Using multilevel modelling to study affect changes during Ramadan fasting

Khairul Anwar Mastor & Hasnan Kasan

Universiti Kebangsaan Malaysia

Joshua Wilt & William Revelle

Northwestern University

Presentation order

- Brief introduction on fasting in Islam
- Study background
- Previous relevant studies
- Research questions
- Methodology
- Findings
- Discussion
- Conclusion

Brief introduction on fasting

- Fasting in Ramadan – one of the pillars in Islam
- Fast between dawn until sunset (duration varies across the globe & seasons) for about 29 or 30 days
- No eating, drinking (of course, not the beer or wine!) and sexual relationship (for husband-wife) during day hours
- Fasting as a test of obedience and patience
- More rewards for existing obligatory rituals (e.g. 5 times daily prayer), good deeds and optional daily activities.
- As a mean to attain **taqwa** (**piety**)
- Two levels of fasting
  - Ordinary level
  - Higher level

Ordinary Level

- No eating, drinking (of course, not the beer or wine!) and sexual relationship (for husband-wife) during day hours
- At the same time, performing additional (recommended) prayer at night
- Not really strict in controlling oneself from talking, looking or doing something less beneficials
- When breaking the fast, eat a lot! and then sleep a lot.

Higher Level

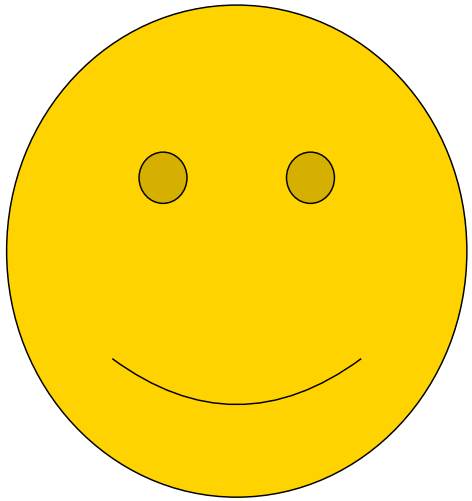
- No eating, drinking and sexual relationships during day hours
- Strictly control the amount of eating when break the fast, & control eye sight – not to see or watch ‘bad’/’naughty’ things.
- More involved in reciting Quran (complete reading of the whole Quran) and other religious obligations.

So, what do we expect the outcome of fasting?

- Pattern of emotion changes differ across weeks in Ramadan
- Higher level of positive emotion/traits
- Lower level of negative emotion/traits
- Muslim experience more of the changes as compared to the non-muslims
- Approaching end of Ramadan, happiness and joy may be higher
- Approaching end of Ramadan, moody and angry may be lower

Fasting as a test, passing test causes happiness and joy

Fasting for 29-30 days in a row



Eidul Fitr – celebration of the test

Targeted aims of fasting

- To become more pious or religious
- To inculcate the religiousness within oneself
- To become a better person in life

Other benefits

- As a mean to become more serene, calm, more patience, more empathetic, more religious, – psychologically (including emotion) more positive and healthier
  - –E.g. empathize the poor (by actual experiencing the hunger)
- As a mean to rejuvenate the healthy body – physically and biologically healthier

Previous Studies

- Afifi (1997) – people get more involved in stress reducing – reciting Quran
- Mesbahzadeh et al (2005) – testosterone level was lower in Ramadan
- Kadri et al (2000) – irritability higher among smokers in Ramadan
  - –People were more irritable at the end of Ramadan

- Roky et al., (2000) – subjective alertness and mood decreased during Ramadan
- Ali & Amir (1989) – fasting is likely reduce perceptual sensitivity.

Present Study

- Based on the expected effects of Ramadan fasting, the hypotheses of the study are:

- Hypothesis 1: During fasting month, levels of positive emotion and personality traits increase
- Hypothesis 2: During fasting month, levels of negative emotion and personality traits decrease

Methodology

- Daily record of emotion : prior, during and after Ramadan fasting.
- Daily record started about 10 days before Ramadan and ended about 30 days after Ramadan
- Students were told to record their daily emotion/feeling/mood without actually reminding them about the coming of Ramadan month – to avoid bias

Respondents

- Total N = 164 undergraduate and postgraduate diploma
- Muslim = 117 (71.3%), Non-Muslim = 47 (28.7%)
- Male = 42 (25.6%), Female = 122 (74.4%)
- Min age = 21.6, (from 18-42 yrs old)

Measure of Emotion

1=very low 2=low 3=slightly low 4=slightly high 5=high 6=very high

- Angry
- Patience
- Impatience
- Calm
- Sadness
- Happiness
- Moody
- Joy
- Fear
- Stubborn
- Obedience
- Jealous

Results

- A total of 11,223 records of emotion across 82 days

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Khairul A. Mastor, Hasnan Kasan, Joshua Wilt, and William Revelle

Department of Psychology
Northwestern University
Evanston, Illinois USA

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Outline

Raw data

Raw data are typically entered in 'long' format

- SPSS data in 'long' format
- The 'foreign' packages is capable of reading SPSS files
- read.spss("filepath", use.value.labels = FALSE)

Matric_number	Gender	Race	Religion	Age	Angry_3Sept	Patience_3Sept	Impatience_3Sept	Calm_3Sept	Sad_3Sept	Happy_3S...
41460.00	1.00	1.00	1.00	30.00	2.00	5.00	3.00	5.00	2.00	4.00
41926.00	2.00	1.00	1.00	39.00	1.00	4.00	2.00	4.00	1.00	4.00
115647.0	2.00	1.00	1.00	21.00	2.00	5.00	2.00	5.00	2.00	5.00
41931.00	2.00	1.00	1.00	31.00	2.00	4.00	1.00	4.00	4.00	3.00

Raw data

Raw data can also be read from Excel and Text files

- Basic commands
  - read.table("filepath", header = T)
  - read.csv("filepath", header = T)
- Using the psych package: read.clipboard and read.clipboard.csv
  - personality-project.org/r/psych
  - Copy the data directly from an Excel or Text file

```
ramadan.data <- read.clipboard()
```

Stack the data

- Data in 'long' format is not suited for repeated measures analyses
- The 'stack' command transforms data from long format to stacked format

```
stack(ramadan.data)  #converts data array to a vector

#see http://personality-project.org/r/ for commands used
 to set number of subjects, variables, etc.
```

- Example participant data in 'stacked' format

number	Gender	Race	Religion	Age	time	anger	patience
1	2	1	1	23	50	3	4
1	2	1	1	23	51	2	4
1	2	1	1	23	52	3	3
1	2	1	1	23	53	2	4
1	2	1	1	23	54	2	3
1	2	1	1	23	55	3	3
1	2	1	1	23	56	1	4
1	2	1	1	23	57	2	2
1	2	1	1	23	58	1	3
1	2	1	1	23	59	2	2
1	2	1	1	23	60	3	3

Describe the data

- Use the 'describe' function to catch mistakes
  - Examining the mean, sd, min, and max can help catch common mistakes* such as missing data and combining data across columns

```
describe(ramadan.data2)
               var     n  mean    sd median trimmed   mad min max range  skew
number           1 13695 83.00 47.63   83.0   83.00 60.79   1 165   164  0.00
Gender           3 13612  1.74  0.44    2.0    1.80  0.00   1   2     1 -1.12
Race             4 13612  1.33  0.58    1.0    1.23  0.00   1   4     3  1.94
Religion         5 13612  1.40  0.77    1.0    1.23  0.00   1   5     4  2.37
Age              6 13280 21.59  4.47   21.0   20.66  1.48   0* 42    42  1.73
time             7 13695 42.00 23.96   42.0   42.00 31.13   1  83    82  0.00
anger            8 11279  1.87  1.13    1.0    1.67  0.00   1  66*   65* 1.32
patience         9 11445  3.80  1.29    4.0    3.84  1.48   1   6     5 -0.34
impatience      10 11282  2.01  1.16    2.0    1.83  1.48   1   6     5  1.13
calm            11 11461  3.72  1.31    4.0    3.77  1.48   1   6     5 -0.32
sad             12 11328  1.98  1.20    2.0    1.77  1.48  -1*  6     7* 1.29
happy           13 11473  3.87  1.32    4.0    3.90  1.48   1   6     5 -0.35
moody           14 11237  2.11  1.22    2.0    1.94  1.48   1   6     5  1.01
joy             15 11471  3.78  1.35    4.0    3.82  1.48   1   6     5 -0.32
fear            16 11250  1.86  1.20    1.0    1.62  0.00   1   6     5  1.50
stubborn        17 11212  1.70  1.05    1.0    1.48  0.00   1   6     5  1.67
obedience       18 11380  3.80  1.44    4.0    3.88  1.48   1   6     5 -0.49
jealous         19 11196  1.42  0.85    1.0    1.21  0.00   1   6     5  2.50
```

Clean the data

- Use the 'scrub' function to fix mistakes

```
scrub(ramadan.data2, where = c(5,7,11), min = c(18,1,1), max = c(42,6,6))
describe(ramadan.data2)
```

	var	n	mean	sd	median	trimmed	mad	min	max	range	skew
number	1	13695	83.00	47.63	83.0	83.00	60.79	1	165	164	0.00
Gender	3	13612	1.74	0.44	2.0	1.80	0.00	1	2	1	-1.12
Race	4	13612	1.33	0.58	1.0	1.23	0.00	1	4	3	1.94
Religion	5	13612	1.40	0.77	1.0	1.23	0.00	1	5	4	2.37
Age	6	13280	21.59	4.47	21.0	20.66	1.48	18*	42	42	1.73
time	7	13695	42.00	23.96	42.0	42.00	31.13	1	83	82	0.00
anger	8	11279	1.87	1.13	1.0	1.67	0.00	1	6*	5*	1.32
patience	9	11445	3.80	1.29	4.0	3.84	1.48	1	6	5	-0.34
impatience	10	11282	2.01	1.16	2.0	1.83	1.48	1	6	5	1.13
calm	11	11461	3.72	1.31	4.0	3.77	1.48	1	6	5	-0.32
sad	12	11328	1.98	1.20	2.0	1.77	1.48	1*	6	6*	1.29
happy	13	11473	3.87	1.32	4.0	3.90	1.48	1	6	5	-0.35
moody	14	11237	2.11	1.22	2.0	1.94	1.48	1	6	5	1.01
joy	15	11471	3.78	1.35	4.0	3.82	1.48	1	6	5	-0.32
fear	16	11250	1.86	1.20	1.0	1.62	0.00	1	6	5	1.50
stubborn	17	11212	1.70	1.05	1.0	1.48	0.00	1	6	5	1.67
obedience	18	11380	3.80	1.44	4.0	3.88	1.48	1	6	5	-0.49
jealous	19	11196	1.42	0.85	1.0	1.21	0.00	1	6	5	2.50

Create Scales

- Use the 'list', 'make.keys', and 'score.items' functions to create positive affect and negative affect scales

```
keys.list <- list(number=(1), Gender=(3), Race=(4), Religion=(5), Age= (6),  Time=(7),
PosA=c(11,13,15), NegA= c(8,12,16))

#PosA = calm, happy, joy
#NegA =anger, sad, fear

ramadan.keys = make.keys(23,keys.list, item.labels= colnames(ramadan.data2))

ramadan.score = score.items(ramadan.keys, ramadan.data2, min=1, max=6, digits=3)

describe(ramadan.scores$scores[,c(7,8))

         var     n  mean    sd median trimmed   mad min max range  skew kurtosis   se
PosA       7 13695  3.82  1.03   4.00    3.87  0.99   1   6     5 -0.40     0.07 0.01
NegA       8 13695  1.80  0.83   1.33    1.67  0.49   1   6     5  1.45     2.11 0.01
```

Data are nested at multiple levels

- Daily reports are nested within subjects and subjects are nested within larger groups (e.g., religion)
- Days are nested within weeks and weeks are nested within months (or other time periods, such as before and after Ramadan)

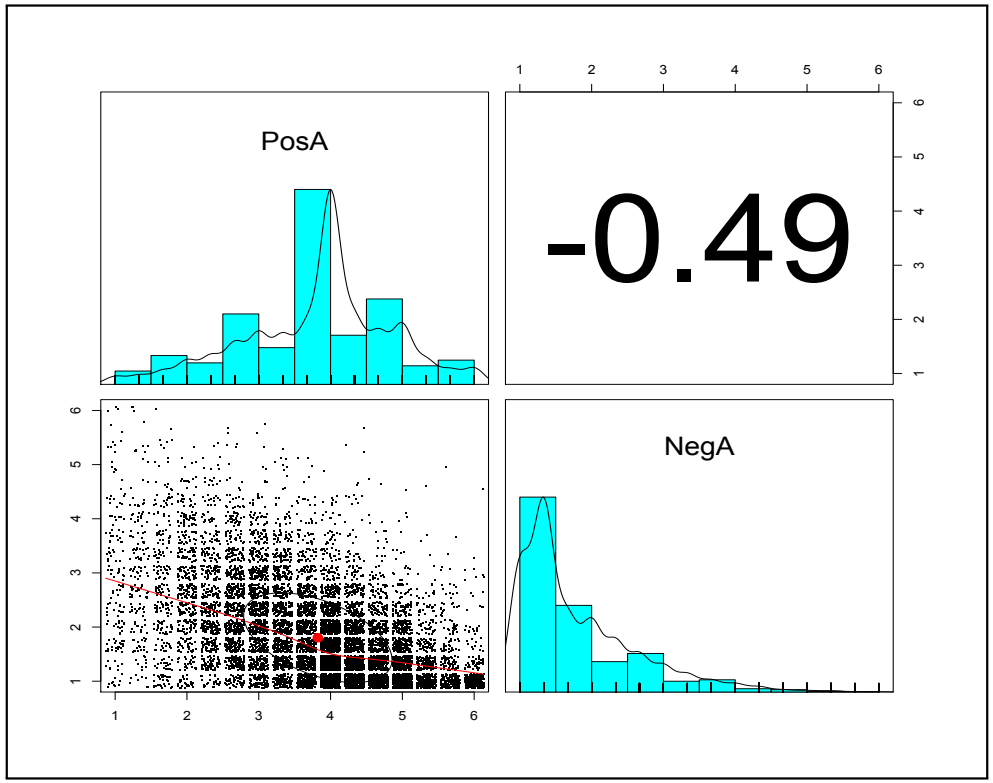
It can be tempting to fall down the rabbit hole and conduct "all possible" analyses

- For example, it might be interesting to examine the associations between positive and negative affect within and across many different levels
- Although some results could be interesting and informative, this strategy is likely to lead to a plethora of Type I errors
- Theory-driven data analysis strategies generate focus in the face of possibly overwhelming amounts of data
  - What are the important levels?
  - What are the theoretically relevant issues that the data can address?

Ignoring the multilevel structure of the data

Describing positive and negative affect across all reports

	Mean	SD	Skew	Kurtosis
Positive Affect	3.82	1.03	-0.40	0.07
Negative Affect	1.80	0.83	1.45	2.11



Ignoring the multilevel structure of the data

Structure of positive and negative affect across all reports

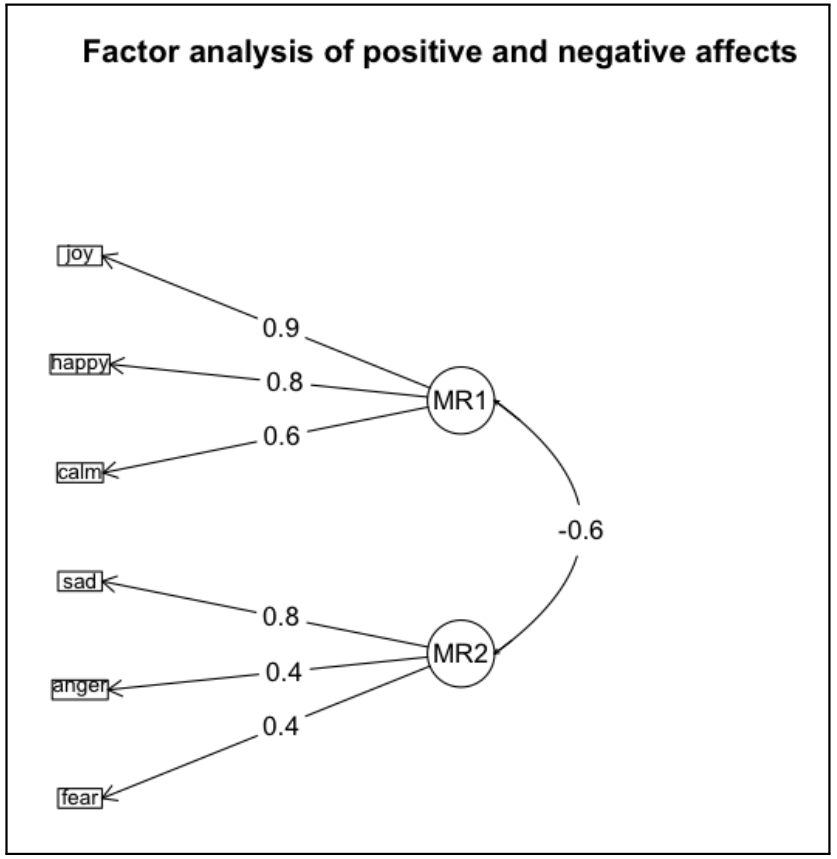
```
fa.all <- fa(ramadan.data2
[,c(11,13,15,8,12,16)],2)

Standardized loadings
        MR1   MR2   h2   u2
calm   0.58 -0.06 0.37 0.63
happy  0.82 -0.05 0.71 0.29
joy    0.88  0.05 0.73 0.27
anger -0.19  0.42 0.29 0.71
sad    0.02  0.82 0.65 0.35
fear  -0.07  0.41 0.21 0.79

With factor correlations of
      MR1   MR2
MR1  1.00 -0.56
MR2 -0.56  1.00

RMSR is  0.02
TLI =  0.955
RMSEA index =  0.073
```

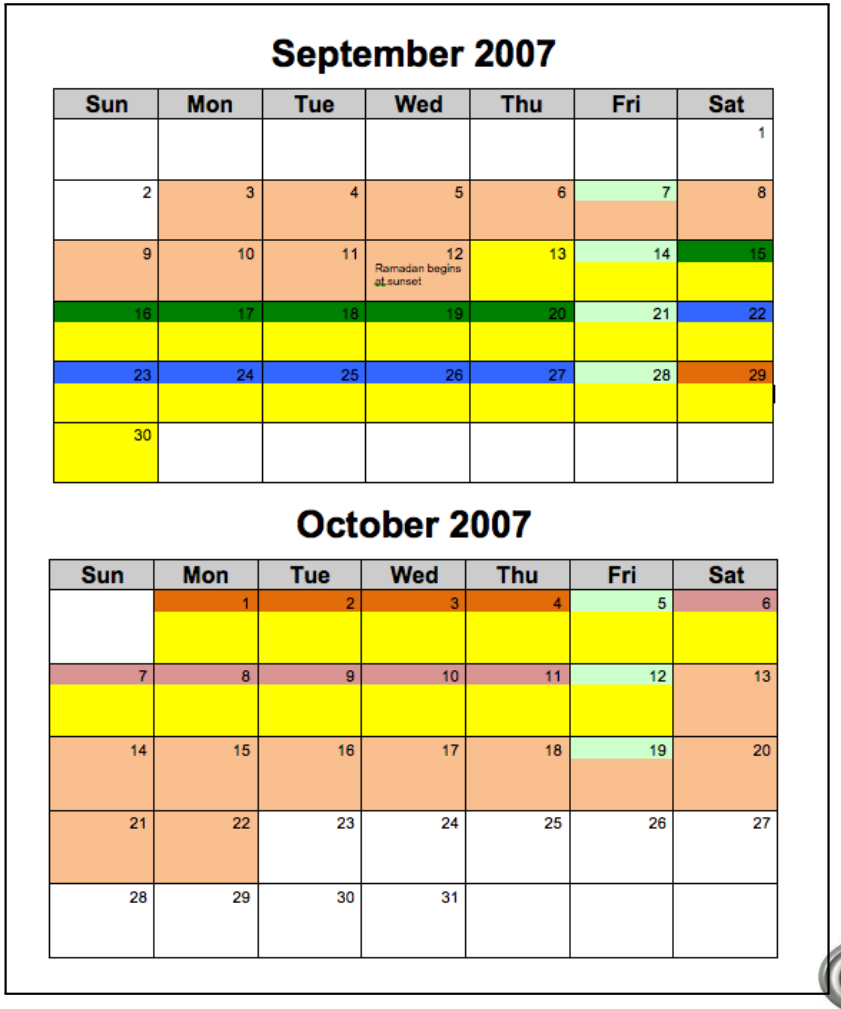
```
fa.diagram(fa.all, main = "Factor analysis of
positive and negative affects")
```



Ramadan

Days are nested within time-periods before, during, and after Ramadan

- Levels of data may correspond with interesting theoretical questions
  - How does Ramadan affect mean levels of PA and NA?
  - How does Ramadan relate to affective variability?
  - How does Ramadan affect the covariation between affects, or the factor structure of affect?
  - Do the answers to these questions depend on whether an individual is Muslim?



statsBy

The 'statsBy' function in the psych package is a simple function to give some basic descriptive statistics for two-level models

```
statsBy(data, group, cors = FALSE, method="pearson")
```

Value	Description
means	The means for each group for each variable.
sd	The standard deviations for each group for each variable.
n	The number of cases for each group and for each variable.
ICC1	The intraclass correlation reflects the amount of total variance associated with the grouping variable.
ICC2	The intraclass correlation (2) reflecting how much the groups means differ.
F	The F from a one-way anova of group means.
rwg	The pooled within group correlations.
rbg	The sample size weighted between group correlations.
etawg	The correlation of the data with the within group values.
etabg	The correlation of the data with the group means.
pbg	The probability of the between group correlation
pwg	The probability of the within group correlation

This presentation contains several examples showing how the statsBy function can be applied to the multilevel Ramadan data. A number of other functions and packages for analyzing multilevel data will also be highlighted.

How does Ramadan affect mean levels of PA and NA?

error.bars.by

The following code generates an 'error.bars.by' plot, which shows means and SDs for PA and NA by day

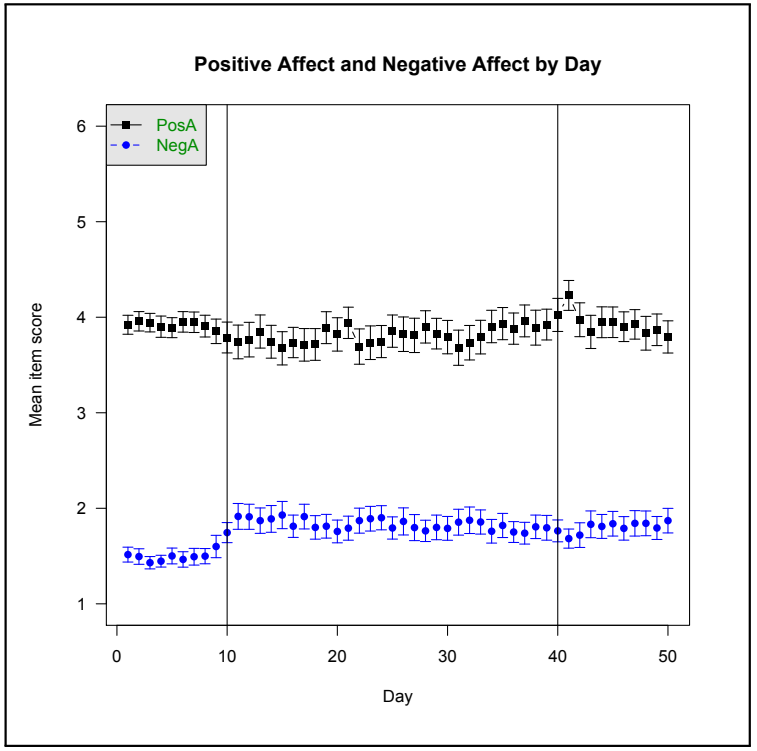
```
error.bars.by(ramadan.10.10.scores[,c(7, 8)],
ramadan.10.10.scores$Time,by.var=TRUE,
main="Positive Affect and Negative Affect by
Day", legend=5, labels=c("PosA","NegA"), xlab
= "Day", ylab="Mean item score", las = 2, xaxt
 = "n")
```

statsBy

The following code uses the 'subset' and 'statsBy' functions to select data by timeframe and compute means and SDs of PA and NA across days (before Ramadan). The table on the right shows means and SDs for PA and NA before, during, and after Ramadan)

```
ramadan.10.scores<-subset(ramadan.scores2,
Time < 11)

stats.first.10.pana <- statsBy(ramadan.10.scores
[,c(6,7,8)], group = "Time")
stats.first.10.pana$mean
stats.first.10.pana$sd
```



Variable	Before Ramadan		Ramadan		After Ramadan	
	Mean	SD	Mean	SD	Mean	SD
Positive Affect	3.91	0.05	3.82	0.09	3.81	0.13
Negative Affect	1.52	0.09	1.83	0.06	1.85	0.19

It appears that NA increases during Ramadan and remains high after Ramadan, however, these results do not take into account that observations are nested within persons

How does Ramadan affect mean levels of PA and NA?

The ability to specify random-effects in multilevel modeling examines whether the previous results are simply due to between-person variation of PA and NA intercepts

Positive Affect

The following linear mixed effects model predicting positive affect from time-frame (period) allows the intercept of positive affect to vary across individuals (number)

```
library(nlme)

pa.b4ram.lme <- lme(PosA ~ as.factor(period),
random=~1|as.factor(number), data =
ramadan.10.10.scores)
```

	Value	p-value
(Intercept)	3.91	<.001
as.factor(period)2	-0.09	<.001
as.factor(period)3	0.02	0.48

Positive affect was lower during Ramadan (period 2) than before Ramadan

Negative Affect

Linear mixed effects model predicting negative affect from time period

```
na.b4ram.lme <- lme(NegA ~ as.factor(period),
random=~1|as.factor(number), data =
ramadan.10.10.scores)
```

	Value	p-value
(Intercept)	1.52	<.001
as.factor(period)2	0.31	<.001
as.factor(period)3	0.28	<.001

Negative affect was higher during Ramadan (period 2) and after Ramadan, as compared with before Ramadan

Does Ramadan correspond to increases in PA and decreases in NA?
Examining this question from the person perspective

- The previous analyses examined affect at multiple levels of "time" (by day and before/during/after Ramadan).
- The following analyses examine affect aggregated by time period, by individuals (each participant), and by religion

Examining affect for Muslim (N= 118) and Non-Muslim (N= 47) participants

```
#After using the `subset' command to divide the data by timeframe (before/during/after Ramadan)
and religion (Muslim/Non-Muslim), the `statsBy' command was used to examine means
(and SDs of means) aggregated at the person level ("number")

#example code for examining positive affect of Muslims during Ramadan

stats.ramadan.pana.muslim.person <- statsBy(ramadan.1140.muslim.scores[,c(1,7,8)],
group = "number")

describe(stats.ramadan.pana.muslim.person$mean)
```

Variable	Before Ramadan		Ramadan		After Ramadan	
	Mean	SD	Mean	SD	Mean	SD
Positive Affect (Muslim)	3.95	0.53	3.88	0.74	3.87	0.60
Positive Affect (Non-Muslim)	3.80	0.54	3.66	0.73	3.65	0.69
Negative Affect (Muslims)	1.52	0.36	1.82	0.49	1.84	0.50
Negative Affect (Non-Muslim)	1.52	0.36	1.86	0.55	1.87	0.53

It appears that PA is higher for Muslims compared to Non-Muslims, and that this effect may be especially strong during and after Ramadan

Does Ramadan correspond to increases in PA and decreases in NA?

Examining this question from the person perspective

Multilevel modeling syntax and results

```
#for positive affect - notice that time period is nested in individuals

pa.time.religion.lme <- lme(PosA ~ as.factor(period)*as.factor
(new.religion), random=~as.factor(period)|as.factor(number),
data = ramadan.10.10.scores)

*There were no significant effects, indicating that PA did not depend on
time period, religion, or their interaction

#for negative affect

na.time.religion.lme <- lme(PosA ~ as.factor(period)*as.factor
(new.religion), random=~as.factor(period)|as.factor(number),
data = ramadan.10.10.scores)

*Religion effects were not significant.  Negative affect was lower
before Ramadan as compared to during Ramadan (b = .30, p <.001) and
after Ramadan (b = .25, p <.001)
```

Variation in Positive and Negative Affect

The 'statsBy' function can also be used to examine between-group variation and within-group variation

Example syntax used to compare between-person variation to within-person variation for Muslims and Non-Muslims during Ramadan

```
#between-person standard deviations for muslims during Ramadan
describe(stats.ramadan.pana.muslim.person$mean)

#average within-person standard deviations for muslims during Ramadan
describe(stats.ramadan.pana.muslim.person$sd)

#percentage of total variation due to between-person variation (ICC1)
stats.ramadan.pana.muslim.person$ICC1

#reliability of group differences (ICC2)
stats.ramadan.pana.muslim.person$ICC2
```

- The 'VarCorr' function in the package multilevel can also be used to compare between-group and within-group variance
- The 'ICC1' and 'ICC2' functions in the nlme package can be used to calculate *ICCs*
- The 'pooledSD' function in the nlme package can be used to obtain pooled *SDs*

Comparing between-person variation to within-person variation for Muslims and Non-Muslims during Ramadan

	Between-person *SD*	Within-person *SD*	*ICC1*	*ICC2*
Positive Affect (Muslim)	0.74	0.80	0.43	0.96
Positive Affect (Non-Muslim)	0.73	0.81	0.40	0.95
Negative Affect (Muslims)	0.49	0.61	0.34	0.94
Negative Affect (Non-Muslim)	0.55	0.63	0.37	0.95

- Results were similar for Muslims and Non-Muslims
- The 'mssd' and 'rmssd' functions in the psych package can be used to obtain time-sensitive indices of variability

Covariation of Positive and Negative Affect

Using the statsBy function to examine between-person and within-person correlations for Muslims and Non-Muslims before, during, and after Ramadan

Example code

```
stats.ramadan.pana.muslim.person$rbg #between-person correlations for Muslims during Ramadan

stats.ramadan.pana.muslim.person$rwg #between-person correlations for Muslims during Ramadan
%\begin{block}
```

Time period	Type of correlation	*r* (Muslim)	*r* (Non-Muslim)
Before Ramadan	Between-person	-.43	-.71
Ramadan	Between-person	-.44	-.43
After Ramadan	Between-person	-.43	-.50
Before Ramadan	Within-person	-.43	-.51
Ramadan	Within-person	-.53	-.55
After Ramadan	Within-person	-.49	-.60

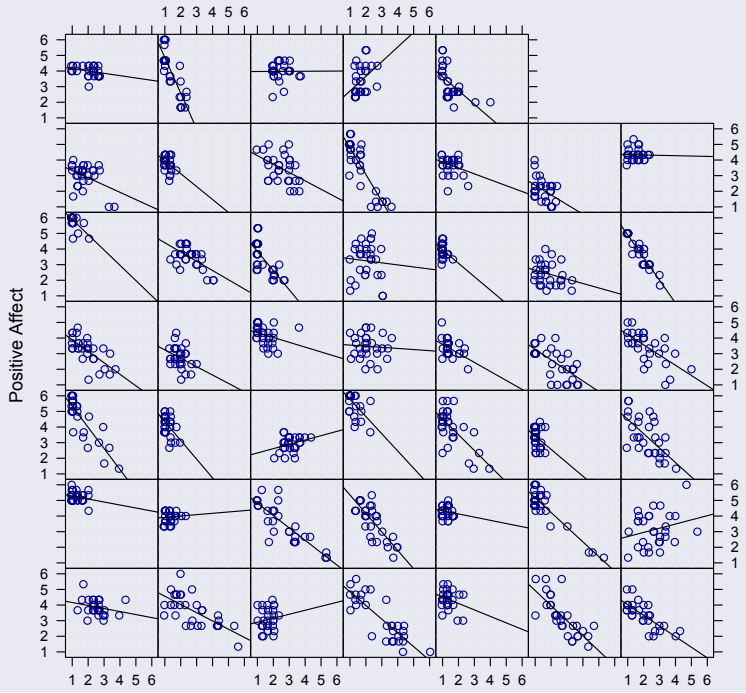
- With the exception of the strong negative between-person correlation for Non-Muslims before Ramadan, results were similar for Muslims and Non-Muslims

Graphing the Covariation of Positive and Negative Affect

The lattice package can be used to graph each individual's association between PA and NA

Example: Association between PA and NA for Non-Muslims during Ramadan

```
library(lattice)
xyplot(PosA ~ jitter(NegA) | number,type = c("p","g","r"),col = "dark blue",col.line = "black",
xlab = "Negative Affect", ylab = "Positive Affect", jitter.data = TRUE, strip = FALSE,
data = ramadan.1140.nonmuslim.scores)
```



Coming attractions: Analytic strategies for multilevel data

- "Multilevel factor analysis"
  - Instead of creating PA and NA composites, we could have looked at the structure of affective adjectives across different levels
  - Between and within-person correlations of calm, happy, joy, anger, sad, fear for Muslims and Non-Muslims before/during/after Ramadan
  - Factor analyses on each of the correlation matrices
  - Coming soon, the factorBy function will be able to handle these analyses
- Just as R is addicting and can lead to proselytizing, so too is analyzing multilevel data with R

Thank You –
Terima kasih

kam2000@ukm.my