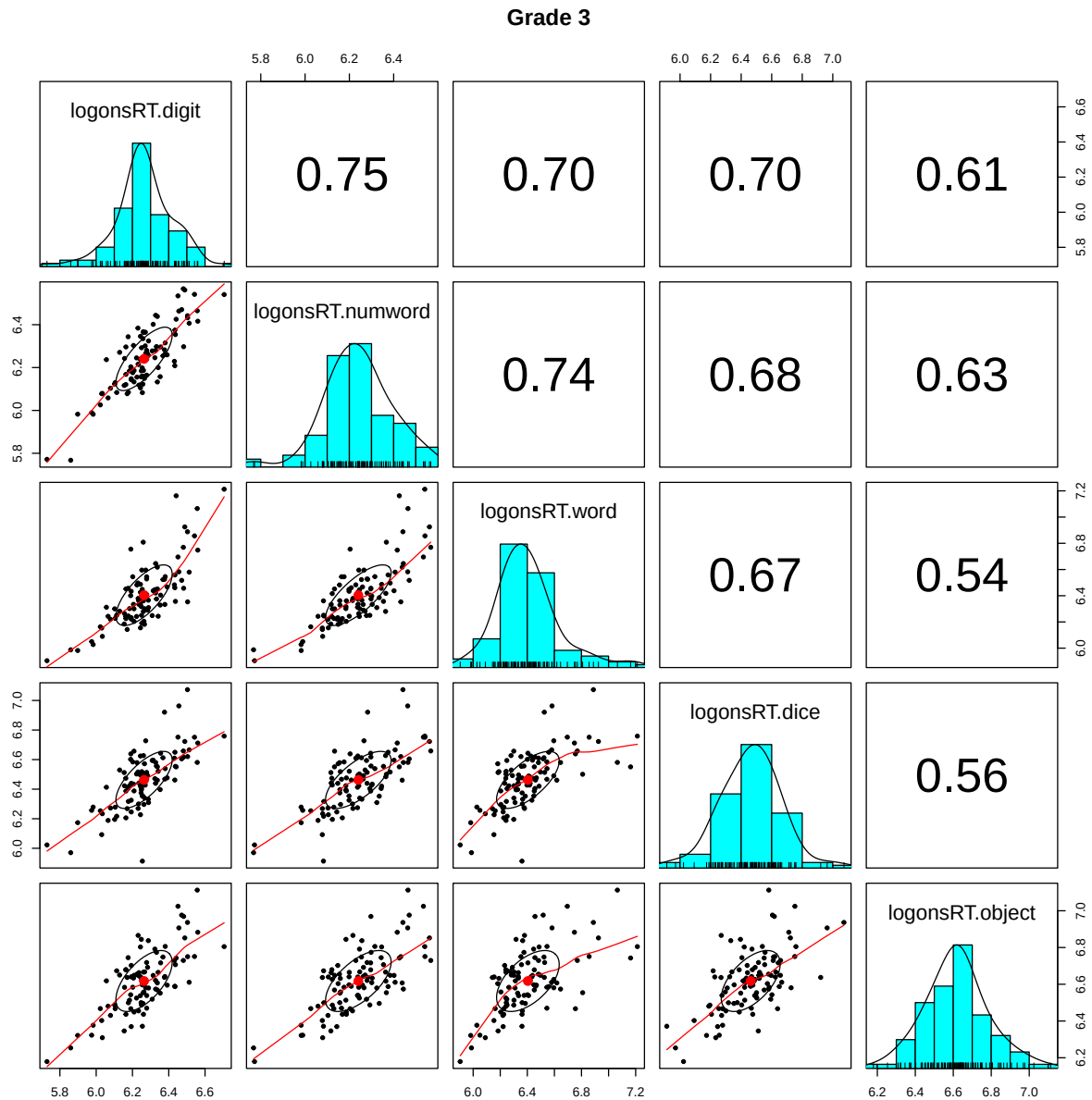
6.4 Intercorrelations among silent intervals

The following graph shows the interrelations among the discrete onset latencies for each grade.

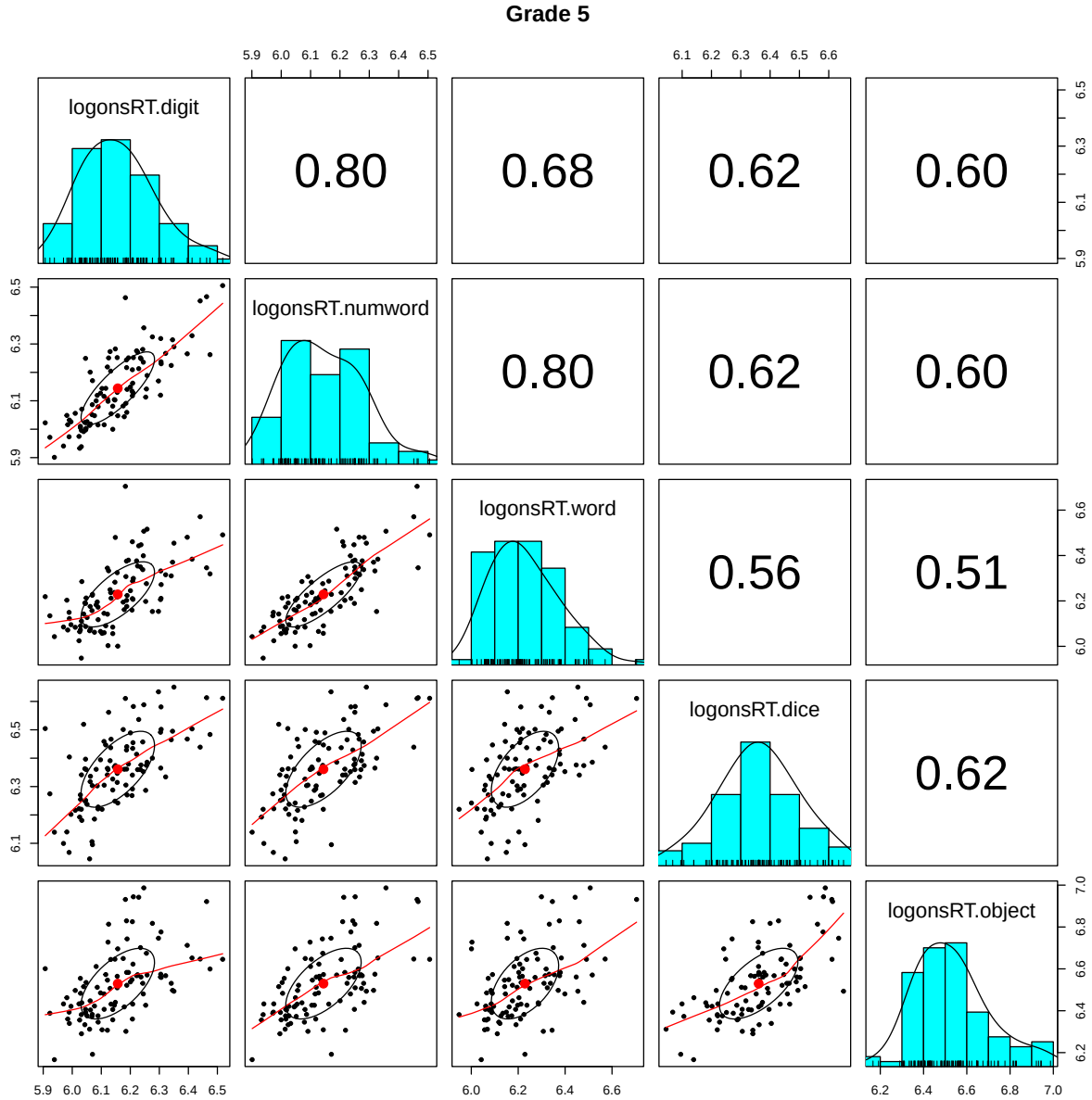
```
onsnm <- paste("logonsRT",tasks,sep=".")
pairs.panels(rsdw[rsdw$grade=="G1",onsnm],method="spearman",main="Grade 1")
```



```
pairs.panels(rsdw[rsdw$grade=="G3",onsnm],method="spearman",main="Grade 3")
```



```
pairs.panels(rsdw[rsdw$grade=="G5",onsnm],method="spearman",main="Grade 5")
```



We can see that onset latencies among all types of content are much less strongly correlated than articulation times. Correlations between digits, number words, and words are highest and increasing with grade.

7 Serial naming data

We now turn to the corresponding analysis of serial naming response components, namely spoken intervals (articulation time) and silent intervals (pause time). For direct comparability with discrete tasks, we calculate corresponding rate variables using the *adjusted* times and error counts, effectively taking only correct responses into account.

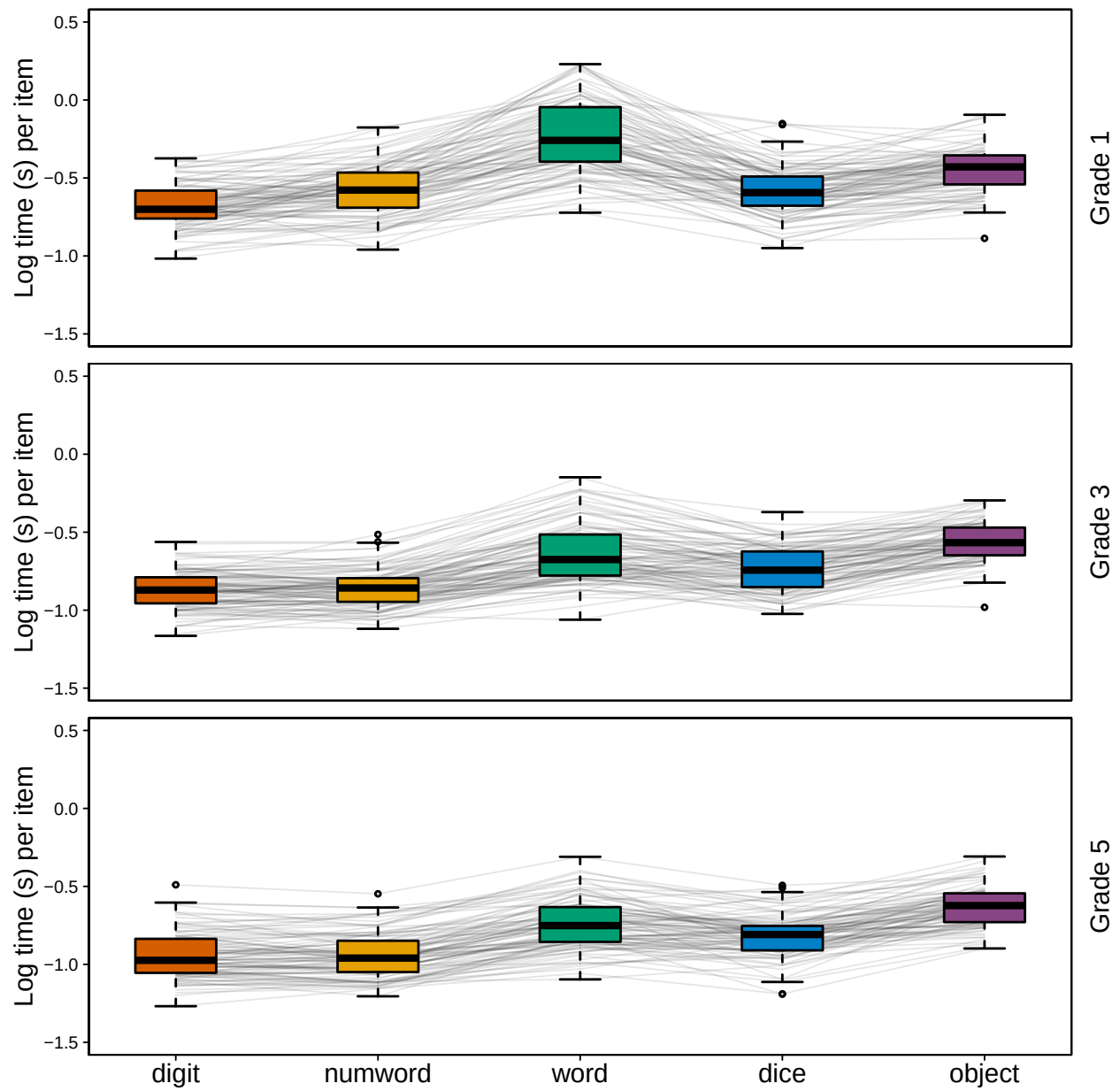
7.1 Spoken intervals (articulation times) per task and grade

We first plot the distribution of performance per task and grade on top of the individual participant data.

```

par(mfrow=c(3,1))
par(oma=c(2,3,0,2))
par(mai=c(0.1,0.1,0.01,0.01))
par(mgp=c(2,0.5,0))
par(tcl= -0.25)
for (grd in levels(rsdw$grade)) {
  plot(NA,NA,type="n",xlim=c(0.75,5.25),ylim=c(-1.5,0.5),yaxt="n",xaxt="n",xlab="",ylab="")
  if (grd=="G5") {
    axis(1,at=1:length(tasks),labels=tasks,cex.axis=1.5,xpd=NA)
  }
  axis(2,at=0:5/2-1.5,las=1)
  mtext("Log time (s) per item",2,line=2.5,xpd=NA)
  mtext(paste("Grade",substr(grd,2,2)),side=4,line=1,xpd=NA)
  for (itsk in 1:(length(tasks)-1) ) {
    for (ss in which(rsdw$grade==grd)) {
      lines(c(itsk,itsk+1),rsdw[ss,paste(c("logarttE"),tasks[c(itsk,itsk+1)]),sep="."]),col="#30303020")
    }
  }
  for (itsk in 1:length(tasks)) {
    tsk <- tasks[itsk]
    boxplot(rsdw[rsdw$grade==grd,paste("logarttE",tsk,sep=".")],at=itsk,add=T,col=tcols[itsk],lwd=1.5,y
  }
}

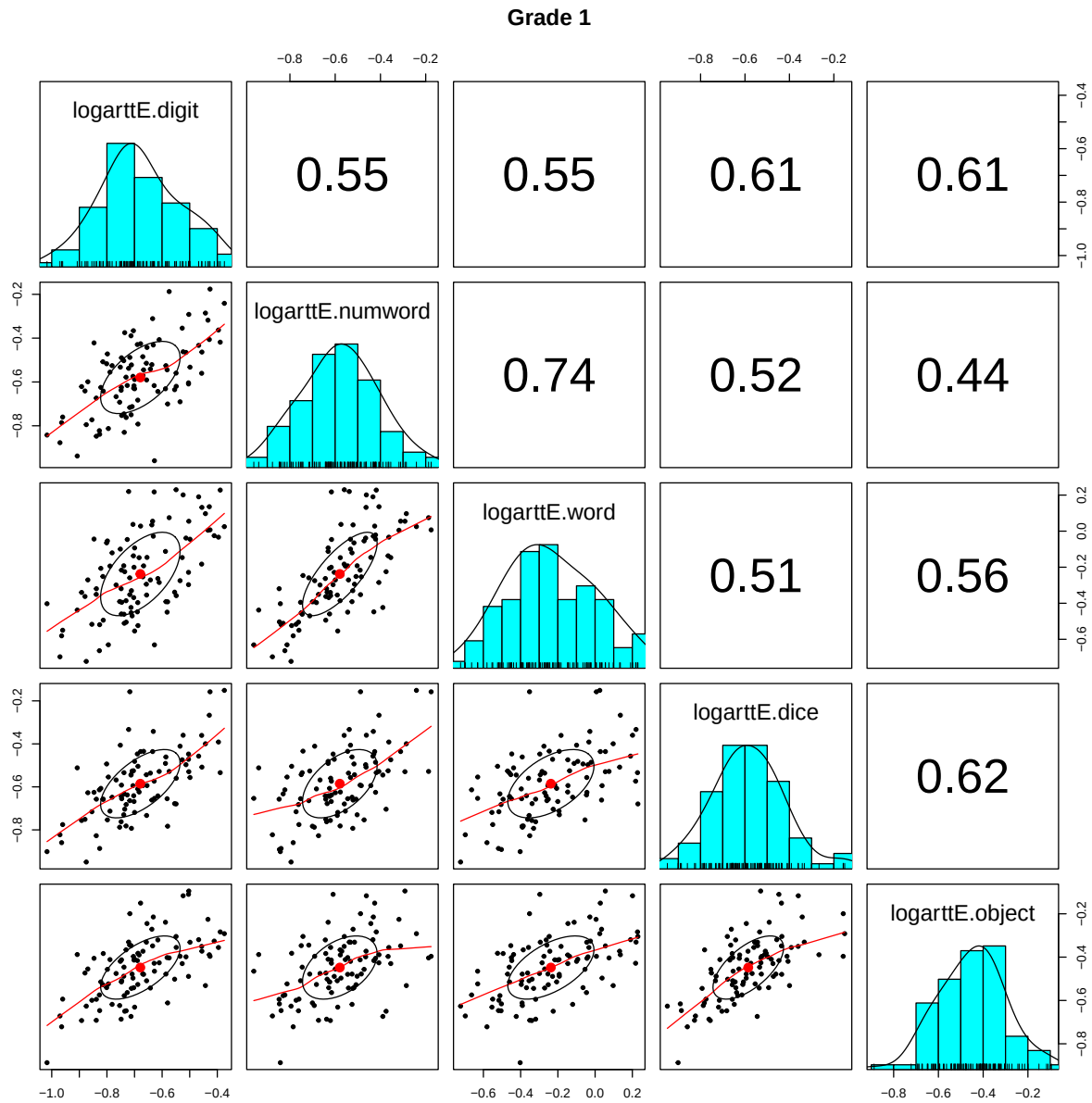
```



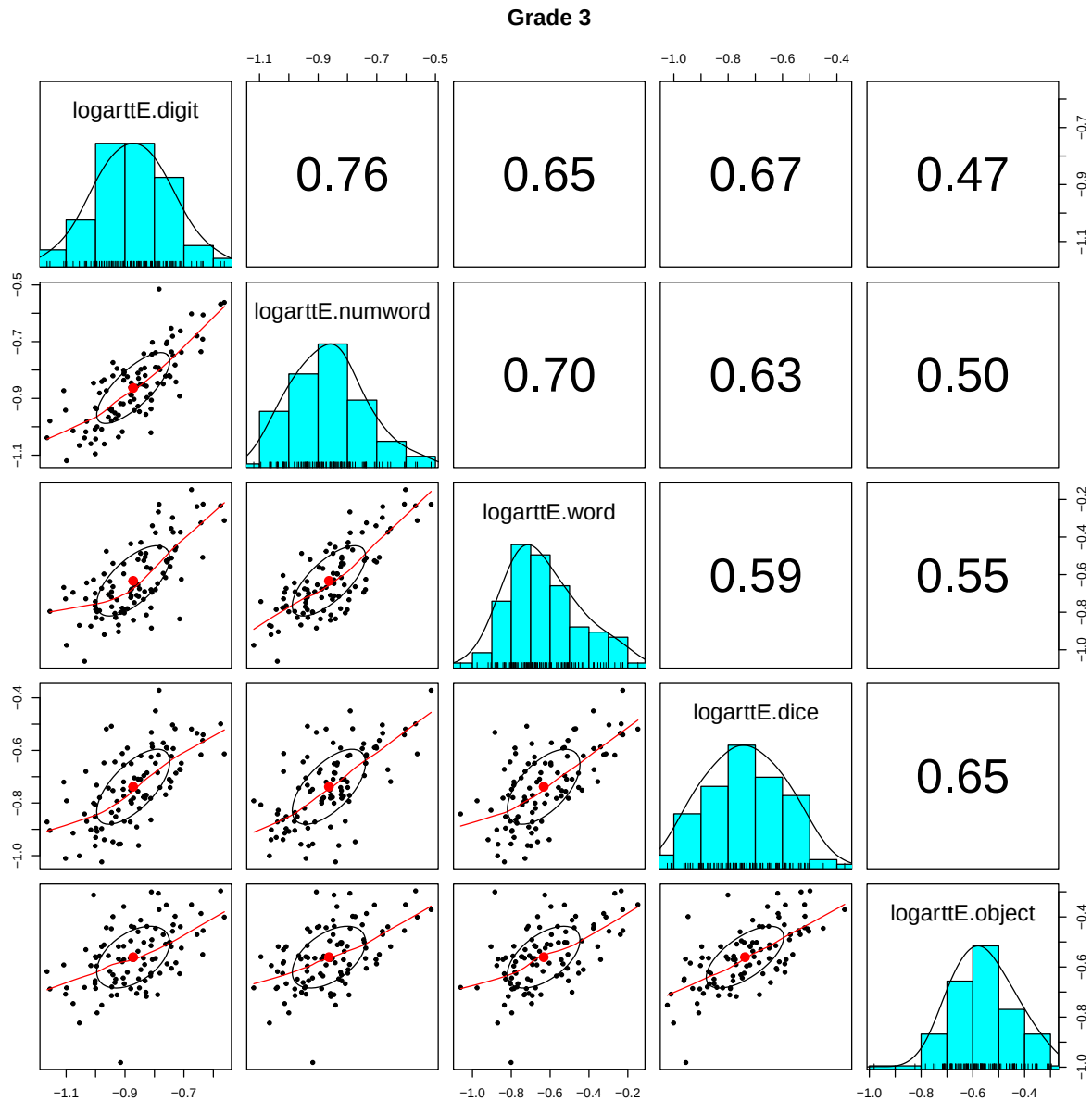
7.2 Intercorrelations among spoken intervals

The following graph shows the interrelations among the serial articulation variables for each grade.

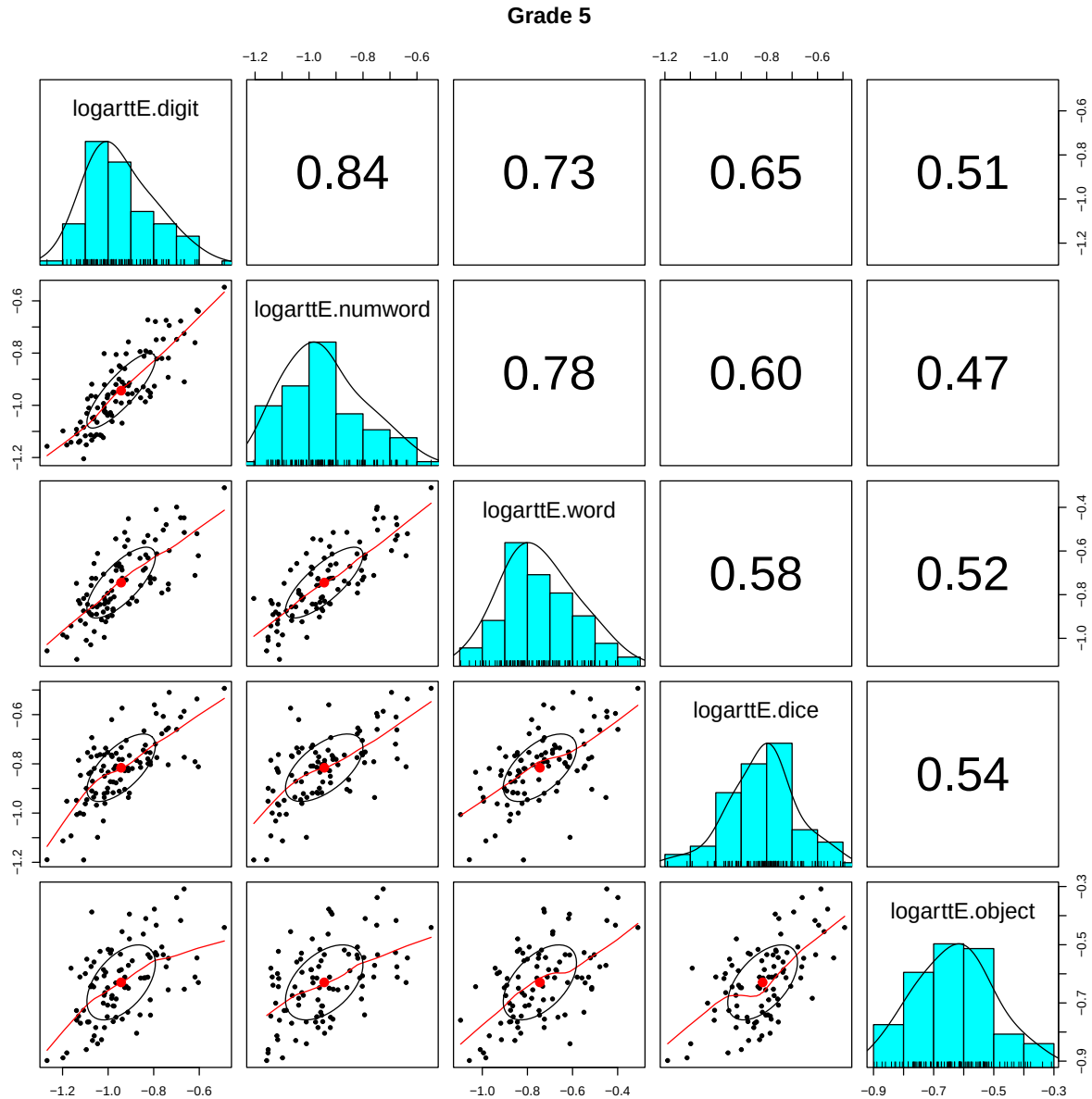
```
serartnm <- paste("logarttE",tasks,sep=".")
pairs.panels(rsdw[rsdw$grade=="G1",serartnm],method="spearman",main="Grade 1")
```



```
pairs.panels(rsdw[rsdw$grade=="G3",serartnm],method="spearman",main="Grade 3")
```



```
pairs.panels(rsdw[rsdw$grade=="G5",serartnm],method="spearman",main="Grade 5")
```



Articulation durations among all types of content are moderately correlated ($> .5$) but vary widely across task pairs in every grade.

7.3 Silent intervals (pause times) per task and grade

We now turn to the (adjusted) silent intervals in the serial responses and apply the same approach to plotting the distribution of performance per task and grade on top of the individual participant data.

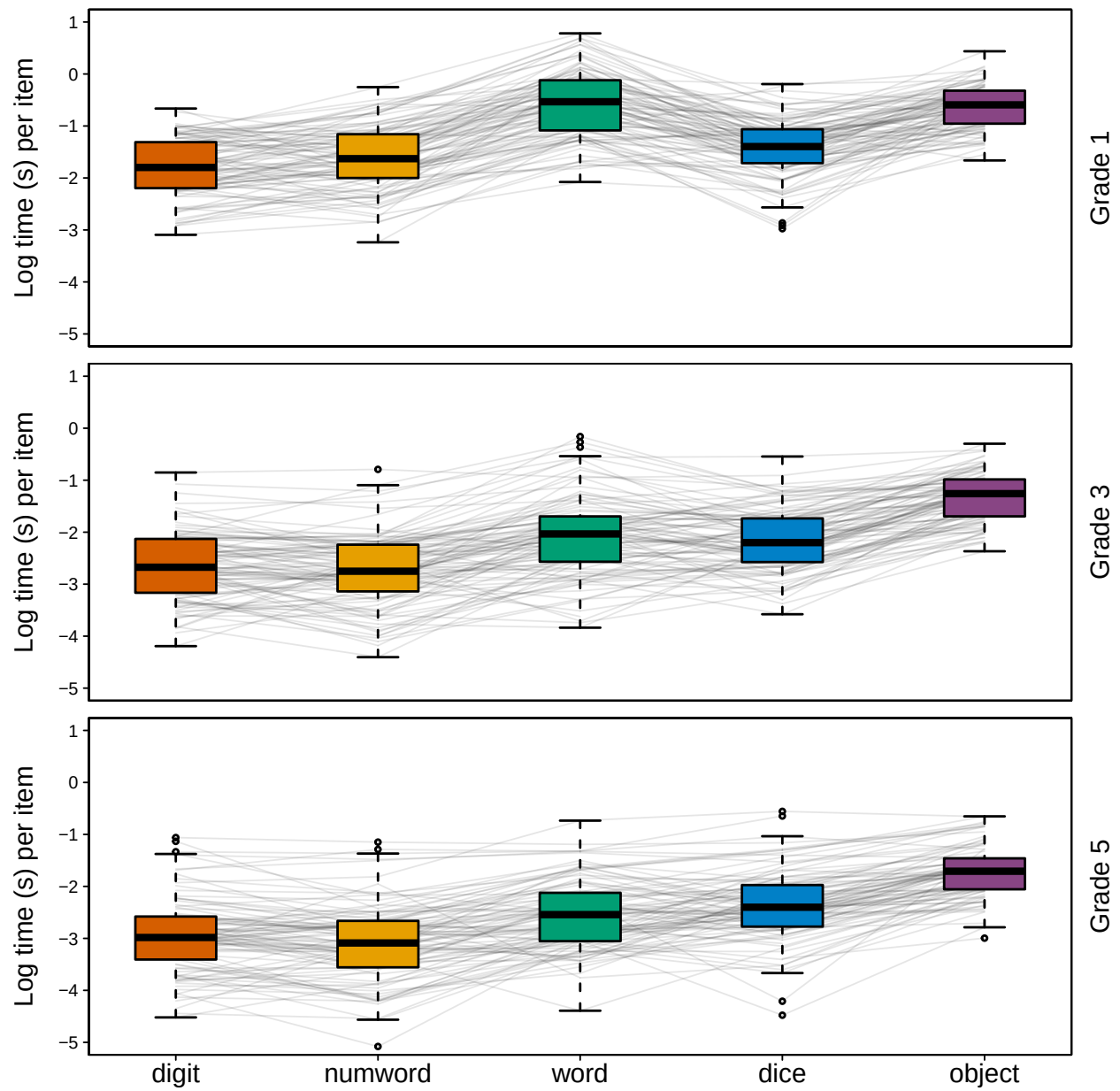
```
par(mfrow=c(3,1))
par(oma=c(2,3,0,2))
par(mai=c(0.1,0.1,0.01,0.01))
par(mgp=c(2,0.5,0))
par(tcl= -0.25)
for (grd in levels(rsdw$grade)) {
  plot(NA,NA,type="n",xlim=c(0.75,5.25),ylim=c(-5,1),yaxt="n",xaxt="n",xlab="",ylab="")

```

```

if (grd=="G5") {
  axis(1,at=1:length(tasks),labels=tasks,cex.axis=1.5,xpd=NA)
}
axis(2,at=-5:1,las=1)
mtext("Log time (s) per item",2,line=2.5,xpd=NA)
mtext(paste("Grade",substr(grd,2,2)),side=4,line=1,xpd=NA)
for (itsk in 1:(length(tasks)-1) ) {
  for (ss in which(rsdw$grade==grd)) {
    lines(c(itsk,itsk+1),rsdw[ss,paste(c("logpautE"),tasks[c(itsk,itsk+1)],sep=".")],col="#30303020")
  }
}
for (itsk in 1:length(tasks)) {
  tsk <- tasks[itsk]
  boxplot(rsdw[rsdw$grade==grd,paste("logpautE",tsk,sep=".")],at=itsk,add=T,col=tcols[itsk],lwd=1.5,y
}
}

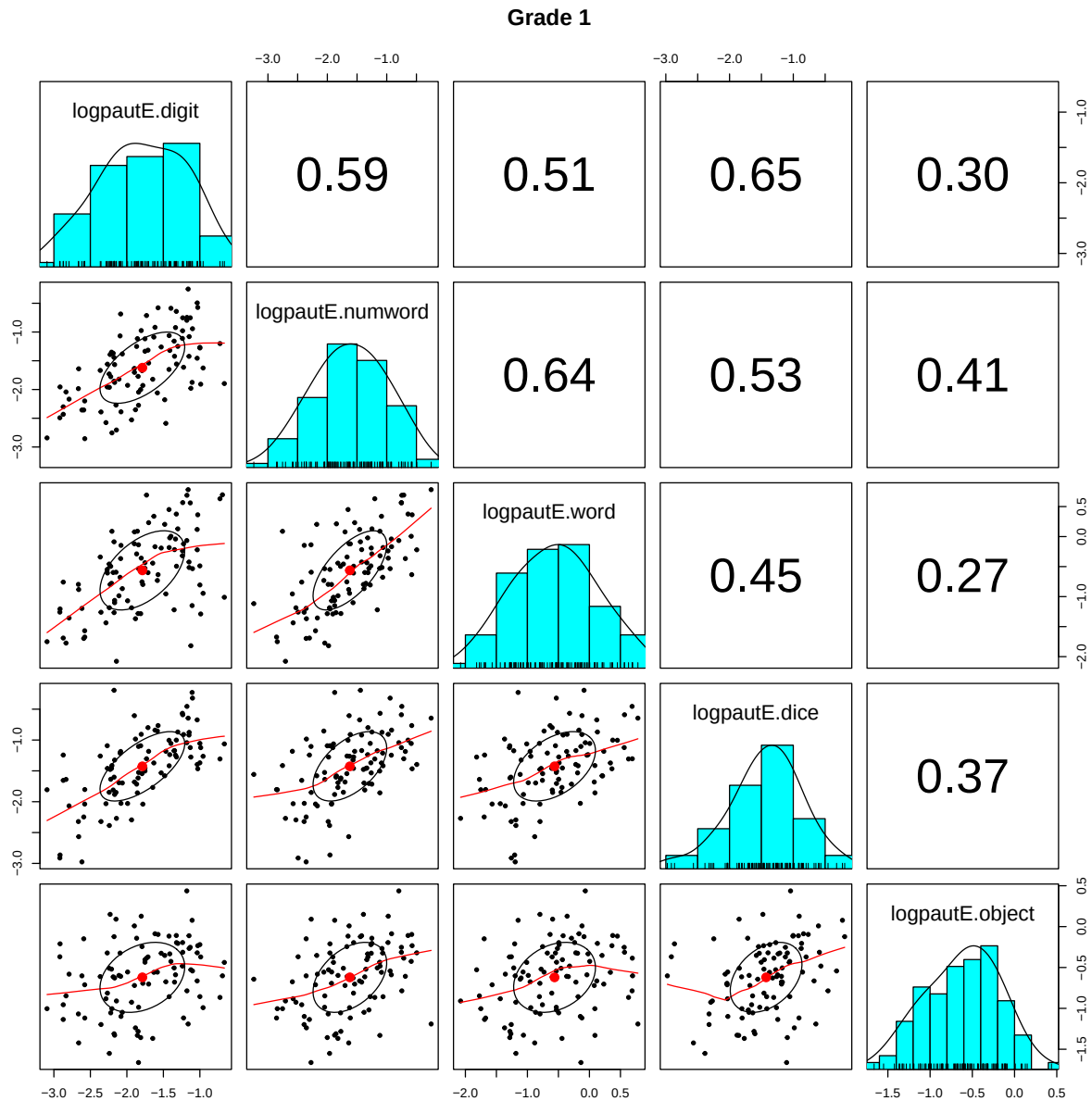
```



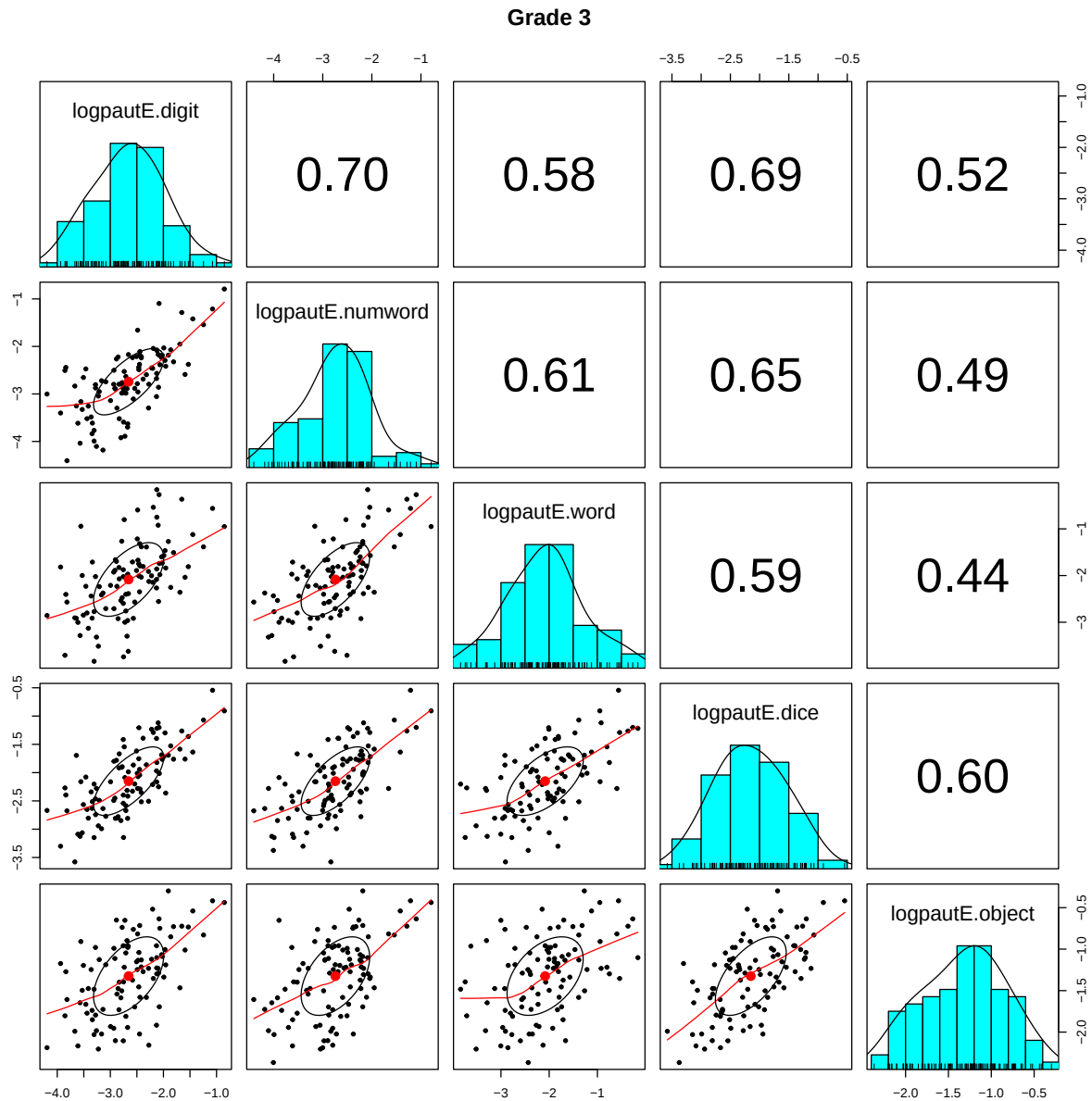
7.4 Intercorrelations among silent intervals

The following graph shows the interrelations among the serial pause times for each grade.

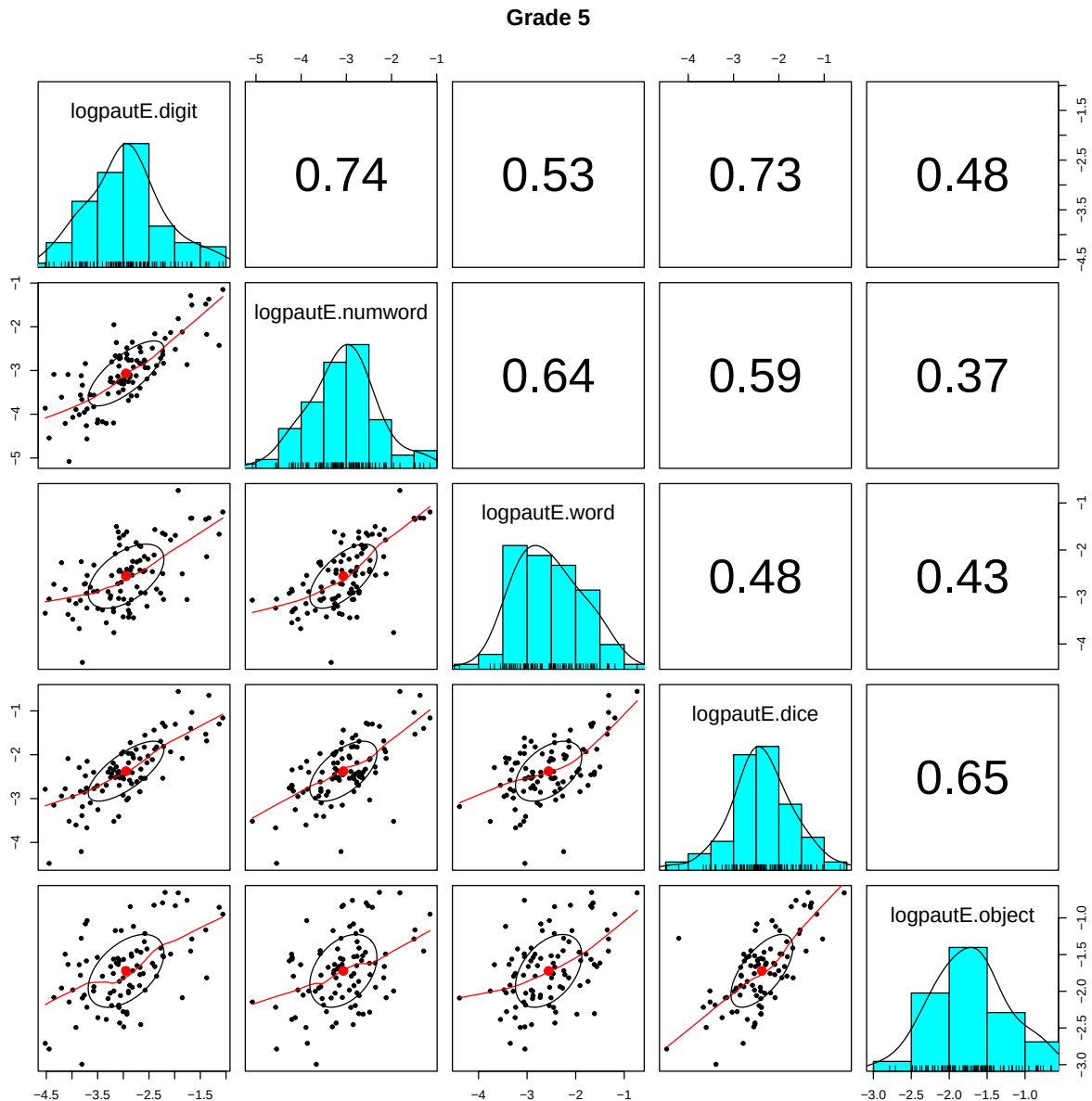
```
paunm <- paste("logpautE",tasks,sep=".")
pairs.panels(rsdw[rsdw$grade=="G1",paunm],method="spearman",main="Grade 1")
```



```
pairs.panels(rsdw[rsdw$grade=="G3",paunm],method="spearman",main="Grade 3")
```



```
pairs.panels(rsdw[rsdw$grade=="G5",paunm],method="spearman",main="Grade 5")
```



Correlations among pause times in different tasks vary a lot in all grades.

8 Session information

```
date()
```

```
## [1] "Fri Feb 9 12:19:50 2024"
```

```
sessionInfo()
```

```
## R version 4.3.1 (2023-06-16 ucrt)
## Platform: x86_64-w64-mingw32/x64 (64-bit)
## Running under: Windows 10 x64 (build 19045)
##
```

```

## Matrix products: default
##
##
## locale:
## [1] LC_COLLATE=Norwegian Bokmål_Norway.utf8 LC_CTYPE=Norwegian Bokmål_Norway.utf8
## [3] LC_MONETARY=Norwegian Bokmål_Norway.utf8 LC_NUMERIC=C
## [5] LC_TIME=Norwegian Bokmål_Norway.utf8
##
## time zone: Europe/Berlin
## tzcode source: internal
##
## attached base packages:
## [1] stats      graphics  grDevices  utils      datasets  methods   base
##
## other attached packages:
## [1] multcomp_1.4-24 TH.data_1.1-2 MASS_7.3-60 survival_3.5-5 mvtnorm_1.2-
2 nlme_3.1-162
## [7] lattice_0.21-8 mice_3.16.0 psych_2.3.3
##
## loaded via a namespace (and not attached):
## [1] sandwich_3.0-2 utf8_1.2.3 generics_0.1.3 tidyr_1.3.0 shape_1.4.6
## [6] lme4_1.1-33 digest_0.6.31 magrittr_2.0.3 mitml_0.4-5 evaluate_0.21
## [11] grid_4.3.1 iterators_1.0.14 fastmap_1.1.1 foreach_1.5.2 jomo_2.7-6
## [16] glmnet_4.1-7 Matrix_1.5-4.1 nnet_7.3-19 backports_1.4.1 purrr_1.0.1
## [21] fansi_1.0.4 codetools_0.2-19 mnormt_2.1.1 cli_3.6.1 rlang_1.1.1
## [26] splines_4.3.1 yaml_2.3.7 pan_1.6 tools_4.3.1 parallel_4.3.1
## [31] nloptr_2.0.3 minqa_1.2.5 dplyr_1.1.2 boot_1.3-28.1 broom_1.0.5
## [36] rpart_4.1.19 vctrs_0.6.3 R6_2.5.1 zoo_1.8-12 lifecycle_1.0.3
## [41] pkgconfig_2.0.3 pillar_1.9.0 glue_1.6.2 Rcpp_1.0.10 highr_0.10
## [46] xfun_0.39 tibble_3.2.1 tidyselect_1.2.0 rstudioapi_0.14 knitr_1.43
## [51] htmltools_0.5.5 rmarkdown_2.22 compiler_4.3.1

```