

Moderated Mediation Analysis

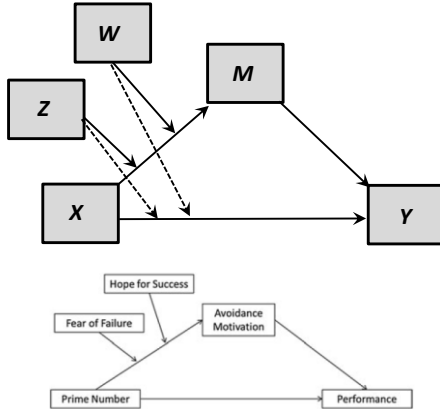
Andrew Hayes, Ph.D.

Upcoming Seminar:

October 27-28, 2017, Philadelphia, PA

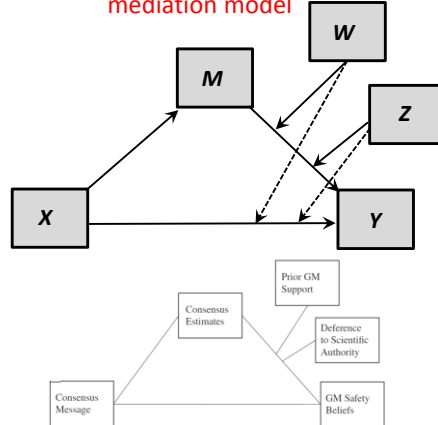
Two moderators of the same path

A first stage dual moderated mediation model



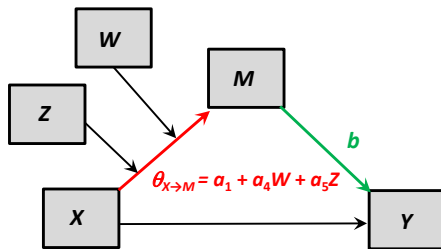
Schuler, J., Brandstatter, V., & Baumann, N. (2013). Failure cue priming and impaired cognitive performance-analyses of avoidance motivation as a mediator and fear of failure as a moderator. *European Journal of Social Psychology*, 43, 335-343.

A second stage dual moderated mediation model



Dixon, G. (2016). Applying the gateway belief model to genetically modified food perceptions: New insights and additional questions. *Journal of Communication*, 66, 888-908.

The indirect effect is an additive linear function of two moderators



Indirect effect of X

$$\theta_{X \rightarrow M} b = (a_1 + a_4W + a_5Z)b$$

or

$$a_1b + a_4bW + a_5bZ$$

which is a linear function of both W and Z .

$$\hat{M} = i_1 + a_1X + a_2W + a_3Z + a_4XW + a_5XZ$$

$$\hat{Y} = i_2 + c'X + bM$$

The model for M can be written in equivalent form as

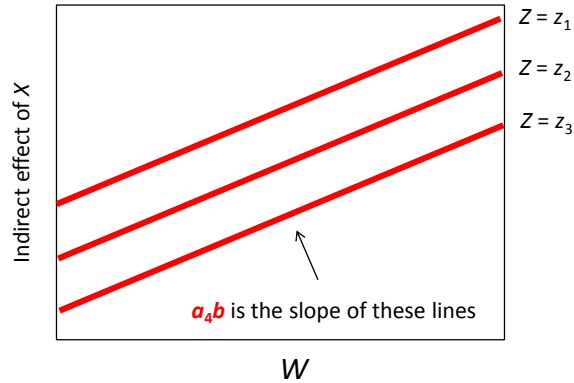
$$\hat{M} = i_1 + (a_1 + a_4W + a_5Z)X + a_2W + a_3Z \quad \text{or} \quad \hat{M} = i_1 + \theta_{X \rightarrow M}X + a_2W + a_3Z$$

where $\theta_{X \rightarrow M} = a_1 + a_4W + a_5Z$ is the conditional effect of X on M . It is a linear function of both W and Z .

Index of “partial moderated mediation”

$$\text{Indirect effect of } X: (a_1 + a_4W + a_5Z)b = a_1b + \underline{a_4bW} + a_5bZ$$

When visualized, the model of the indirect effect of X might look something like this (depending on the estimates of the regression coefficients)

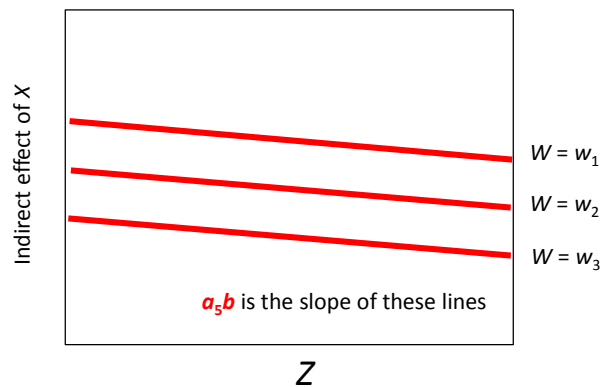


- a_4b , the “index of partial moderated mediation” by W , quantifies how the indirect effect of X changes as W changes but Z is fixed.
- Test whether this index is different from zero to test “partial moderated mediation.” of X ’s effect on Y through M by W . PROCESS can do this using a bootstrap CI.

Index of “partial moderated mediation”

$$\text{Indirect effect of } X: (a_1 + a_4W + a_5Z)b = a_1b + a_4bW + \underline{a_5bZ}$$

When visualized, the model of the indirect effect of X might look something like this: (depending on the estimates of the regression coefficients)



- a_5b , the “index of partial moderated mediation” by Z , quantifies how the indirect effect of X changes as Z changes but W is fixed.
- Test whether this index is different from zero to test “partial moderated mediation.” of X ’s effect on Y through M by Z . PROCESS can do this using a bootstrap CI.

An example

Military trauma and social development: The moderating and mediating roles of peer and sibling relations in mental health

Kirsti Peltonen,¹ Samir Qouta,² Eyad El Sarraj,³ and
Rajaa-Leena Punamäke¹

Abstract
We first examined how war-related traumatic events impact on peer and sibling relations, and how the quality of these relations in turn are associated with children's mental health, indicating a mediating model. Second, we tested the moderating (protective) effects of good peer and sibling relations in attenuating the link between trauma and mental health. The participants were 227 Palestinian boys and girls aged 10–14 years living in the Gaza Strip. They reported their exposure to military trauma, indicated the quality of peer relationships (friendliness and friendliness) and sibling relationships (warmth, intimacy, conflict and rivalry), and reported symptoms of PTSD, CDI depression and IQD psychological distress. The results show that exposure to military trauma was associated with weaker quality of sibling relations and with low friendship quality especially among girls and younger children. The association between military trauma and symptoms was mediated by poor friendship and sibling relations. Only sibling relations, but not peer relations had a moderating effect, as military trauma was not associated with severe symptoms among children who reported considerable intimacy and warmth and lacked rivalry in their siblingships. We discuss theoretical and practical implications of the role of peer and sibling relations in helping children to overcome war conditions.

Keywords
mediation, moderation, Palestinians, peer relations, sibling relations, trauma

Trauma as a life-threatening event affects children's mental health and development extensively. Research has largely focused on psychological symptoms such as post-traumatic stress disorder (PTSD), while the impact of trauma on social relations and other developmental aspects, as reported in this case, is ignored. Sibling and peer relations are crucial for children's mental health and development in general, and we may suggest, especially in war conditions where children's sense of security is under threat. In this article we examine how exposure to military violence such as war-related trauma and exposure to military violence are associated with children's social development, indicated by the quality of peer and sibling relationships. We test a mediation model of trauma being associated with psychological symptoms via deteriorated social relations, and a moderation model of good social relations being able to protect children's mental health from negative trauma impacts.

Military violence and children's mental health

War and military violence easily correspond to the criterion of trauma as they expose children to dangers and injuries, and threaten their own and their beloved ones' physical and psychological integrity (Chaffetz, 2006). If diagnosed with post-traumatic stress disorder (PTSD), children have reacted to trauma with intense fear and helplessness and suffer from symptoms characterized by re-experiencing the horrors in dreams and flashbacks, avoidance of trauma reminders and numbing of feelings, and finally, constant

anxiety and vigilance against threats and dangers. The prevalence of PTSD has been found to vary between 33–73% in war zones in Africa (Mogren, Williams, & Lugo, 2007), Asia (Liem, Smith, Schaner, Kishor, & Nasser, 2000) and Middle East (Abdoun, Gervais, & Nadeau, 2000; Thabet, Breakey, Morahan, Warner, & Vostanis, 2009).

In addition to PTSD, children faced mood regulation, depression and other psychological problems are common among children exposed to war trauma. They suffer generalized anxiety, intrusive fears and phobias, somatic complaints and sleeping difficulties (Montgomery & Follingstad, 2005; Pine, Corbello, & Maren, 2005; Yule, 2009). War trauma is further associated with heightened levels of concentration, mood and comprehension problems, often leading to poor school achievement (Dough, Lundy, O'Farrell, Hildreth, & Berman, 2006).

The research on PTSD is sometimes reinterpreted to indicate that war atrocities and military threats are automatically associated with mental health problems. Although extreme dangers result in distress in most children, clinically significant problems in war are

208 Palestinian children between the ages of 10 and 14 living in Gaza and measured in 2006.

TRAUMA: A count of exposure to traumatic events during the Al-Aqsa Intifada (e.g., shelling of home, being shot, losing family members, witnessing of killing). Range: 0 to 18

FRQUAL: Quality of a child's friendships as measured with the Friendship Qualities questionnaire. Eight items scaled 1 to 5 e.g., "I have friends with whom can share my secrets"

DEPRESS: Depressive symptoms measured by the Child Depression Inventory (CDI). Range 1 to 28.

AGE: Child age in years

SEX: Sex of the child (0 = female, 1 = male)

The data: GAZA

GAZA.SAV

	age	sex	frqual	trauma	depress
1	13	1	5.000	8.00	8
2	10	1	4.875	10.00	8
3	10	0	3.500	6.00	7
4	12	1	3.000		
5	11	0	4.125		
6	11	1	4.250		
7	11	1	4.125		
8	10	1	3.375		
9	11	1	5.000		
10	12	1	5.000		
11	10	1	1.000		

GAZA.SAS

```
data gaza;
input age sex frqual trauma depress;
datalines;
13 1 5.000 8.00 8
10 1 4.875 10.00 8
10 0 3.500 6.00 7
12 1 3.000 8.00 19
11 0 4.125 8.00 3
11 1 4.250 15.00 5
11 1 4.125 12.00 8
10 1 3.375 9.00 11
11 1 5.000 6.00 6
12 1 5.000 7.00 4
```

The model

**Military trauma and social development:
The moderating and mediating roles of
peer and sibling relations in mental health**

Kirsi Peltonen,¹ Samir Qouta,² Eyad El Sarraj,² and
Rajja-Leena Punamäke³

Abstract

We first examined how war-related traumatic events impact on peer and sibling relations, and how the quality of these relations in turn are associated with children's mental health, indicating a mediation model. Second, we tested the moderating (processes) effects of good peer and sibling relations in attenuating the link between trauma and mental health. The participants were 227 Palestinian boys and girls aged 10–14 years living in the Gaza Strip. They reported their exposure to military trauma, evaluated the quality of peer relationships (friendship and friendship) and sibling relationships (sisterhood, intimacy, conflict and rivalry), and reported symptoms of PTSD, GDS depression and SDQ psychological distress. The results show that exposure to military trauma was associated with more rivalry in sibling relations and with low friendship quality especially among girls and younger children. The association between military trauma and symptoms was mediated by poor friendship and rivalry sibling relations. Only sibling relations had a moderating effect, as military trauma was not associated with severe symptoms among children who reported considerable intimacy and warmth and lacked rivalry in their siblingships. We discuss theoretical and practical implications of the role of peer and sibling relations in helping children in traumatic war conditions.

Keywords

mediation, moderation, Palestinians, peer relations, sibling relations, trauma

Trauma as a life-threatening event affects children's mental health and development extensively. Research has largely focused on psychological symptoms such as post-traumatic stress disorder (PTSD), while the impact of trauma on social relations and other developmental aspects, as important as they are, is ignored. Optimal family and peer relations are crucial for children's mental health and development in general, and, we may suggest, especially in war conditions where children's sense of security is under threat. In this article we examine how exposure of military violence such as loss of close persons and witnessing killing are associated with children's social development, indicated by the quality of peer and sibling relationships. We test a mediation model of trauma being associated with psychological symptoms via deteriorated social relations, and a moderating model of good social relations being able to protect children's mental health from negative trauma impacts.

Military violence and children's mental health

War and military violence mostly correspond to the criterion of trauma as they expose children to dangers and injuries, and threaten their own and their beloved ones' physical and psychological integrity (Holland, 2000). If diagnosed with post-traumatic stress disorder (PTSD), children have reacted to trauma with intense fear and helplessness and suffer from symptoms characteristic for re-experiencing the horrors in dreams and flashbacks, avoidance of trauma reminders and numbing of feelings, and finally, constant

anxiety and vigilance against threats and dangers. The prevalence of PTSD has been found to vary between 15–75% in war zones in Africa (Hague, Wessely, & Caplan, 2007), Asia (Carmel, Inzhar, Schreier, Kishitani, & Nasser, 2000) and Middle East (Jablon, Qouta, & Nasser, 2000; Thabet, Brodwin, Shervin, & Wanas, 2000; Yehuda, 2000).

In addition to PTSD, dysfunctional mood regulation, depression and other psychological problems are common among children exposed to war trauma. They suffer from decreased anxiety, concentration and physical, somatic complaints and sleeping difficulties (Manninen & Peltola, 2005; Pine, Cohen, & Maser, 2005; Yule, 2000). War trauma is further associated with heightened levels of concentration, reading and comprehension problems, often leading to poor school achievement (Singh, Yank, Oberklaid, & Horwood, 2006).

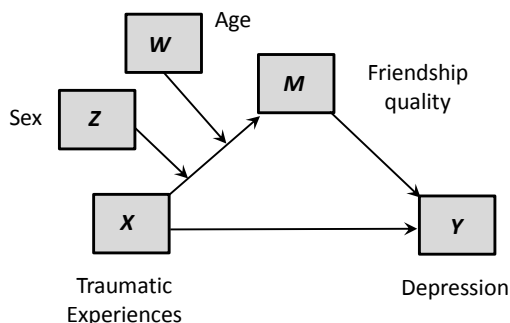
The research on PTSD is sometimes misunderstood to indicate that war-related and military threats are automatically associated with mental health problems. Although extreme dangers result in trauma in most children, clinically significant problems in war are

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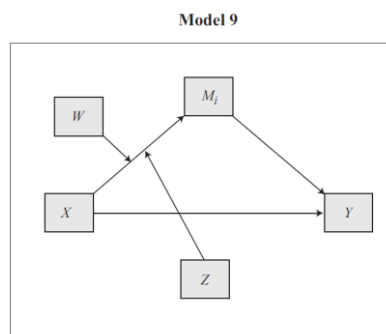
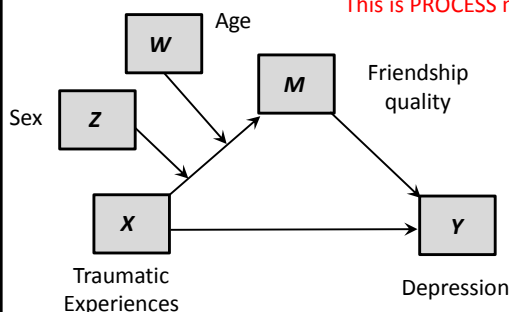
Corresponding author:
Kirsi Peltonen, University of Turku, Department of Psychology, 20014
University of Turku, Finland
Email: kirsi.peltonen@utu.fi



They propose a model in which friendship quality mediates the effect of trauma on depression, with that mechanism varying by both sex and age due to the effect of trauma on friendship quality varying as a function of sex and age.

Estimation in PROCESS

This is PROCESS model 9



$$\hat{M} = i_1 + a_1X + a_2W + a_3Z + a_4XW + a_5XZ$$

$$\hat{Y} = i_2 + c'X + bM$$

```
process y=depress/x=trauma/m=frqual/w=age/z=sex/moments=1/plot=1/boot=10000/model=9.
```

```
%process (data=gaza,y=depress,x=trauma,m=frqual,w=age,z=sex,moments=1,plot=1,boot=10000,model=9);
```

PROCESS output

Model : 9
Y : depress
X : trauma
M : frqual
W : age
Z : sex

Output K

Sample Size: 208

$$\hat{M} = 1.825 + 0.223X + 0.242W - 0.914Z - 0.029XW + 0.122XZ$$

OUTCOME VARIABLE:
frqual

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.3062	.0938	.5754	4.1811	5.0000	202.0000	.0012

Model	coeff	se	t	p	LLCI	ULCI	
constant	1.8247	1.1547	1.5803	.1156	-.4521	4.1016	
trauma	.2232	.1220	1.8299	.0687	-.0173	.4638	← a_1
age	.2424	.1071	2.2636	.0247	.0312	.4535	
Int_1	-.0288	.0111	-2.5921	.0003	-.0507	-.0069	← a_4
sex	-.9141	.2452	-3.7276	.0003	-1.3976	-.4306	
Int_2	.1219	.0323	3.7767	.0002	.0582	.1855	← a_5

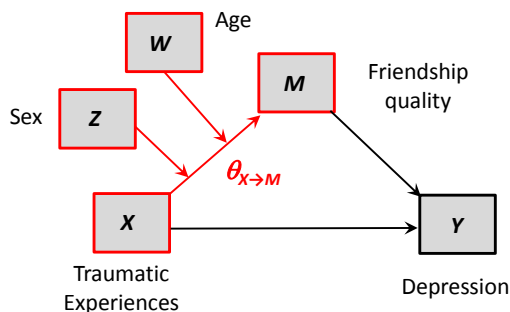
Product terms key:
Int_1 : trauma x age
Int_2 : trauma x sex

Test(s) of highest order unconditional interaction(s):

	R2-chng	F	df1	df2	p
X*W	.0301	6.7192	1.0000	202.0000	.0102
X*Z	.0640	14.2636	1.0000	202.0000	.0002

Notice that the effect of trauma on friendship quality varies significantly by both age and sex. More on this later.

The conditional effect of X on M



$\hat{M} = i_1 + a_1X + a_2W + a_3Z + a_4XW + a_5XZ$ can be written in equivalent form as

$$\hat{M} = i_1 + (a_1 + a_4W + a_5Z)X + a_2W + a_3Z$$

$$\hat{M} = 1.825 + 0.223X + 0.242W - 0.914Z - 0.029XW + 0.122XZ$$

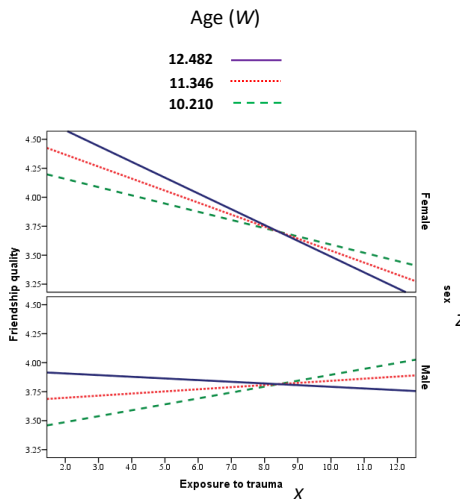
and so X's effect on M is $\theta_{X \rightarrow M} = 0.223 - 0.029W + 0.122Z$

PROCESS provides what we need to visualize the model of *M*

In SPSS, the plot option in PROCESS produces a program you can use to produce a rough visual depiction of the model. Or use the information in the table to plot in your preferred software.

```
DATA LIST FREE/
  trauma age sex frqual
BEGIN DATA.
  3.0987 10.2103 .0000 4.0801
  7.2548 10.2103 .0000 3.7857
  11.4109 10.2103 .0000 3.4914
  3.0987 10.2103 1.0000 3.5436
  7.2548 10.2103 1.0000 3.7557
  11.4109 10.2103 1.0000 3.9678
  3.0987 11.3462 .0000 4.2540
  7.2548 11.3462 .0000 3.8237
  11.4109 11.3462 .0000 3.3934
  3.0987 11.3462 1.0000 3.7175
  7.2548 11.3462 1.0000 3.7937
  11.4109 11.3462 1.0000 3.8698
  3.0987 12.4820 .0000 4.4280
  7.2548 12.4820 .0000 3.8617
  11.4109 12.4820 .0000 3.2954
  3.0987 12.4820 1.0000 3.8915
  7.2548 12.4820 1.0000 3.8316
  11.4109 12.4820 1.0000 3.7718
END DATA.
GRAPH/SCATTERPLOT=
  trauma WITH frqual BY sex
/PANEL ROWVAR= sex.
```

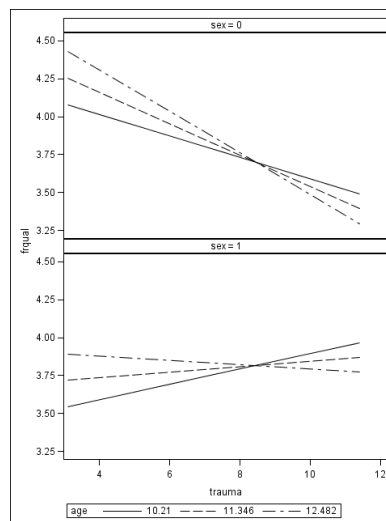
Output K



In SAS

In SAS, write a program around the data to produce a plot.

```
data gazaplot;
input trauma sex age frqual;
datalines;
  3.0987 10.2103 .0000 4.0801
  7.2548 10.2103 .0000 3.7857
  11.4109 10.2103 .0000 3.4914
  3.0987 10.2103 1.0000 3.5436
  7.2548 10.2103 1.0000 3.7557
  11.4109 10.2103 1.0000 3.9678
  3.0987 11.3462 .0000 4.2540
  7.2548 11.3462 .0000 3.8237
  11.4109 11.3462 .0000 3.3934
  3.0987 11.3462 1.0000 3.7175
  7.2548 11.3462 1.0000 3.7937
  11.4109 11.3462 1.0000 3.8698
  3.0987 12.4820 .0000 4.4280
  7.2548 12.4820 .0000 3.8617
  11.4109 12.4820 .0000 3.2954
  3.0987 12.4820 1.0000 3.8915
  7.2548 12.4820 1.0000 3.8316
  11.4109 12.4820 1.0000 3.7718
3.7718proc sgpanel;
panelby sex / columns=1;
series x=trauma y=frqual/group=age lineattrs
=(color=black);run;
```



The conditional effect of X on M

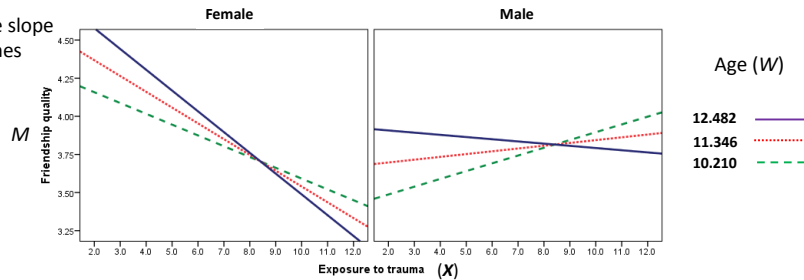
Focal predict: trauma (X)
Mod var: age (W)
Mod var: sex (Z)

$$\theta_{X \rightarrow M} = 0.223 - 0.029W + 0.122Z$$

Conditional effects of the focal predictor at values of the moderator(s):

W	age	Z	sex	Effect	se	t	p	LLCI	ULCI
10.2103	.0000			-.0708	.0257	-2.7593	.0063	-.1214	-.0202
10.2103	1.0000			.0510	.0251	2.0335	.0433	.0015	.1005
11.3462	.0000			-.1035	.0258	-4.0078	.0001	-.1545	-.0526
11.3462	1.0000			.0183	.0173	1.0575	.2915	-.0158	.0525
12.4820	.0000			-.1363	.0315	-4.3204	.0000	-.1984	-.0741
12.4820	1.0000			-.0144	.0170	-.8470	.3980	-.0479	.0191

$\theta_{X \rightarrow M}$ is the slope of these lines



The differences in slope conditioned on the second moderator are constant across values of the second moderator. These depict two-way and not "three way" interaction.