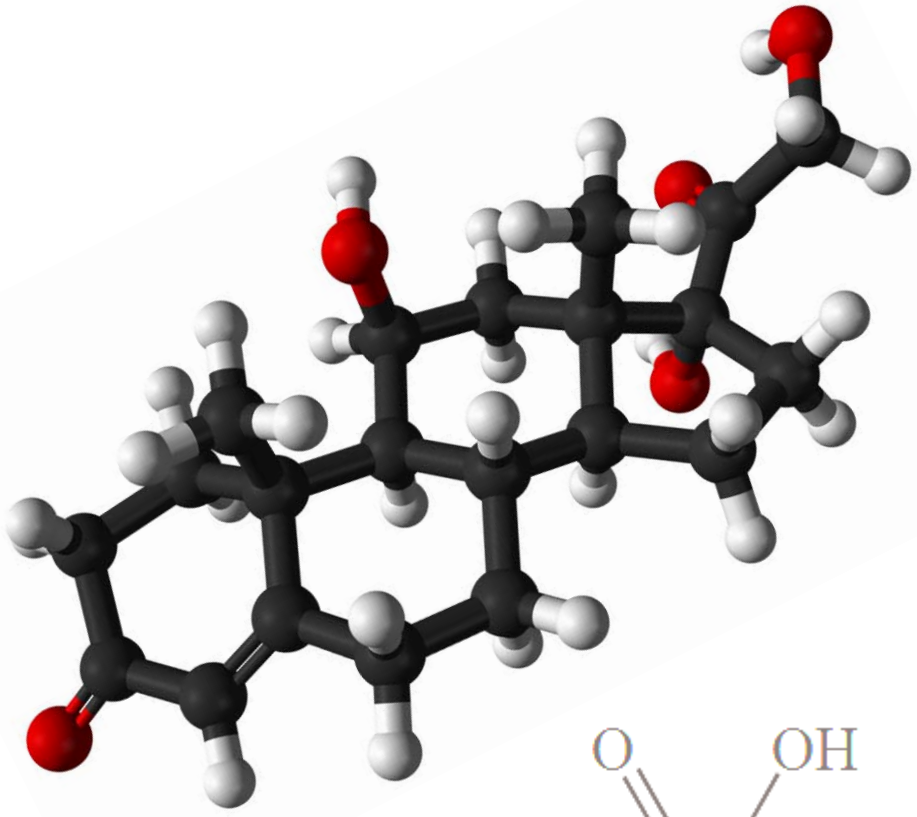
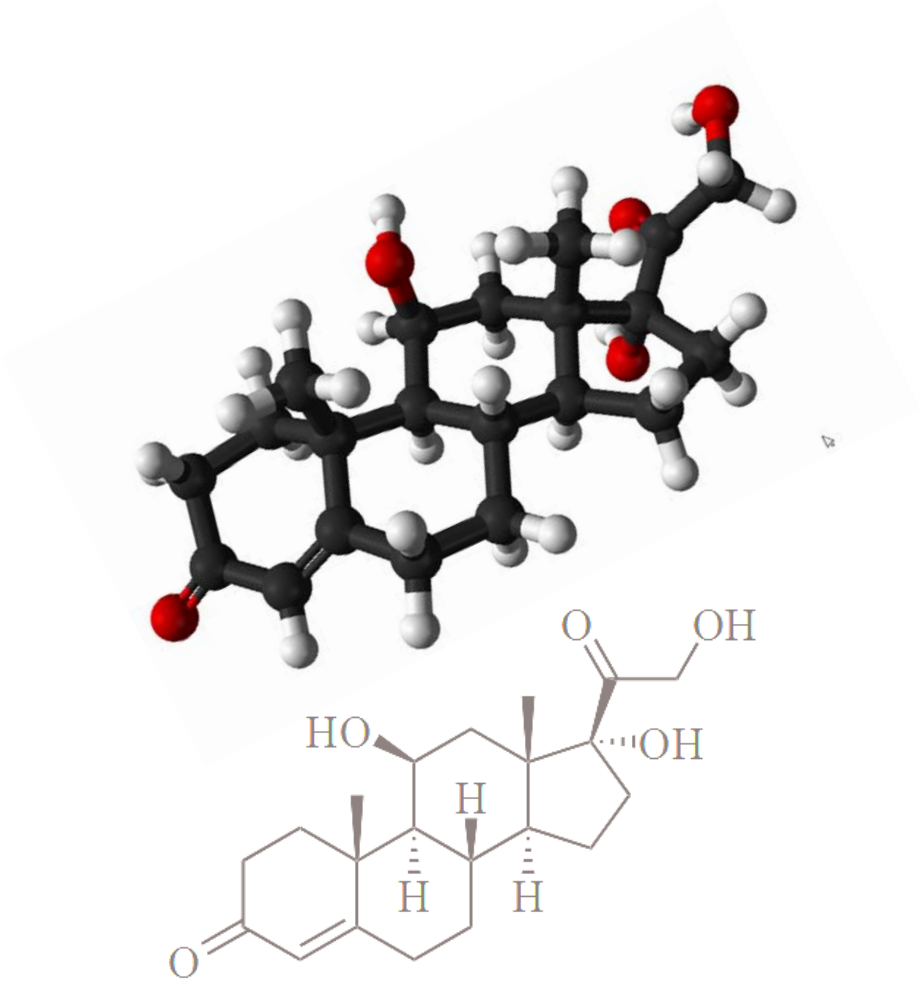


Stress & Creativity

A Hormetic Relationship to Optimize the Social Adaption of the Phenotype?

Prof. Dr. Wulf Schiefenhövel,
- *Max Planck Human Ethology Institute*
Prof. Dr. Karsten Müller,
- *University of Mannheim*



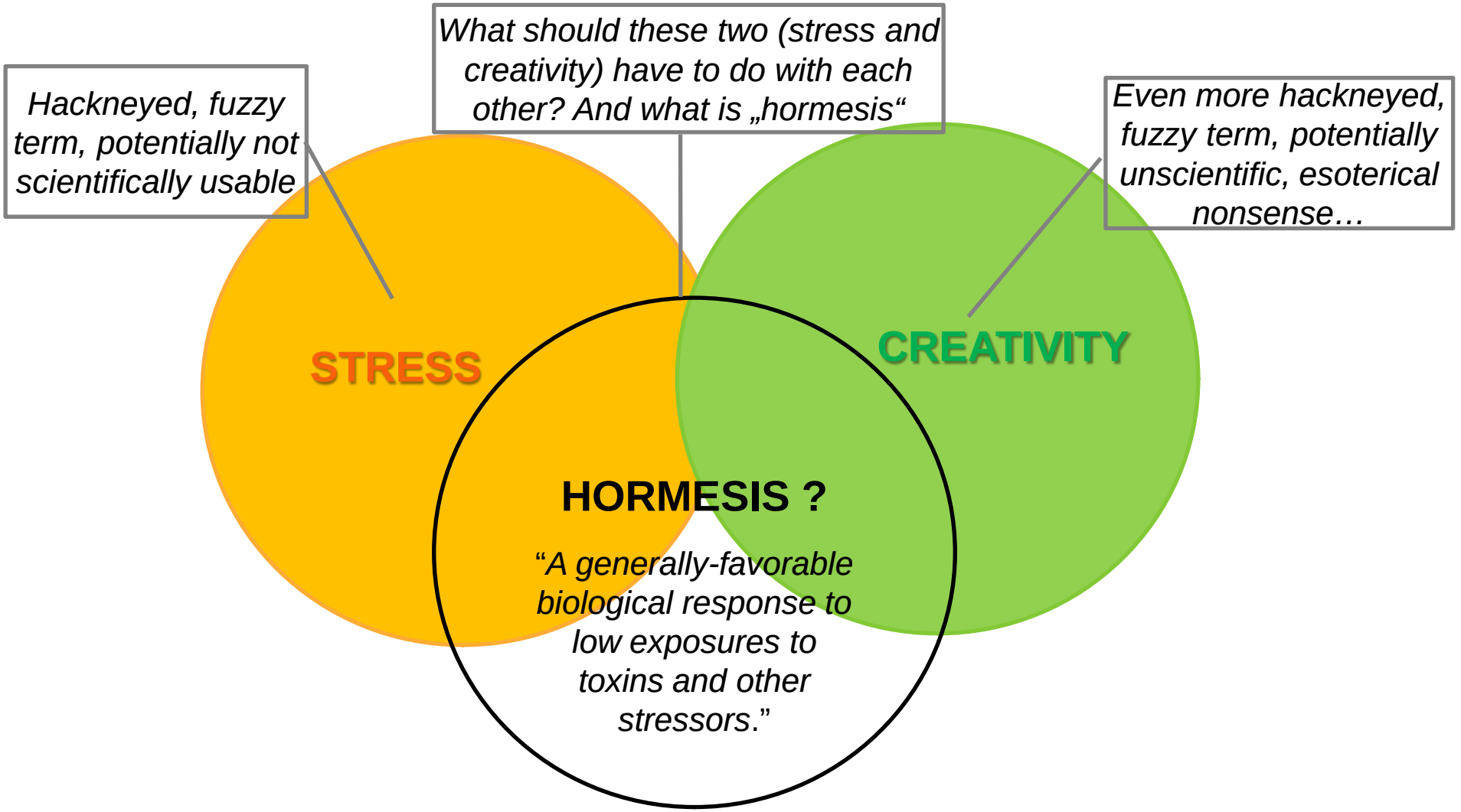
Agenda

Stress and Creativity?

Experimental Setting

First Results

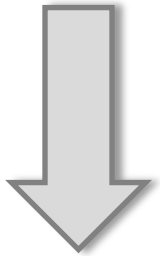
STRESS & CREATIVITY – HOW DO THEY COME TOGETHER?



CREATIVITY

„There are, certainly, many definitions of creativity. … most definitions, while using the creative product as the distinguishing sign of creativity, propose that the general qualities of ***novelty*** *and* ***appropriateness*** *differentiate creative from uncreative products. … In other words, the product or response must be unusual … and it must also be* ***correct in the context of the problem or audience to which it was addressed****.*

…



A product or response is creative to the extent that appropriate observers independently agree it is creative. Appropriate observers are those familiar with the domain in which the product was created or the response articulated.”

Source: Amabile, T. 1982. Social Psychology of Creativity: A Consensual Assessment Technique, J. of Pers. & Soc. Psych., Vol. 43, No. 5, 997-1013

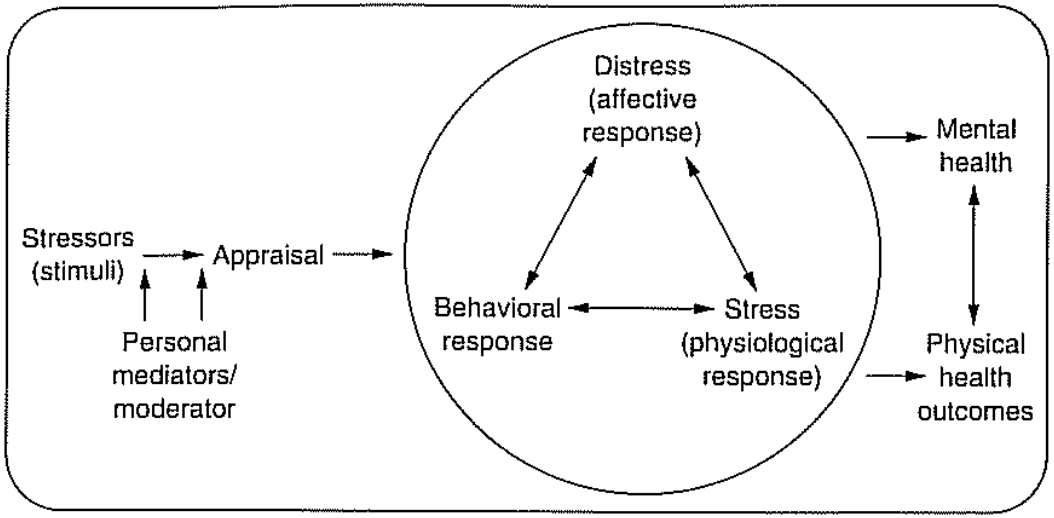
Creativity is hard to grasp.

- Common ground among creativity researchers is very small: ***novelty & appropriateness*** as only „common denominators“.

- There is no universal definition of „appropriateness“, meaning, there is no context-free creativity-definition: Creativity is a „**genuinely social phenomenon**“.

- Not only the assessment of creativity but also its **emergence is determined by social factors**: extrinsic constraints (like rewards or external evaluation) can lead to decrements in creativity.

STRESS



What is Stress?

Stress is a biological term which refers to the response of a human or animal to emotional or physical demands, whether actual or imagined.

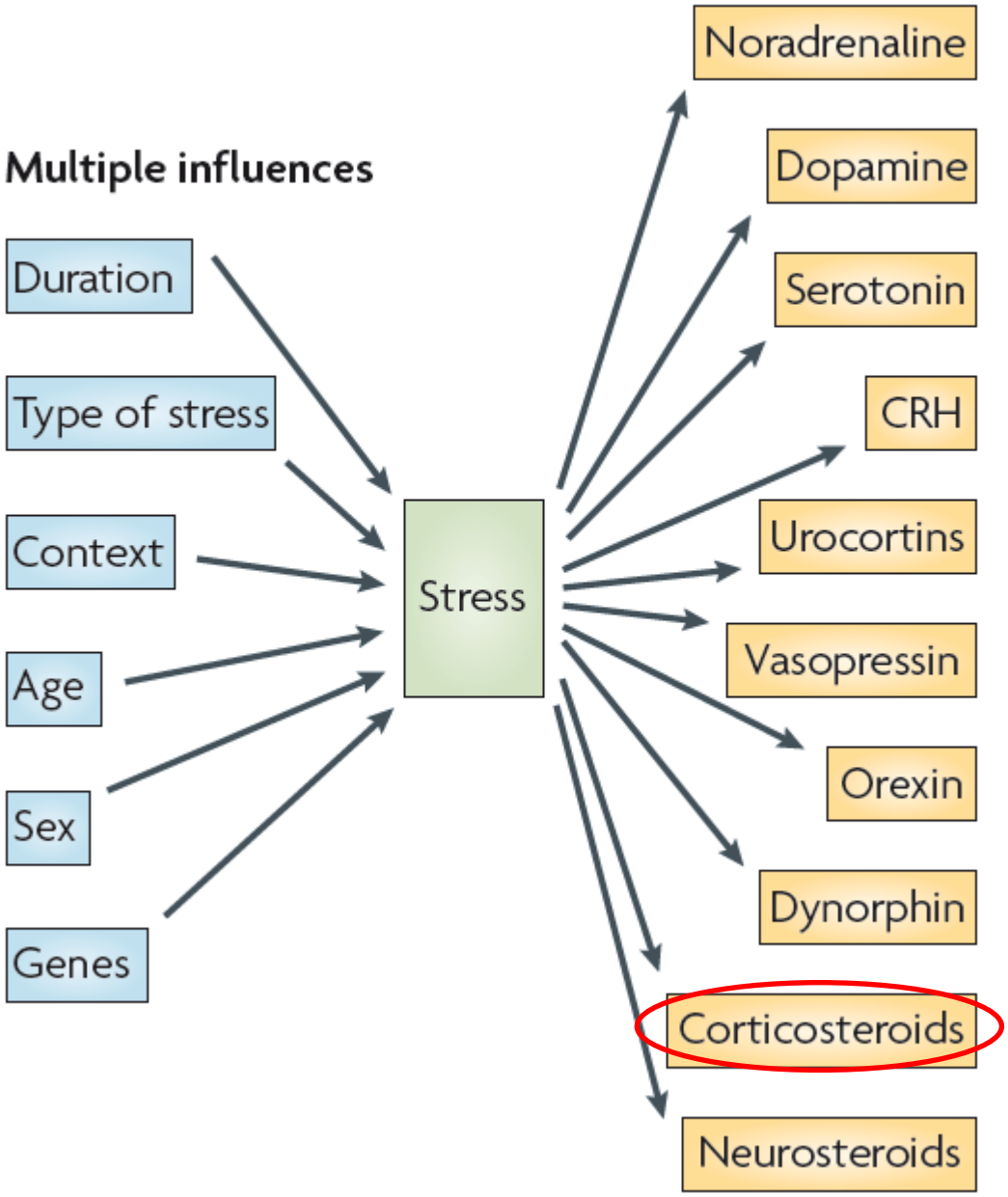
It includes a state of alarm and adrenaline production, short-term resistance as a coping mechanism, and exhaustion.

Common stress symptoms include irritability, muscular tension, inability to concentrate and a variety of physical reactions, such as headaches and elevated heart rate.

When the body is under stress, the adrenal gland increases secretion of a **hormone called cortisol**. Short-term, this hormone can help aid in survival, for example by mobilizing energy reserves. Long-term elevation of cortisol, however, can have detrimental effects.

Source: Ice & James, 2007, Measuring Stress in Humans. Cambridge University Press.

STRESS



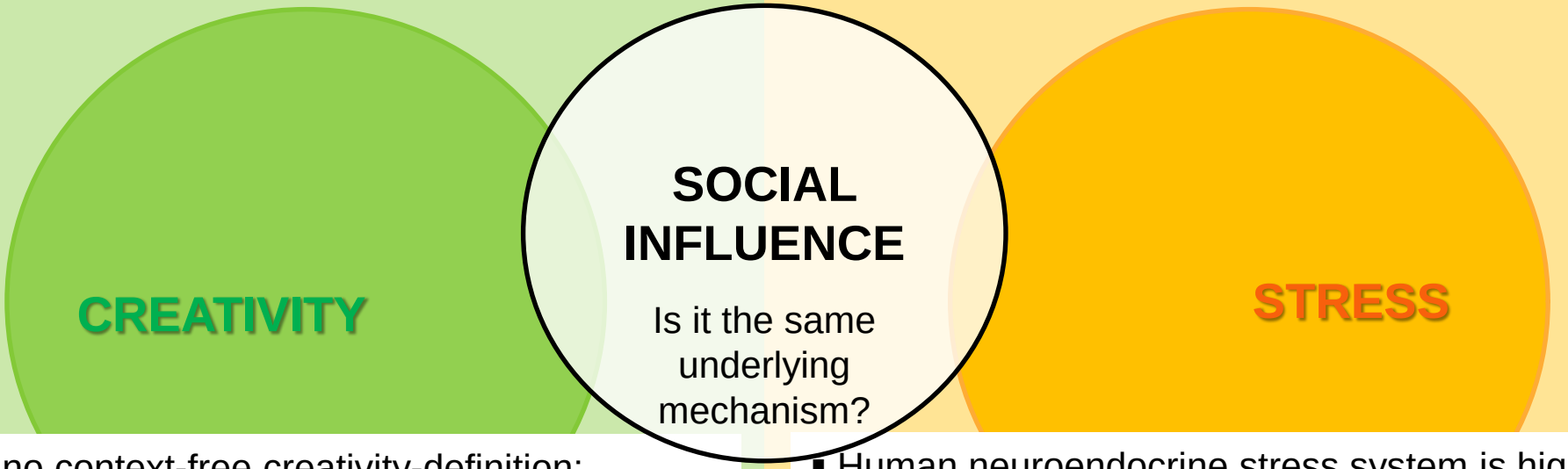
Complex chains of effects

Stress is no easy cause-and-effect-relationship!

- Multiple influences determine style and intensity of the stress reaction.
- Multiple mediators are channeling the stress response with regard to bodily reactions.
- … and the psychological aspects and processes of stress are not yet factored in!

Source: Joëls, Marian; Baram, Tallie Z.. Nature Reviews Neuroscience, Jun2009, Vol. 10 Issue 6, p459-466

STRESS & CREATIVITY: WHERE IS THE CONNECTION?



- There is no context-free creativity-definition: creativity is a „**genuinely social phenomenon**“.
- **Social constraints** (like rewards, competition or external evaluation) can lead to decrements in creativity (Amabile, 1979, 1986).
- As human **intelligence is social**, and creativity is part of it, creativity must also have a social quality (van Schaik, 2007; Jäger et.al. 1997).

- Human neuroendocrine stress system is highly sensitive to **social challenges** (Flinn, 2007; Kirschbaum et.al. 1993)
- Stressing life events are almost all **social** (Holmes & Masuda, 1967)
- Early life exposure to stress via constrained **maternal care** may result in a vulnerable, chronically stressed phenotype (Bardi et.al. 2005).

Sources: van Schaik, C.P., 2007. Culture in primates and other animals. In: Dunbar, R.I.M & Barret, L. (Eds.). The Oxford Handbook of Evolutionary Psychology. 103-113.

Jäger, A.O., Süß, H.-M., & Beauducel, A. 1997. Berliner Intelligenzstruktur-Test. Handanweisung. Göttingen: Hogrefe.

Amabile, T.M. 1979. Effects of External Evaluation on Artistic Creativity. Journal of Personality and Social Psychology, Vol. 37, No. 2, 221-233.

Amabile, T.M., Hennessey, B.A., & Grossman, B.S. 1986. Social Influences on Creativity: The Effects of Contracted-for Reward. Journal of Personality and Social Psychology, Vol. 50(1), 14–23.

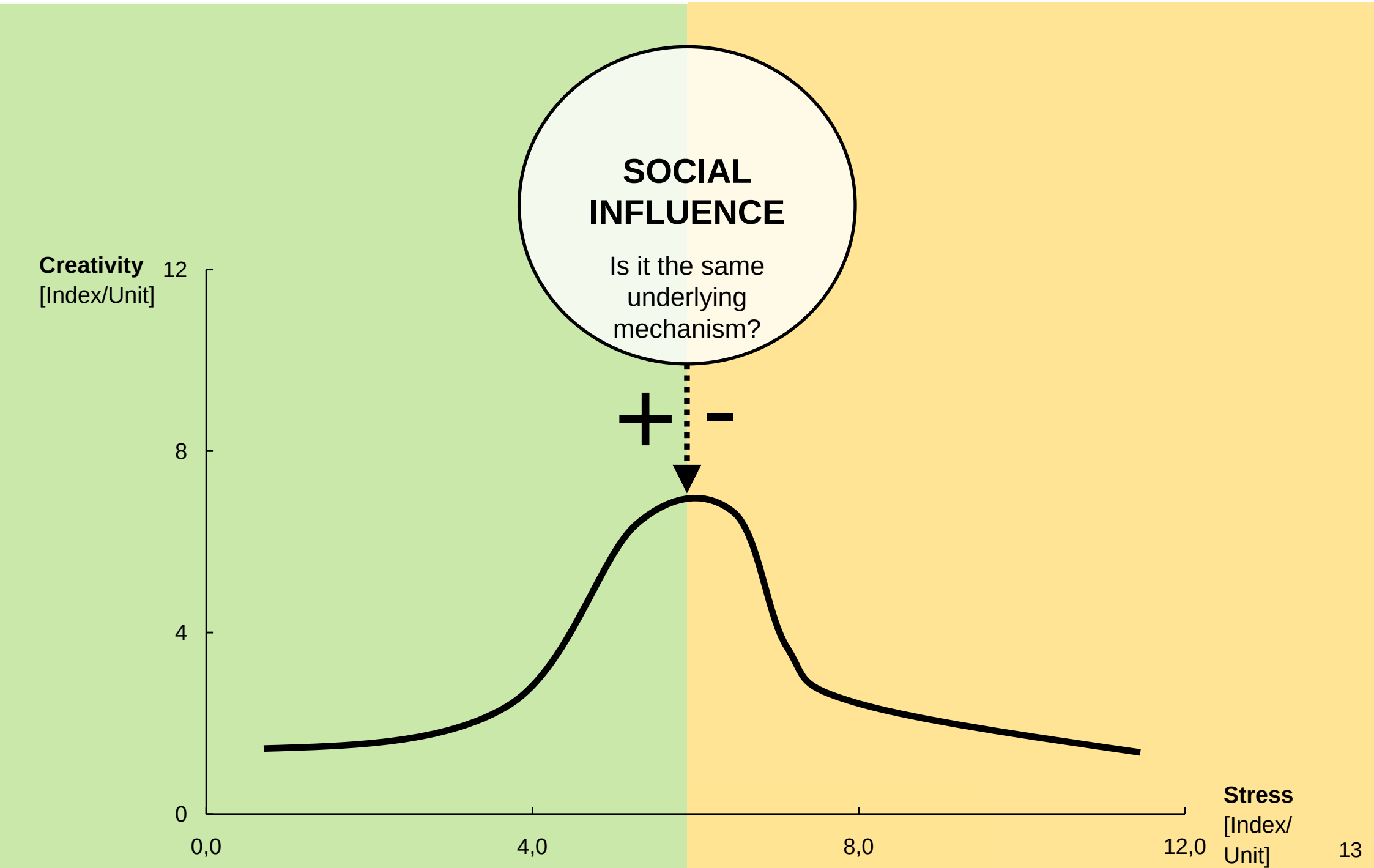
Sources: Flinn, M.V. 2007. Evolution of stress responses to social threat. In: Dunbar, R.I.M & Barret, L. (Eds.). The Oxford Handbook of Evolutionary Psychology. New York: Oxford University Press, 273-288.

Holmes, T.H., Masuda, M. 1967. The Social Radjustment Rating Scale. Journal of Psychosomatic Resaarch. Vol. 11. pp. 227 to 237.

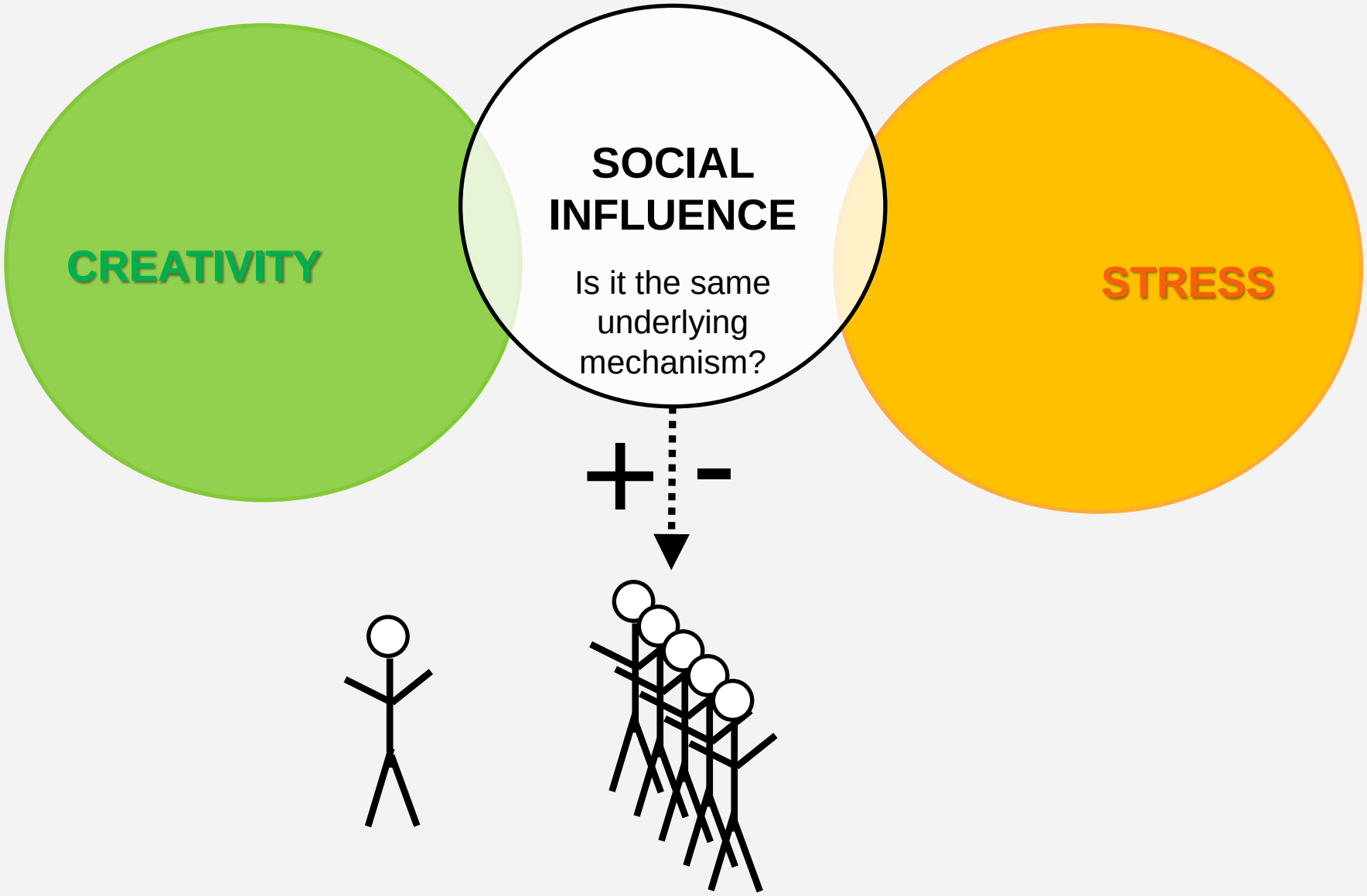
Bardi, M., Bode, A.E., Ramirez, S.M. and Brent, L.Y. 2005. Maternal Care and Development of Stress Responses in Baboons. American Journal of Primatology. Vol. 66, 263–278.

Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H., 1993. The 'Trier Social Stress Test' - a tool for investigating psychobiological stress responses in a laboratory setting. Neuropsychobiology 28(1-2), 76-81.

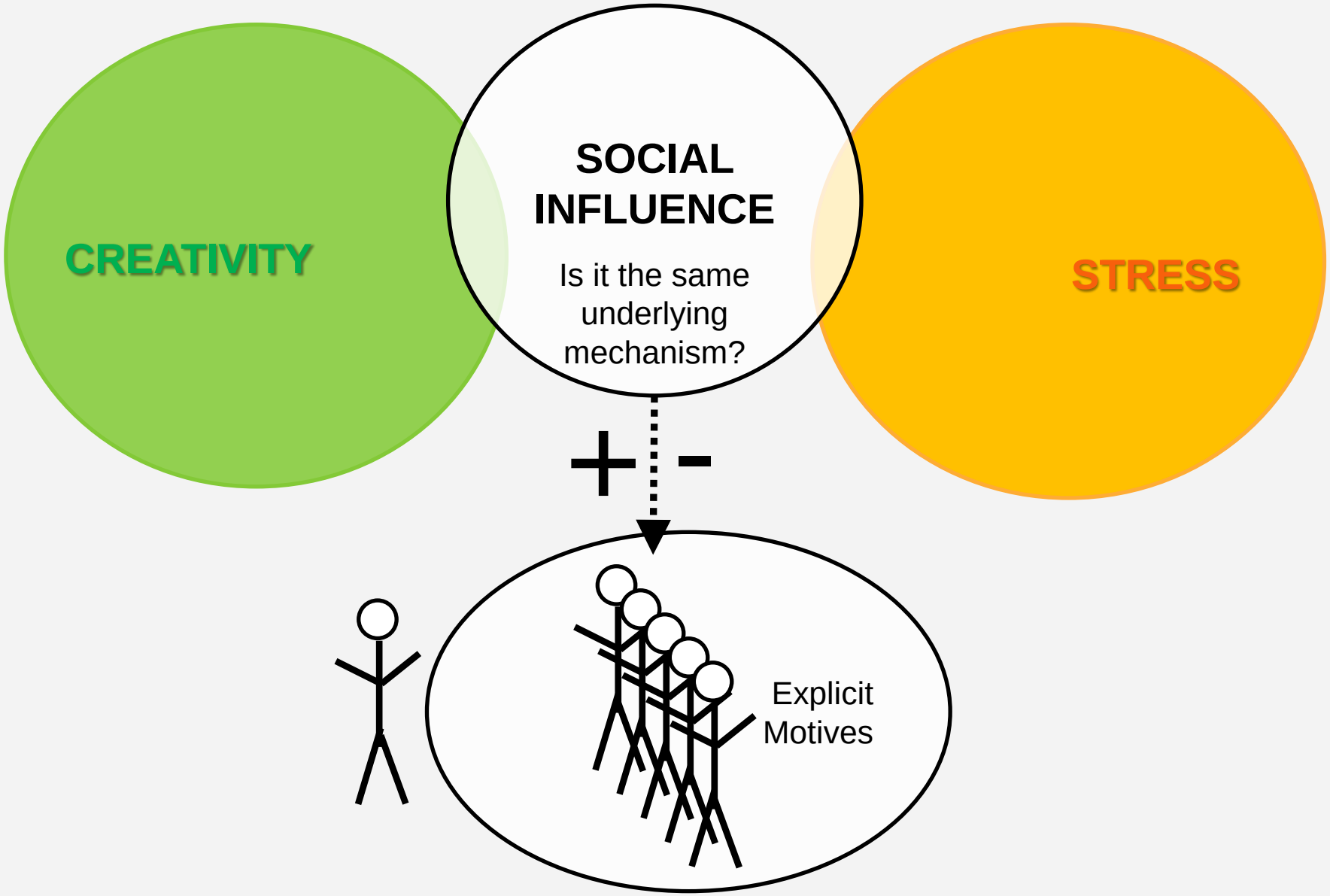
STRESS & CREATIVITY: WHERE IS THE CONNECTION?



STRESS & CREATIVITY: WHAT/HOW IS THE CONNECTION?

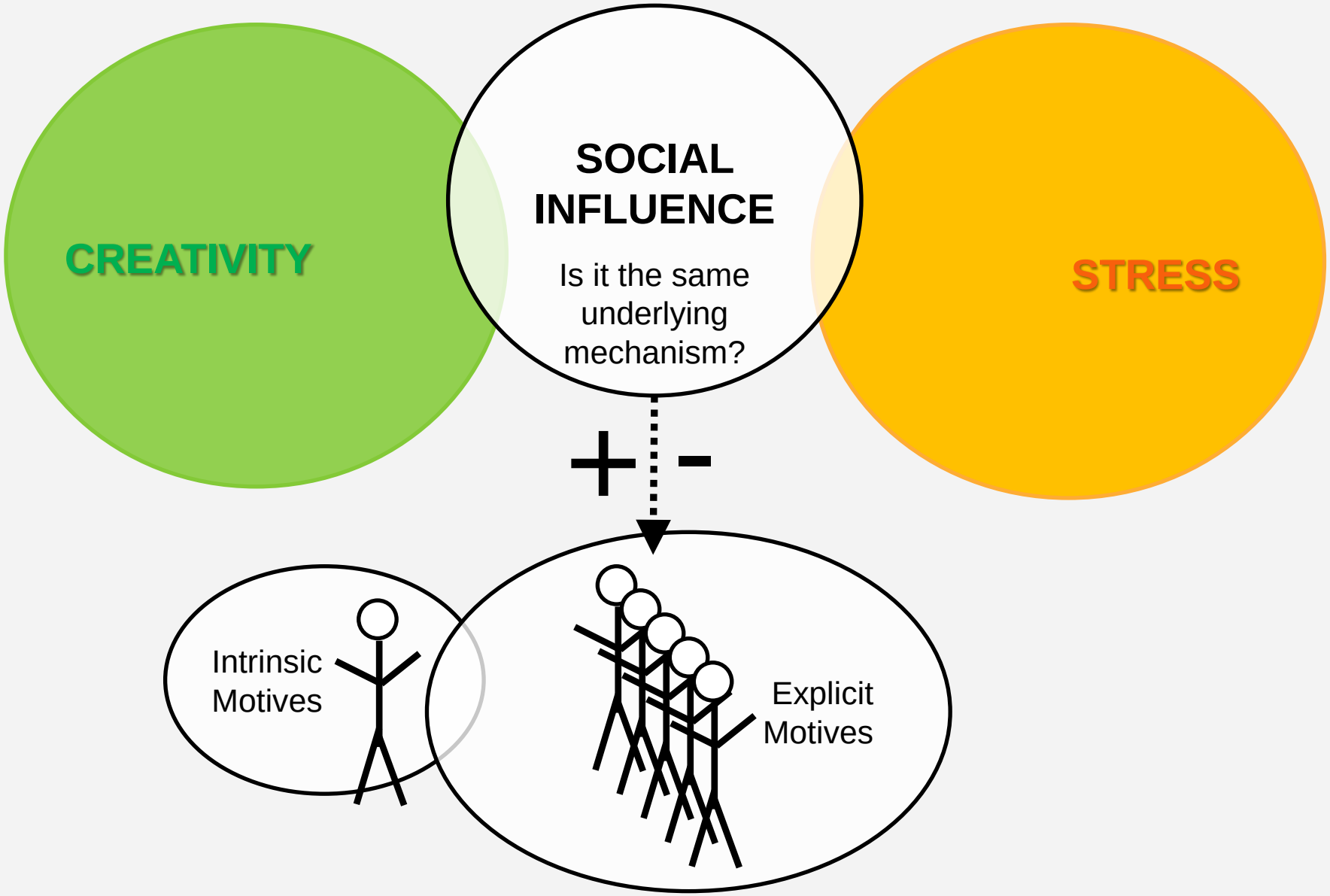


STRESS & CREATIVITY: WHAT/HOW IS THE CONNECTION?



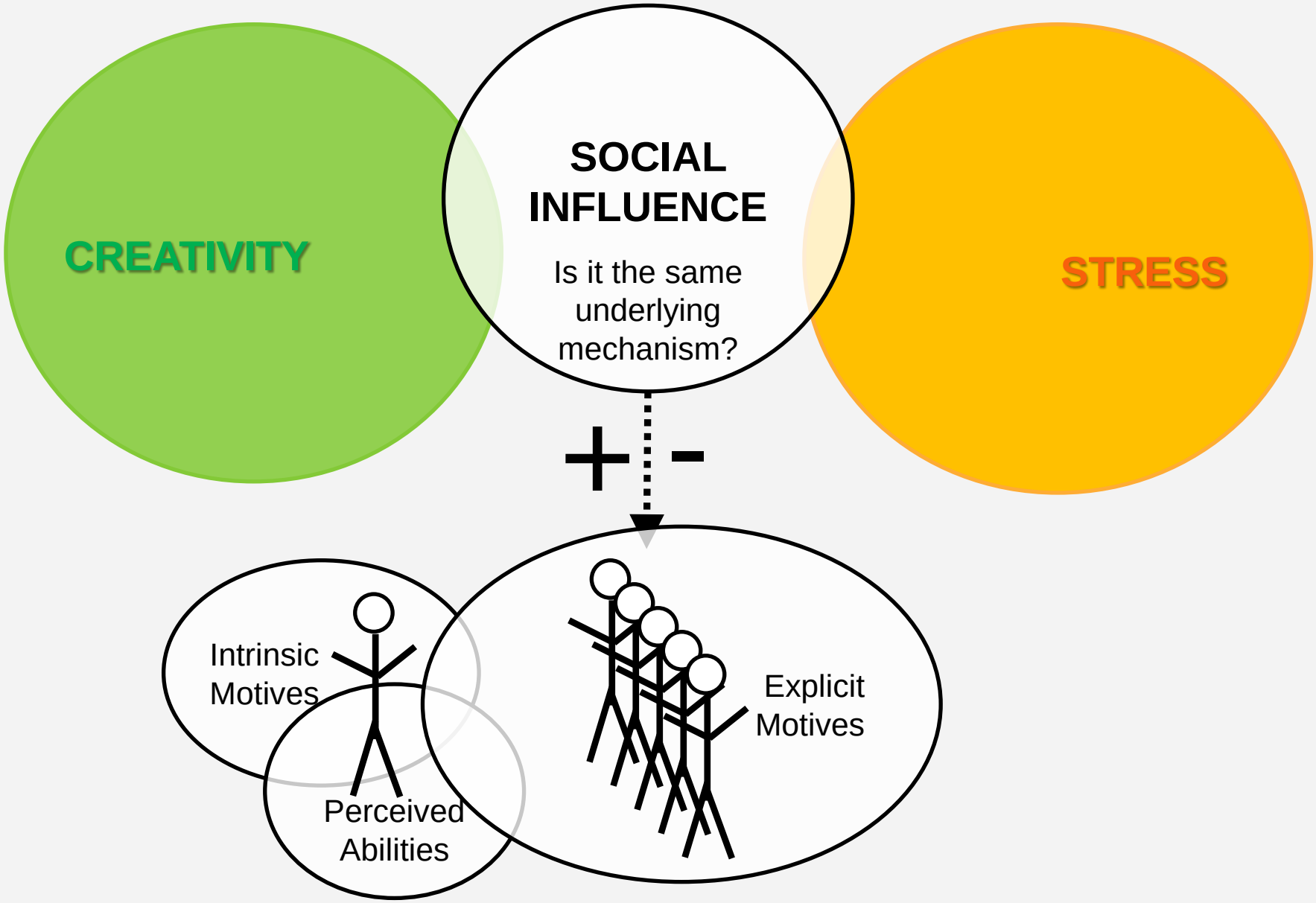
Source: Kehr, H.M. 2004. Integrating Implicit Motives, Explicit Motives, and Perceived Abilities: The Compensatory Model of Work Motivation and Volition. Academy of Management Review, Vol. 29, No. 3, 479-499.

STRESS & CREATIVITY: WHAT/HOW IS THE CONNECTION?



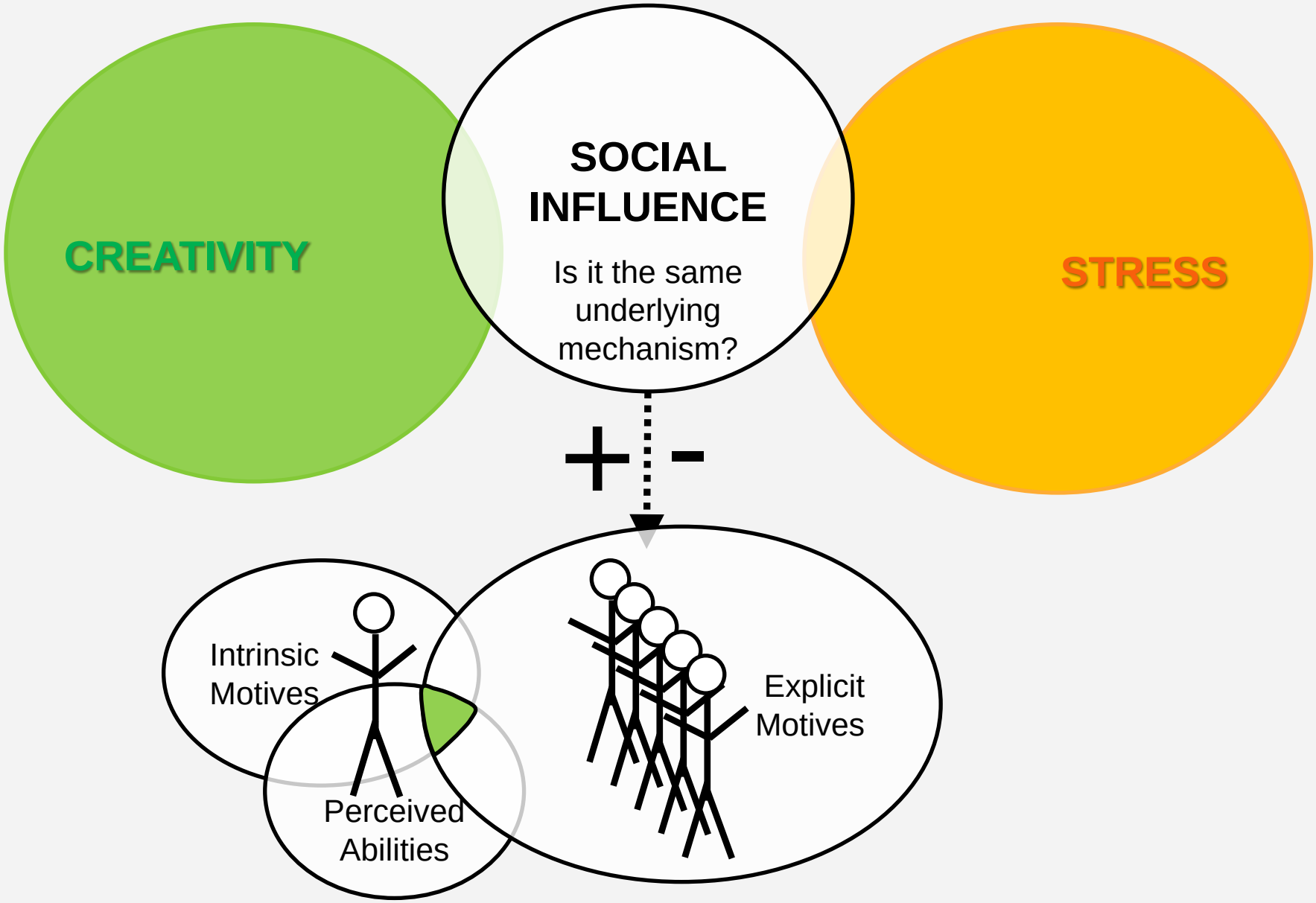
Source: Kehr, H.M. 2004. Integrating Implicit Motives, Explicit Motives, and Perceived Abilities: The Compensatory Model of Work Motivation and Volition. Academy of Management Review, Vol. 29, No. 3, 479-499.

STRESS & CREATIVITY: WHAT/HOW IS THE CONNECTION?



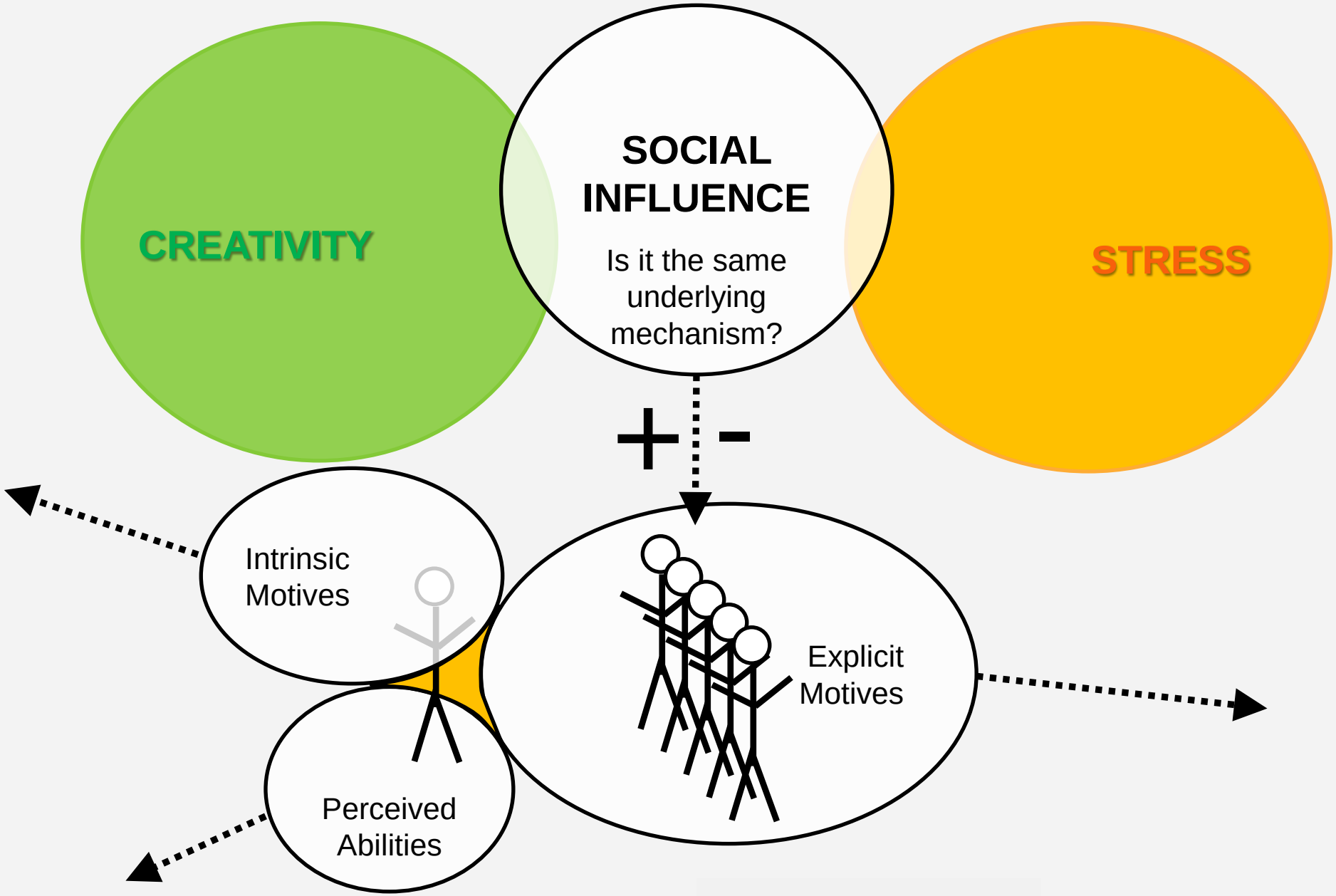
Source: Kehr, H.M. 2004. Integrating Implicit Motives, Explicit Motives, and Perceived Abilities: The Compensatory Model of Work Motivation and Volition. Academy of Management Review, Vol. 29, No. 3, 479-499.

STRESS & CREATIVITY: WHAT/HOW IS THE CONNECTION?



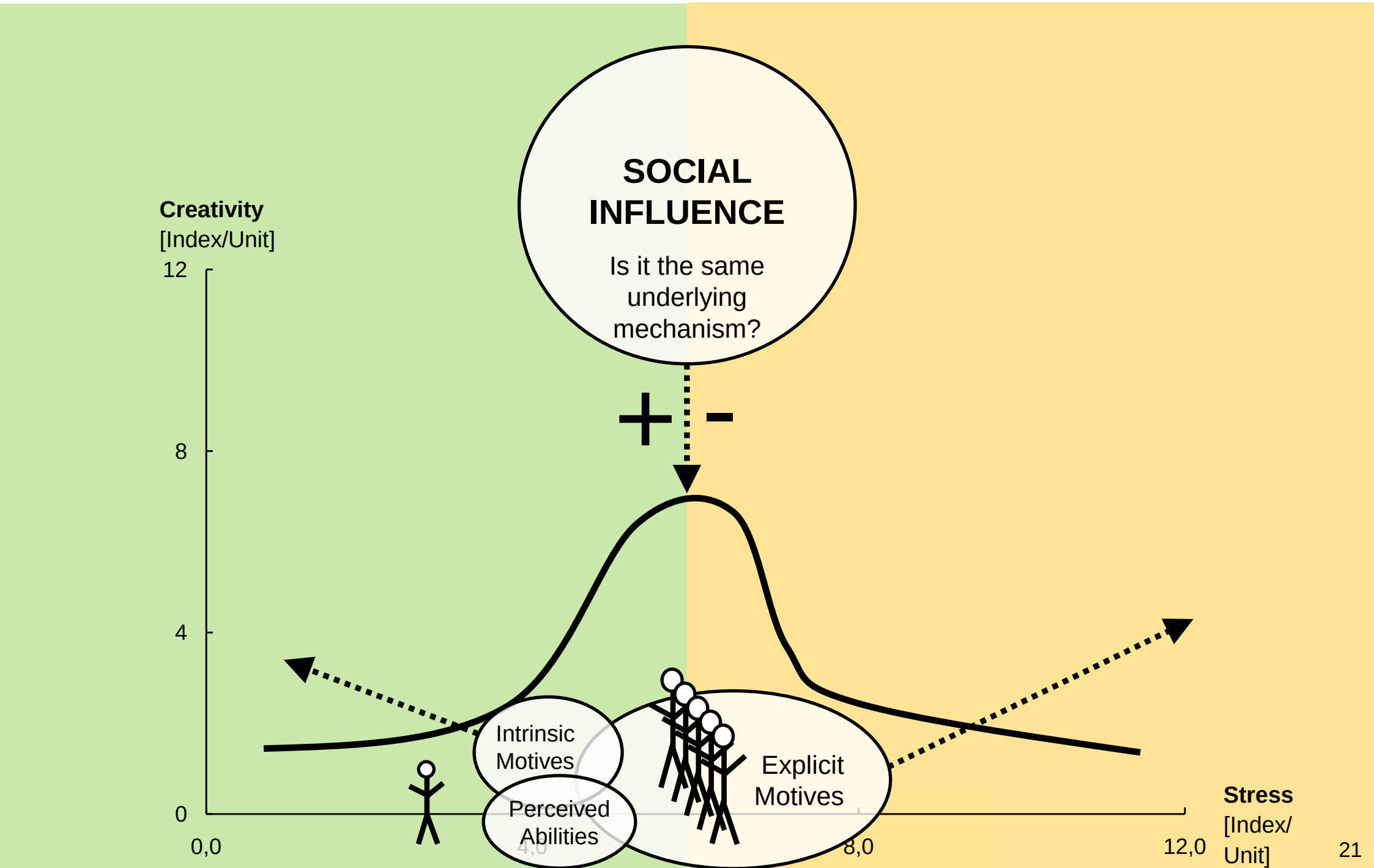
Source: Kehr, H.M. 2004. Integrating Implicit Motives, Explicit Motives, and Perceived Abilities: The Compensatory Model of Work Motivation and Volition. Academy of Management Review, Vol. 29, No. 3, 479-499.

STRESS & CREATIVITY: WHAT/HOW IS THE CONNECTION?

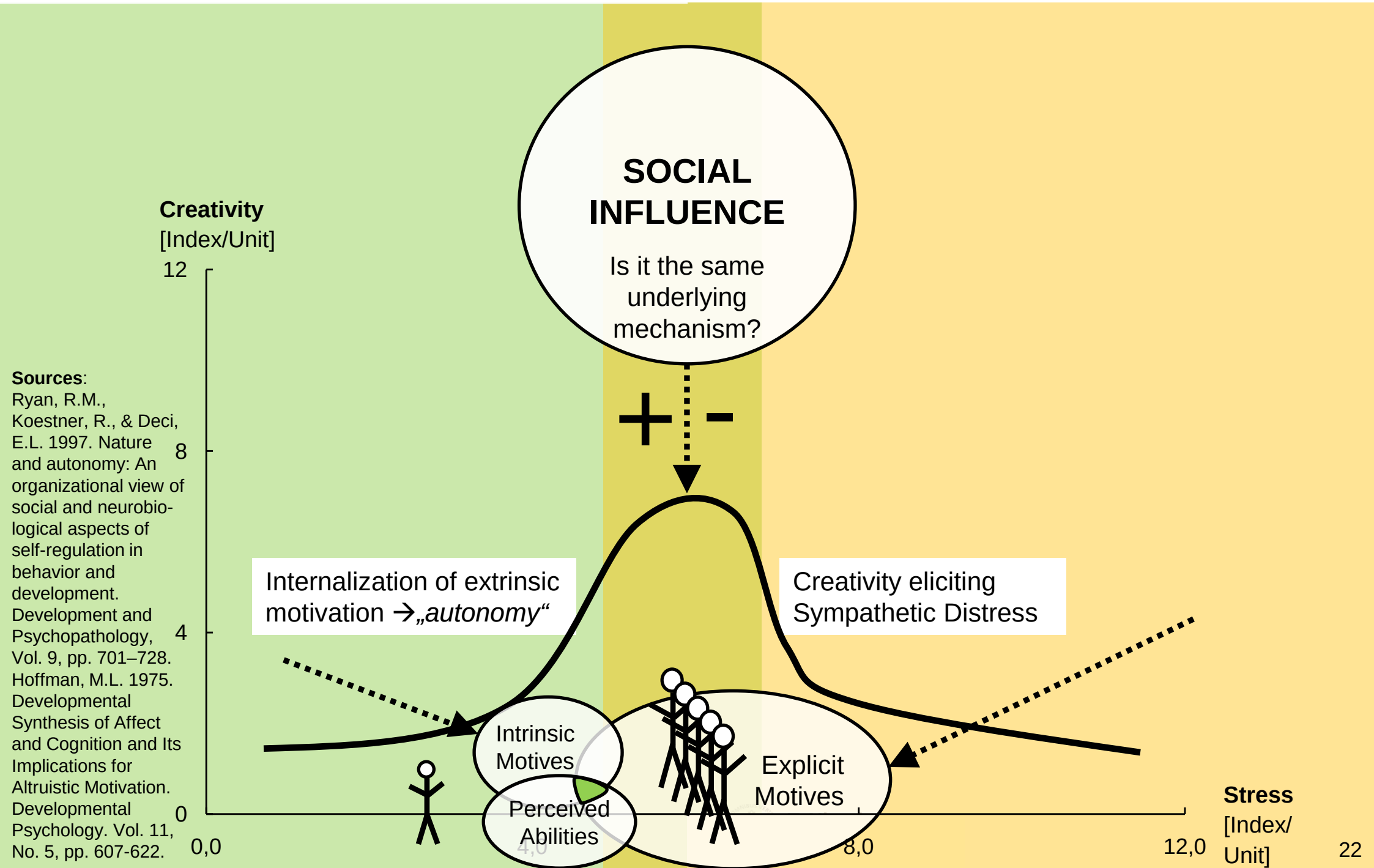


Source: Kehr, H.M. 2004. Integrating Implicit Motives, Explicit Motives, and Perceived Abilities: The Compensatory Model of Work Motivation and Volition. Academy of Management Review, Vol. 29, No. 3, 479-499.

STRESS & CREATIVITY: WHAT/HOW IS THE CONNECTION?

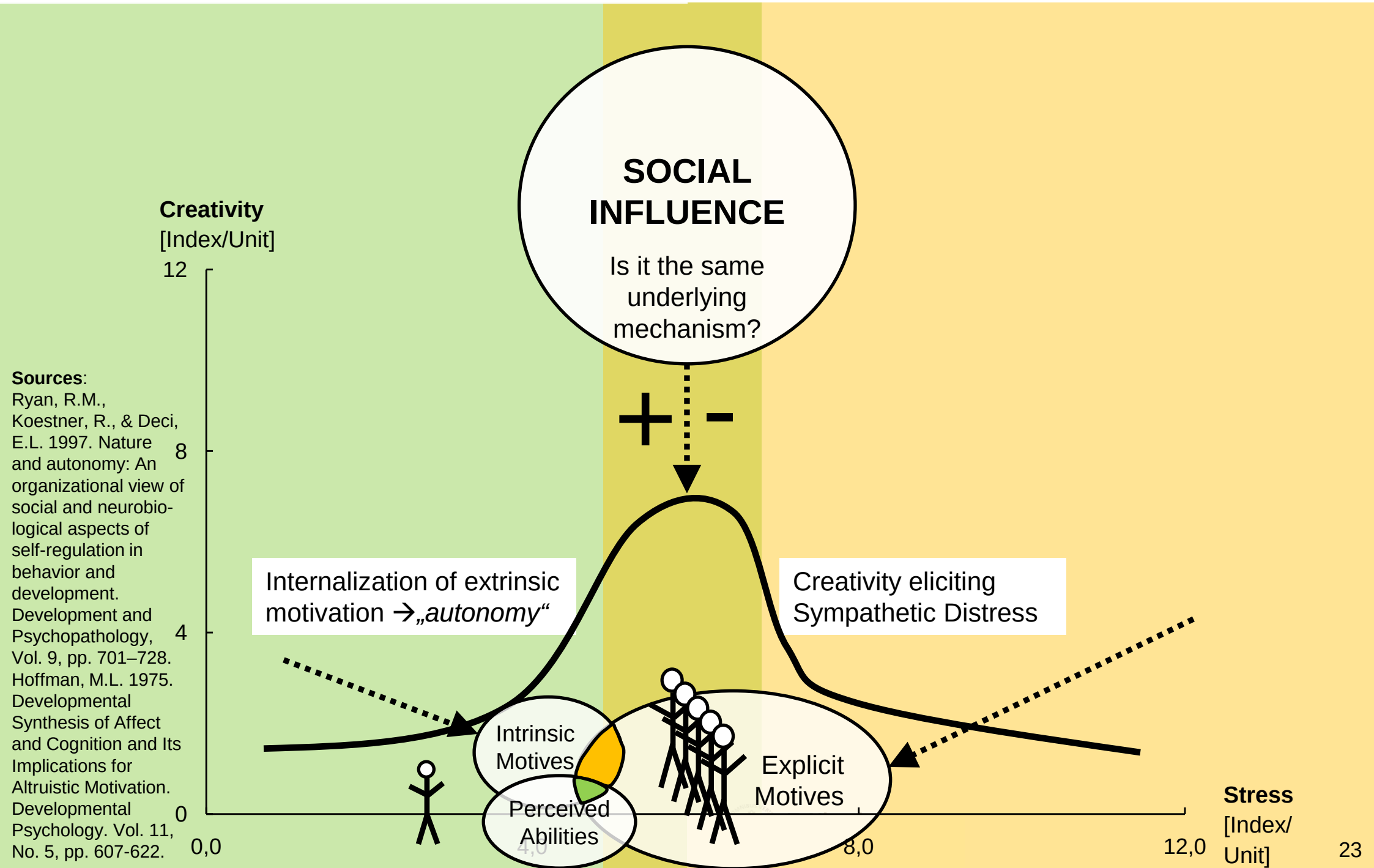


STRESS & CREATIVITY: WHAT/HOW IS THE CONNECTION?



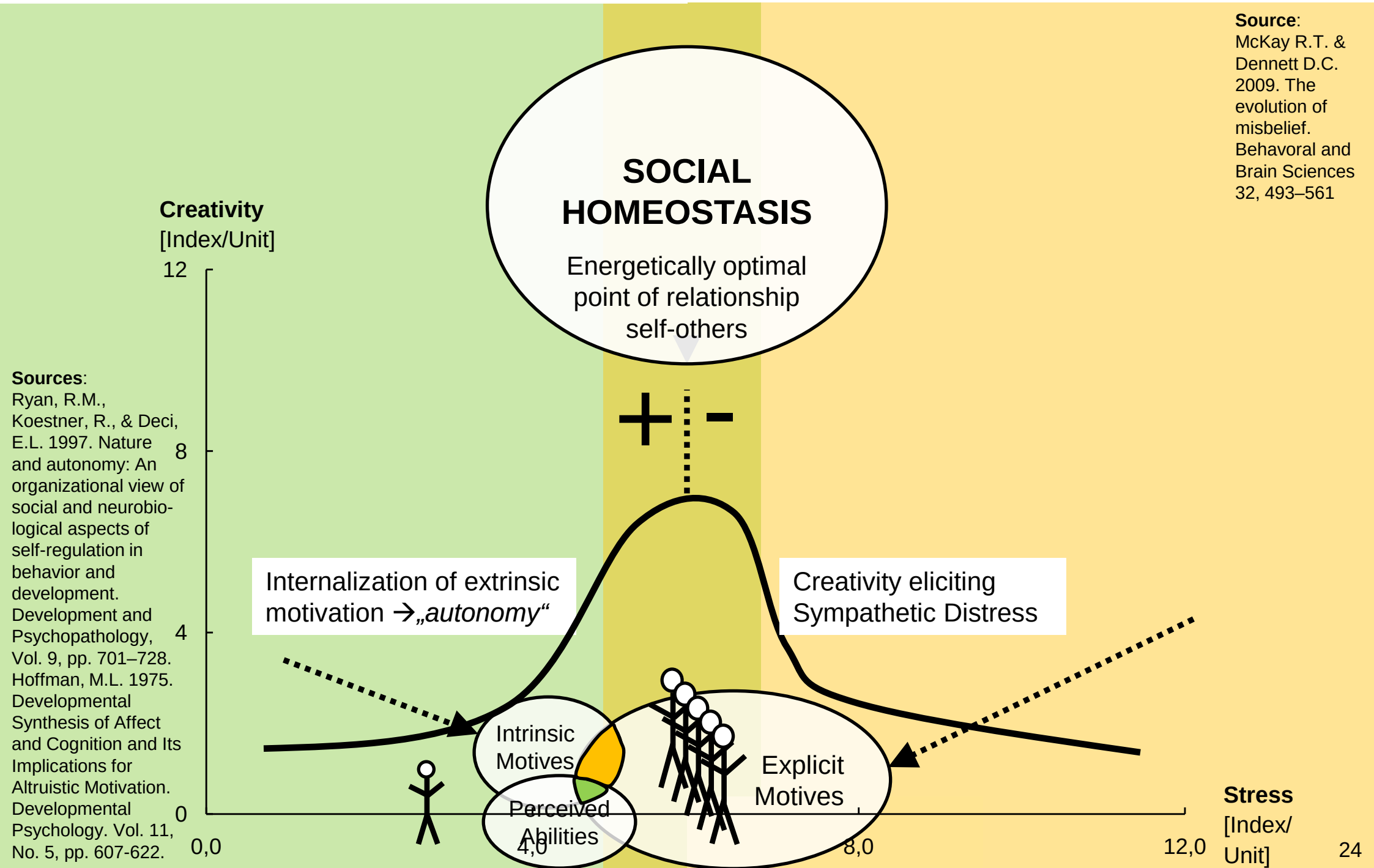
Sources:
Ryan, R.M., Koestner, R., & Deci, E.L. 1997. Nature and autonomy: An organizational view of social and neurobio-logical aspects of self-regulation in behavior and development. Development and Psychopathology, Vol. 9, pp. 701–728.
Hoffman, M.L. 1975. Developmental Synthesis of Affect and Cognition and Its Implications for Altruistic Motivation. Developmental Psychology. Vol. 11, No. 5, pp. 607-622.

STRESS & CREATIVITY: WHAT/HOW IS THE CONNECTION?



Sources:
Ryan, R.M., Koestner, R., & Deci, E.L. 1997. Nature and autonomy: An organizational view of social and neurobio-logical aspects of self-regulation in behavior and development. Development and Psychopathology, Vol. 9, pp. 701–728.
Hoffman, M.L. 1975. Developmental Synthesis of Affect and Cognition and Its Implications for Altruistic Motivation. Developmental Psychology. Vol. 11, No. 5, pp. 607-622.

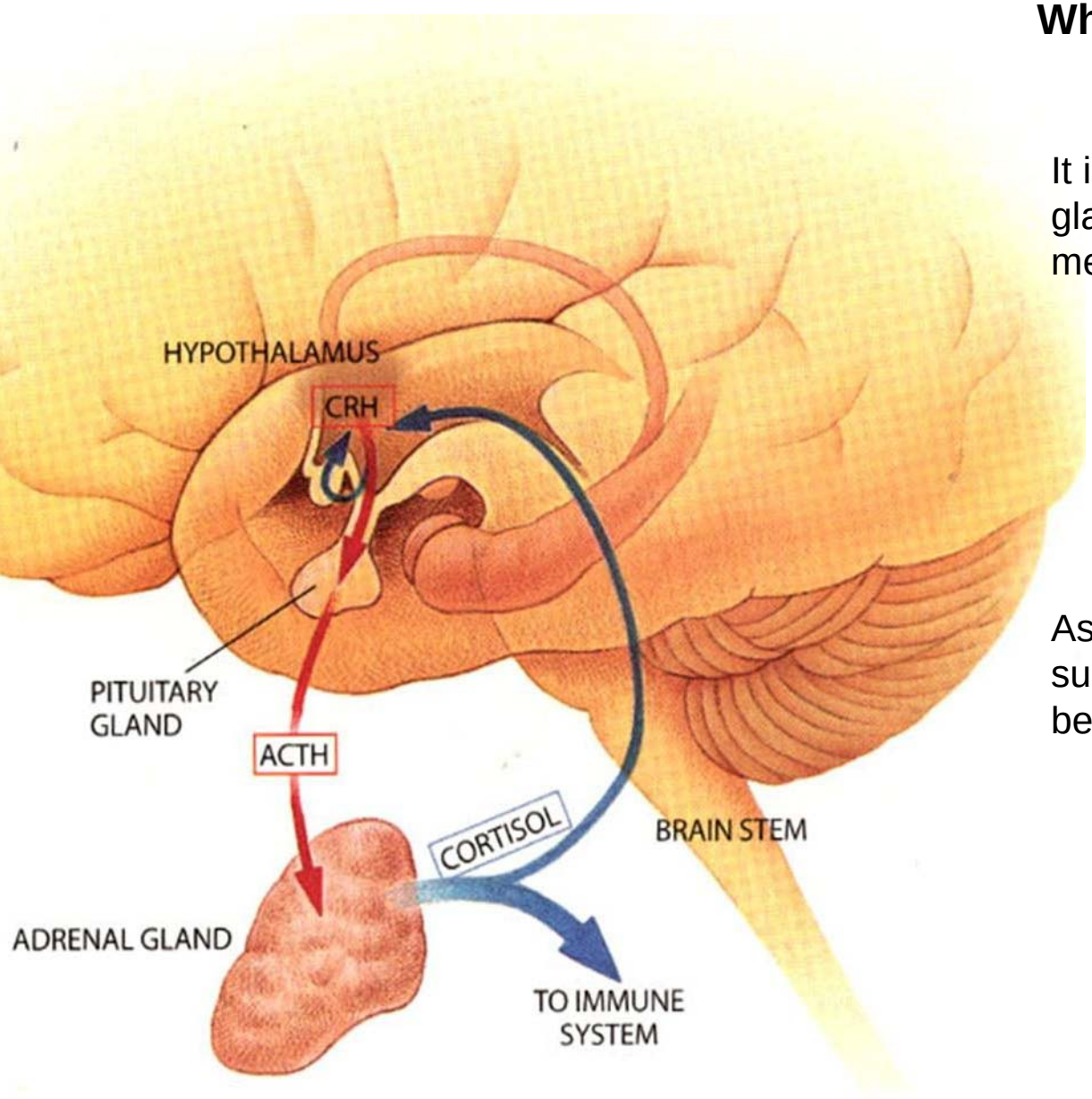
STRESS & CREATIVITY: WHAT/HOW IS THE CONNECTION?



Source:
McKay R.T. & Dennett D.C. 2009. The evolution of misbelief. Behavoral and Brain Sciences 32, 493–561

Sources:
Ryan, R.M., Koestner, R., & Deci, E.L. 1997. Nature and autonomy: An organizational view of social and neurobio-logical aspects of self-regulation in behavior and development. Development and Psychopathology, Vol. 9, pp. 701–728.
Hoffman, M.L. 1975. Developmental Synthesis of Affect and Cognition and Its Implications for Altruistic Motivation. Developmental Psychology. Vol. 11, No. 5, pp. 607-622.

THE HPA AXIS



What is the HPA axis?

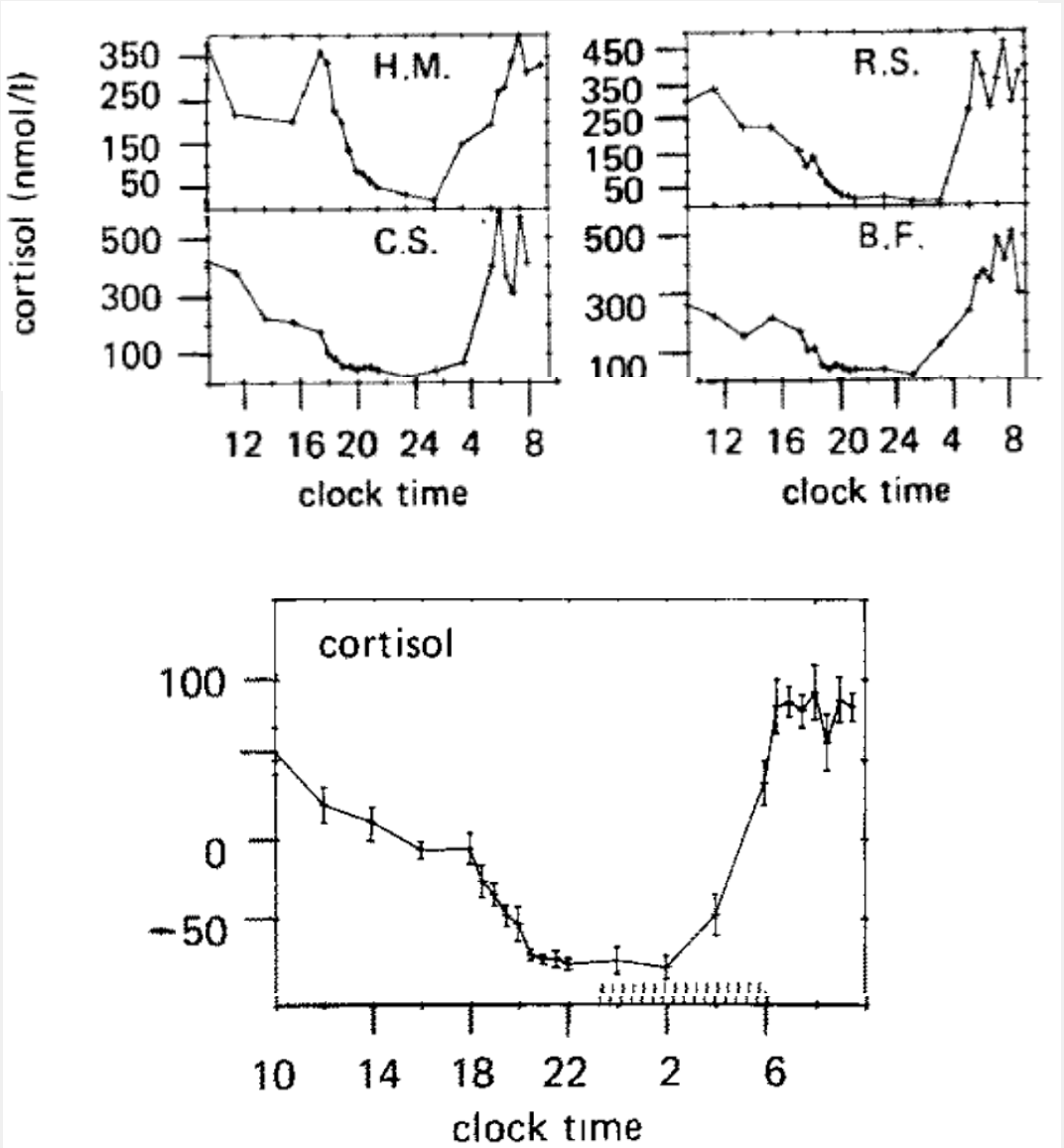
It is the common mechanism for interactions among glands, hormones, and parts of the midbrain that mediate the general adaptation syndrome (GAS).

→ **The HPA axis is the endocrine core of the stress regulation system.**

As such, it links the individual to its social surrounding, setting the stage for the individual's behavioral as well as creative options!

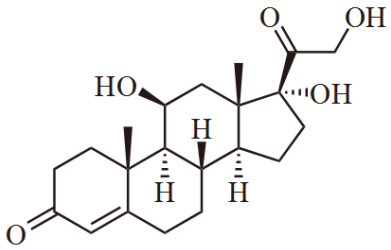
Source: Netherlands Institute for Neuroscience, http://www.nin.knaw.nl/Portals/0/Department/Huitinga/hypothalmus%20zijknat%20jeroen.jpg

CORTISOL



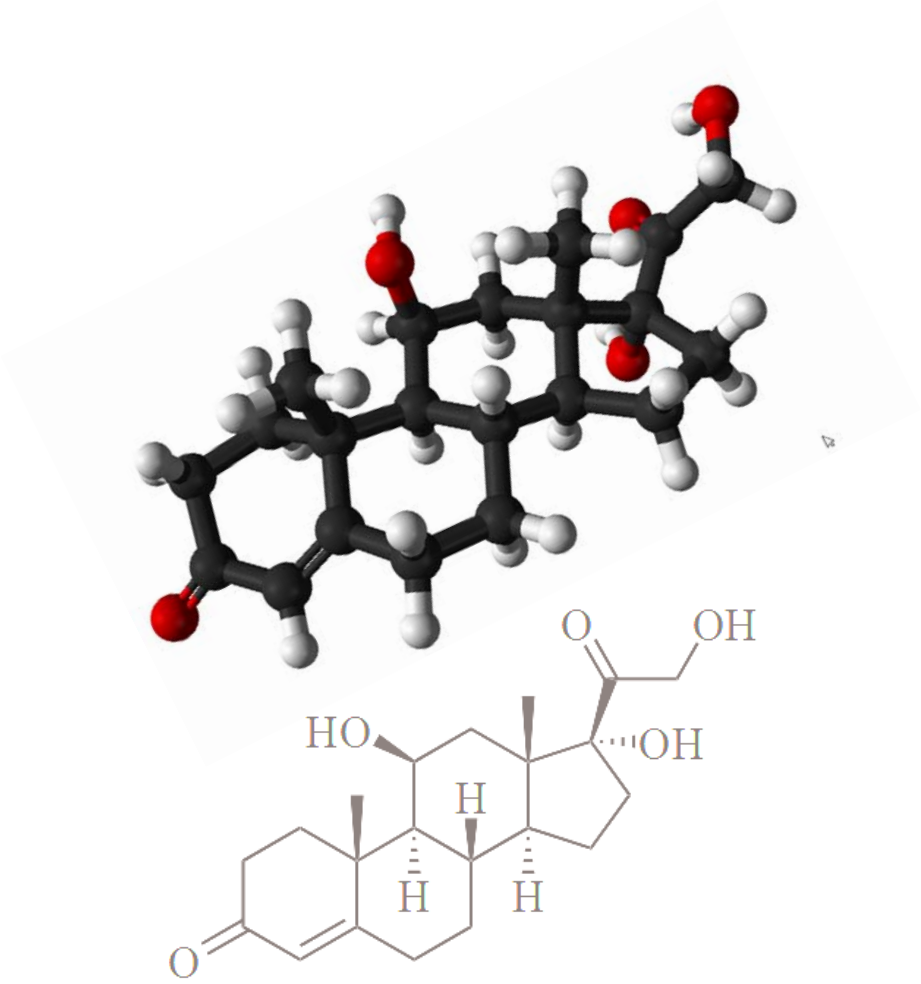
Source: Kage et.al. 1982. Diurnal and Ultradian Variations of Plasma Concentrations of Eleven Adrenal Steroid Hormones in Human Males. KlinWochenschr 60, 659-666.

What is Cortisol?



Cortisol is the body's primary stress hormone. When the brain stimulates its release in response to physical or emotional stress, the adrenal glands secrete cortisol into the blood. Cortisol helps the body regulate blood sugar levels and blood pressure. It also is an anti-inflammatory, an anti-allergic agent and reduces the actions of the immune system.

It is known that in normal people the level of cortisol in the bloodstream peaks in the morning, then decreases as the day progresses. In depressed people, however, cortisol peaks earlier in the morning and does not level off or decrease in the afternoon or evening. Chronically elevated cortisol may potentially contribute to the emergence of clinical depression by affecting the serotonergic neurotransmission.



Agenda

Stress and Creativity?

Experimental Setting

First Results

EXPERIMENTAL SETTING

Group 1: **Reward**	Group 2: **Stressful Task**	Group 3: **Stressful Task + Reward**	Group 4: **Control Group**
Saliva Cortisol 1st sample	Saliva Cortisol 1st sample	Saliva Cortisol 1st sample	Saliva Cortisol 1st sample
-	**Stressful Task**	**Stressful Task**	-
Announcement Reward	-	Announcement Reward	-
Creativity Task	**Creativity Task**	**Creativity Task**	**Creativity Task**
Reward	-	Reward	-
Perceived Stress Questionnaire	Perceived Stress Questionnaire	Perceived Stress Questionnaire	Perceived Stress Questionnaire
Saliva Cortisol 2nd sample	Saliva Cortisol 2nd sample	Saliva Cortisol 2nd sample	Saliva Cortisol 2nd sample
Intrinsic Motivation Inventory	Intrinsic Motivation Inventory	Intrinsic Motivation Inventory	Intrinsic Motivation Inventory

EXPERIMENTAL SETTING – Saliva Cortisol

Saliva Cortisol Samples:

Pre- and post experimental sample using „Salivette“ system:

A: Complete Salivette

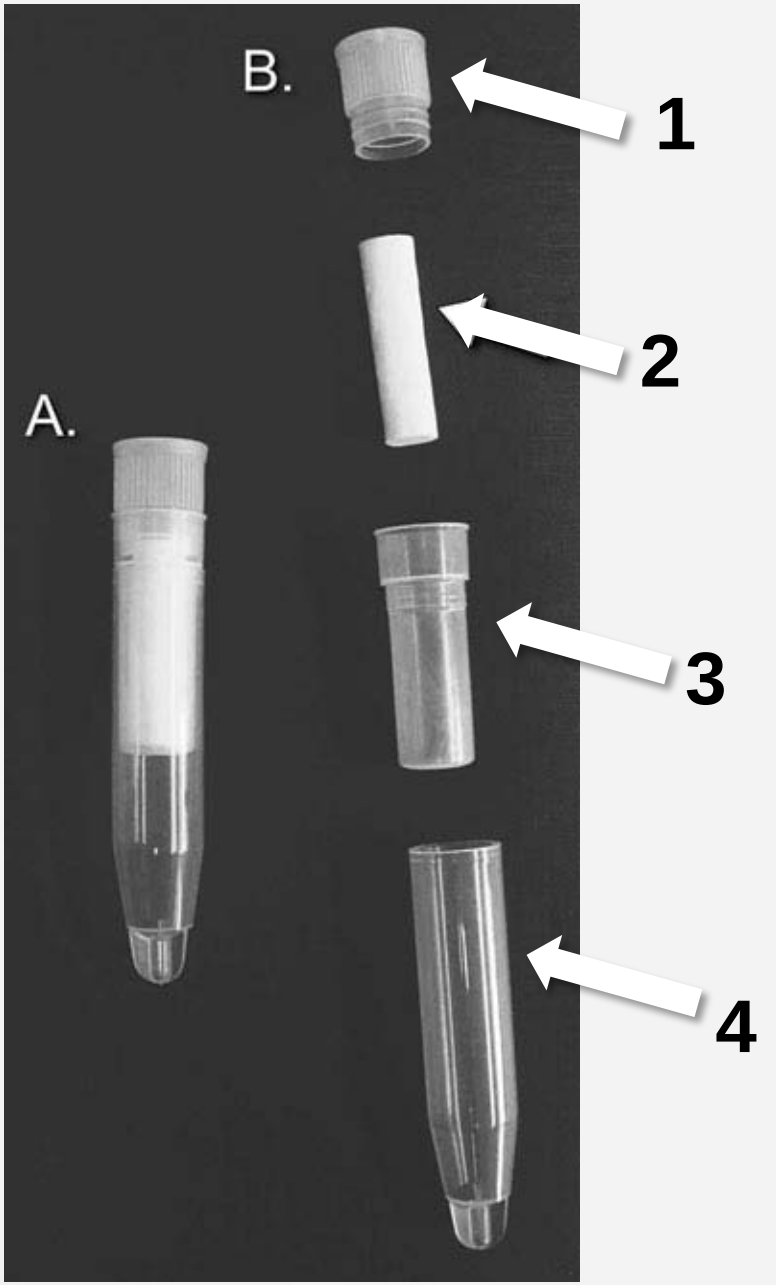
B: Parts:

1: Stopper

2: Swab

3: Suspended Insert

4: Centrifuge Vessel



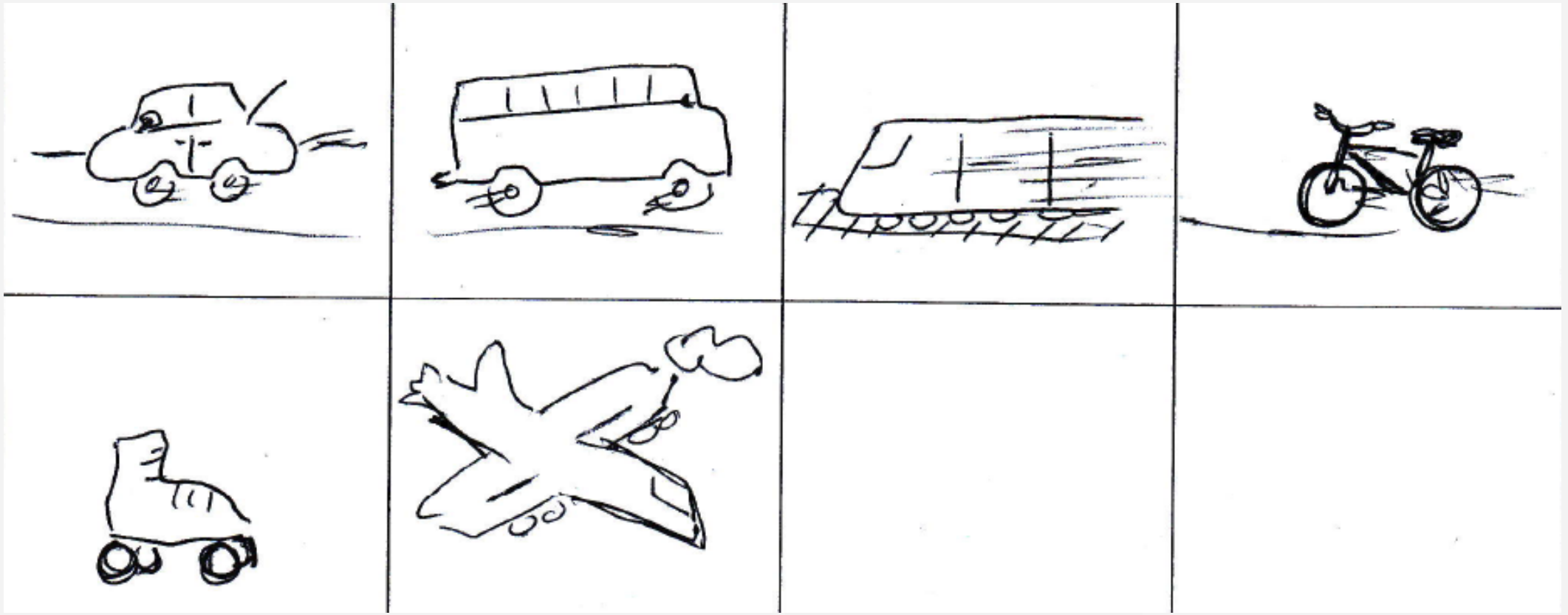
EXPERIMENTAL SETTING – measuring creativity

Sample „drawing task“ (task 1)

Task 1 **2:30**

Please draw in the boxes below as many different pictures on the subject „mobility“.

Please start only after the lab supervisor tells you to!



EXPERIMENTAL SETTING – measuring psychological aspect of stress

The **Perceived Stress Questionnaire** (Fliege et al., 2005; Levenstein et al. 1993)

For each sentence, mark the number that describes how often it applies to you during the last 4 weeks. There are no right or wrong answers. Please work quickly, without bothering to check your answers, and do not skip any question.

		Almost never 1	Some-times 2	Often 3	Usually 4
01	You feel rested 01				
02	You feel that too many demands are being made on you 02				
03	You have too many things to do 04				
04	You feel you're doing things you really like 07				
05	You fear you may not manage to attain your goals 09				
06	You feel calm 10				
07	You feel frustrated 12				

EXPERIMENTAL SETTING – measuring intrinsic motivation

The **Intrinsic Motivation Inventory** (Ryan, 1982)

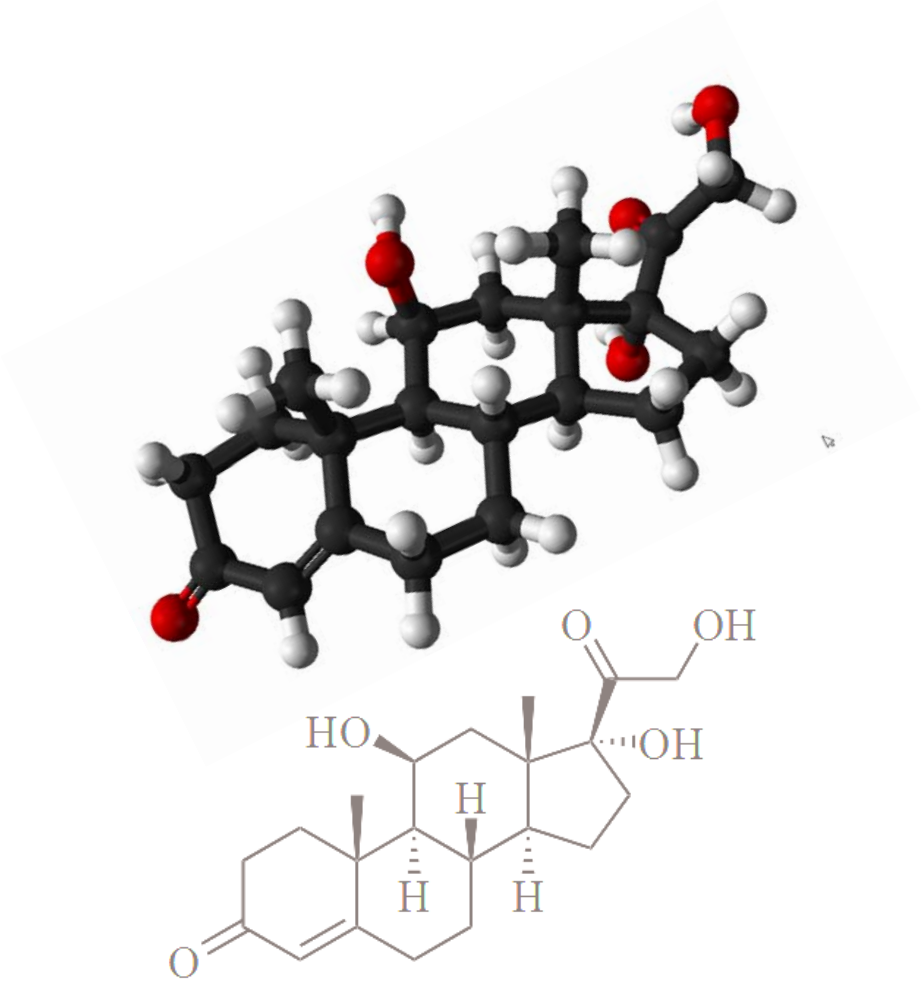
The following is a 22 item version of the scale that has been used in some lab studies on intrinsic motivation. It has four subscales: interest/enjoyment, perceived choice, perceived competence, and pressure/tension. The interest/enjoyment subscale is considered the self-report measure of intrinsic motivation; perceived choice and perceived competence are theorized to be positive predictors of both self-report and behavioral measures of intrinsic motivation. Pressure tension is theorized to be a negative predictor of intrinsic motivation. Scoring information is presented after the questionnaire itself.

TASK EVALUATION QUESTIONNAIRE

For each of the following statements, please indicate how true it is for you, using the following scale:

1	2	3	4	5	6	7
not at all true			somewhat true			very true

1. While I was working on the task I was thinking about how much I enjoyed it.
2. I did not feel at all nervous about doing the task.
3. I felt that it was my choice to do the task.
4. I think I am pretty good at this task.
5. I found the task very interesting.
6. I felt tense while doing the task.



Structure

Stress and Creativity?

Experimental Setting

First Results

FIRST RESULTS – test sample of N=44

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Group Size	44	4	1	5	3,36	1,259	-,226	,357	-1,072	,702
Condition	44	3	1	4	2,50	1,229	,039	,357	-1,609	,702
Sex	40	1	0	1	,75	,439	-1,200	,374	-,592	,733
Age	37	17	18	35	24,59	4,233	,838	,388	-,111	,759
Cortisol 1	39	,366	,028	,394	,13338	,084881	1,209	,378	1,733	,741
Cortisol 2	43	,283	,000	,283	,12298	,071573	,233	,361	-1,028	,709
Cortisol Delta (2 minus 1)	39	,235	-,155	,080	-,00449	,048564	-,893	,378	1,423	,741
Cortisol Delta in Percent	39	198,6	-68,9	129,7	4,010	39,6798	,918	,378	1,617	,741
Q2 Avg Creativity	44	5,26	3,58	8,84	5,4814	1,00496	,627	,357	1,686	,702
Q2 Avg Creativity Drawing	44	4,86	2,22	7,08	3,7807	,97979	,873	,357	1,526	,702
Q2 Avg Creativity Verbal	44	5,86	4,15	10,01	6,6270	1,11223	,312	,357	1,116	,702
Q3 Total Score	44	75,0	8,3	83,3	42,832	17,6628	,151	,357	-,557	,702
PSQ + Cortisol Index	39	96,2	39,7	135,9	72,810	22,5364	1,030	,378	1,139	,741
PSQ + Cortisol Index Reversed	39	106,0	2,6	108,6	68,815	20,6169	-,771	,378	1,530	,741
Q4 Total Score	44	3,5	2,5	6,0	4,175	,9148	-,008	,357	-,874	,702
Valid N (listwise)	32									

FIRST RESULTS – Did the “stressing” work?

Analysis of variance: „Condition“ as Independent Variable

Descriptives

			N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between-Component Variance
							Lower Bound	Upper Bound			
Cortisol Delta (2 minus 1)	Reward		9	,00578	,036911	,012304	-,02259	,03415	-,054	,050	
	Stressful Task		9	,00378	,065553	,021851	-,04661	,05417	-,155	,072	
	Stressful Task + Reward		7	-,01343	,052990	,020028	-,06244	,03558	-,080	,080	
	Control Group		14	-,01193	,043498	,011625	-,03704	,01319	-,111	,052	
	Total		39	-,00449	,048564	,007776	-,02023	,01126	-,155	,080	
	Model	Fixed Effects			,049777	,007971	-,02067	,01169			
		Random Effects				,007971[a]	-,02985[a]	,02088[a]			-,000159
Q3 Total Score	Reward		13	39,608	20,2073	5,6045	27,397	51,819	16,7	83,3	
	Stressful Task		10	46,500	19,1161	6,0451	32,825	60,175	8,3	70,0	
	Stressful Task + Reward		7	52,129	13,2082	4,9922	39,913	64,344	35,0	78,3	
	Control Group		14	38,557	15,3140	4,0928	29,715	47,399	18,3	68,3	
	Total		44	42,832	17,6628	2,6628	37,462	48,202	8,3	83,3	
	Model	Fixed Effects			17,5245	2,6419	37,492	48,171			
		Random Effects				2,9493	33,446	52,218			6,4729

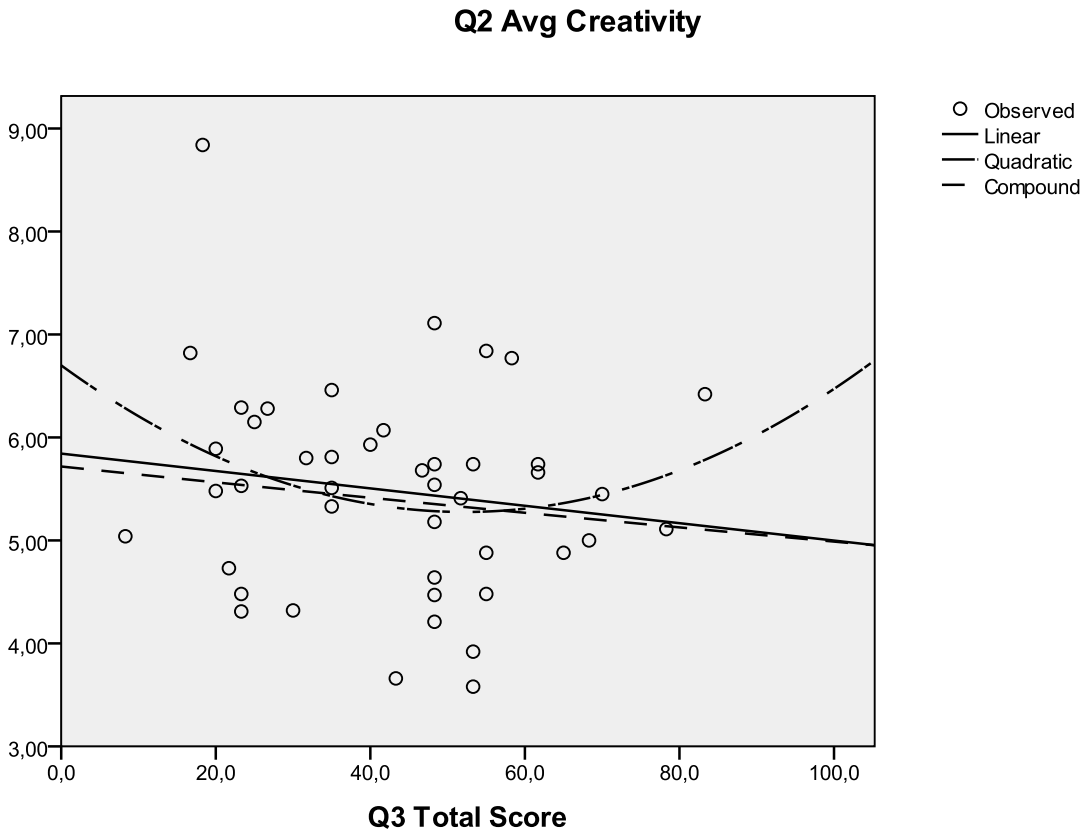
a. Warning: Between-component variance is negative. It was replaced by 0.0 in computing this random effects measure.

FIRST RESULTS – How does the relation stress & creativity look like?

Regression – curve fit: Perceived stress as indipendent, average creativity as dependent variable

Dependent Variable:Q2 Avg Creativity

Equation	Model Summary					Parameter Estimates		
	R Square	F	df1	df2	Sig.	Constant	b1	b2
Linear	,022	,946	1	42	,336	5,843	-,008	
Quadratic	,057	1,234	2	41	,302	6,700	-,055	,001
Compound	,017	,746	1	42	,393	5,718	,999	

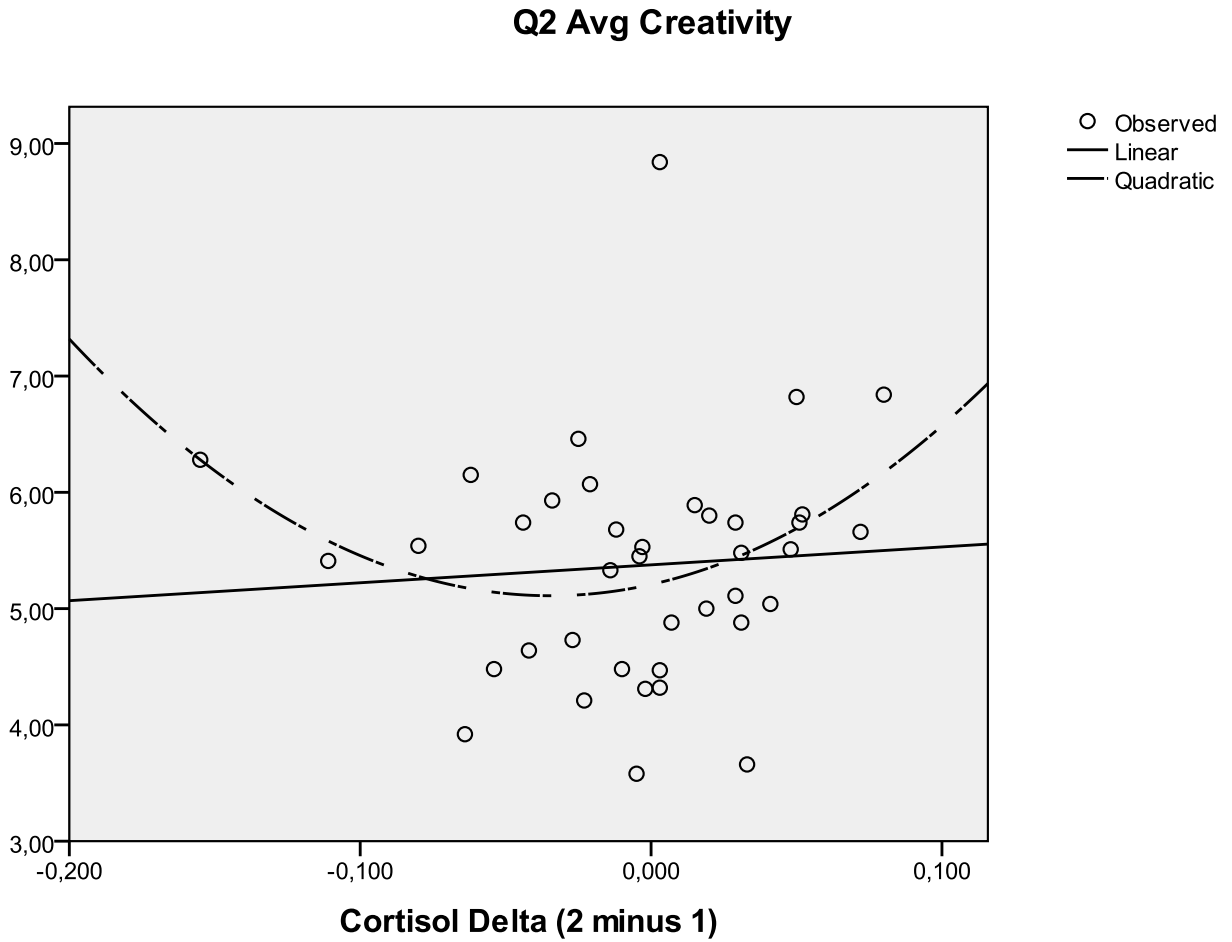


FIRST RESULTS – How does the relation stress & creativity look like?

Regression – curve fit: Cortisol delta as indipendent, average creativity as dependent variable

Dependent Variable:Q2 Avg Creativity

Equation	Model Summary					Parameter Estimates		
	R Square	F	df1	df2	Sig.	Constant	b1	b2
Linear	,006	,214	1	37	,646	5,376	1,541	
Quadratic	,091	1,808	2	36	,179	5,208	5,584	80,685

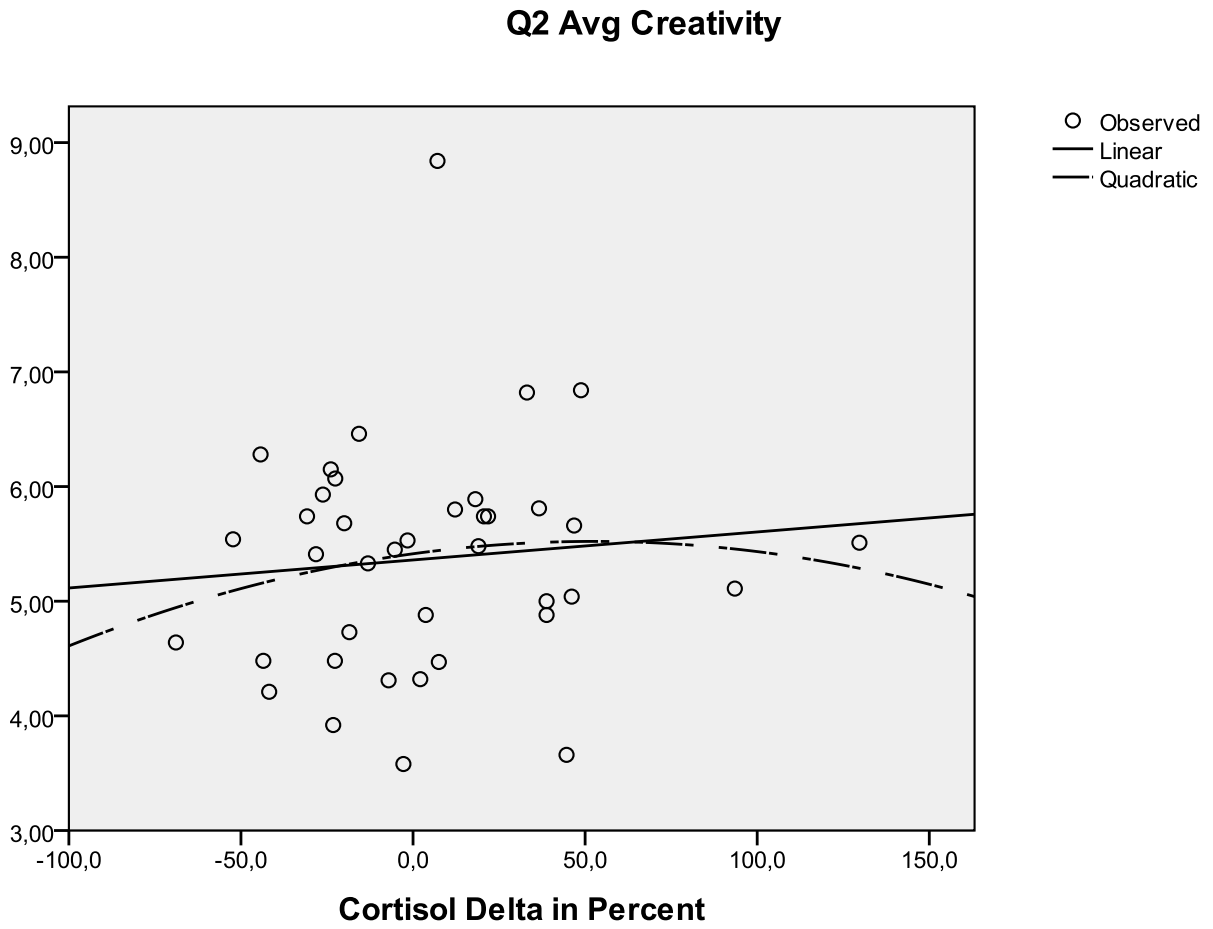


FIRST RESULTS – How does the relation stress & creativity look like?

Regression – curve fit: Cortisol delta % as indipendent, average creativity as dependent variable

Dependent Variable:Q2 Avg Creativity

	Model Summary					Parameter Estimates		
Equation	R Square	F	df1	df2	Sig.	Constant	b1	b2
Linear	,010	,361	1	37	,552	5,360	,002	
Quadratic	,019	,352	2	36	,706	5,414	,004	-3,924E-5



FIRST RESULTS – Does stress always feel bad?

Validation of self-rated wellbeing: Correlation between PSQ „joy“ and IMI „interest & enjoyment“

Correlations

		Q3 Joy Scale	Q4 Interest/Enjoyment Scale
Q3 Joy Scale	Pearson Correlation	1	,419**
	Sig. (2-tailed)		,005
	Sum of Squares and Cross-products	16588,619	368,762
	Covariance	385,782	8,576
	N	44	44
Q4 Interest/Enjoyment Scale	Pearson Correlation	,419**	1
	Sig. (2-tailed)	,005	
	Sum of Squares and Cross-products	368,762	46,684
	Covariance	8,576	1,086
	N	44	44

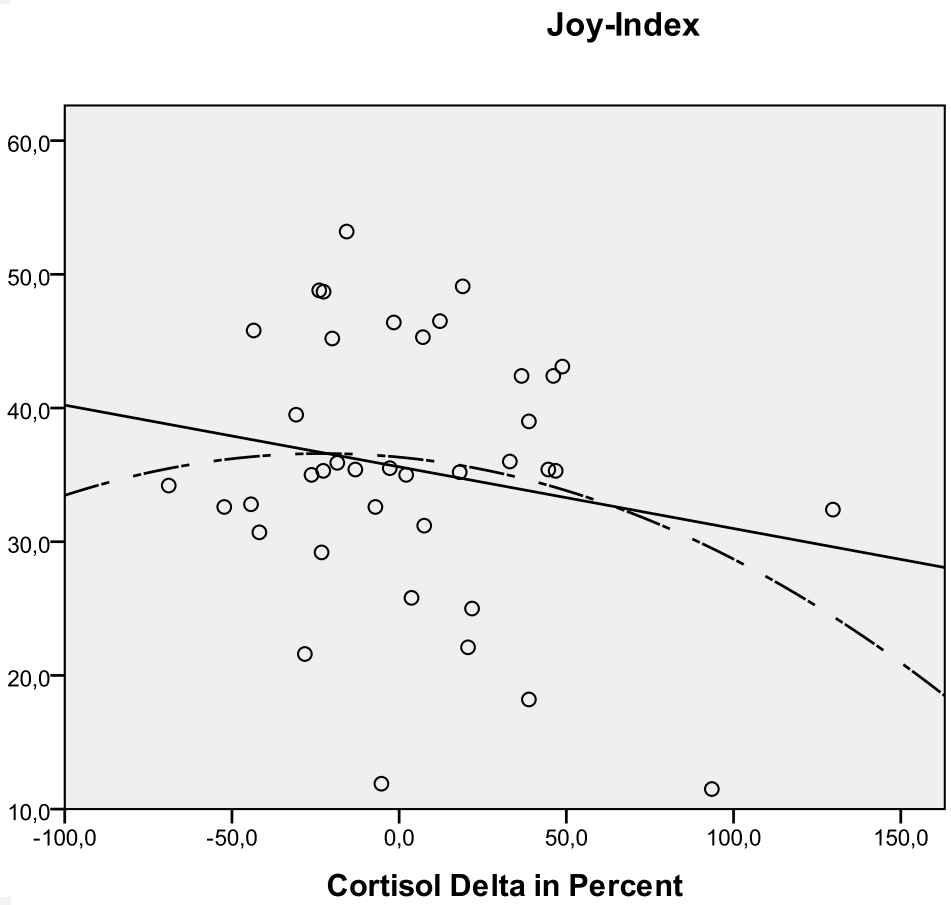
**. Correlation is significant at the 0.01 level (2-tailed).

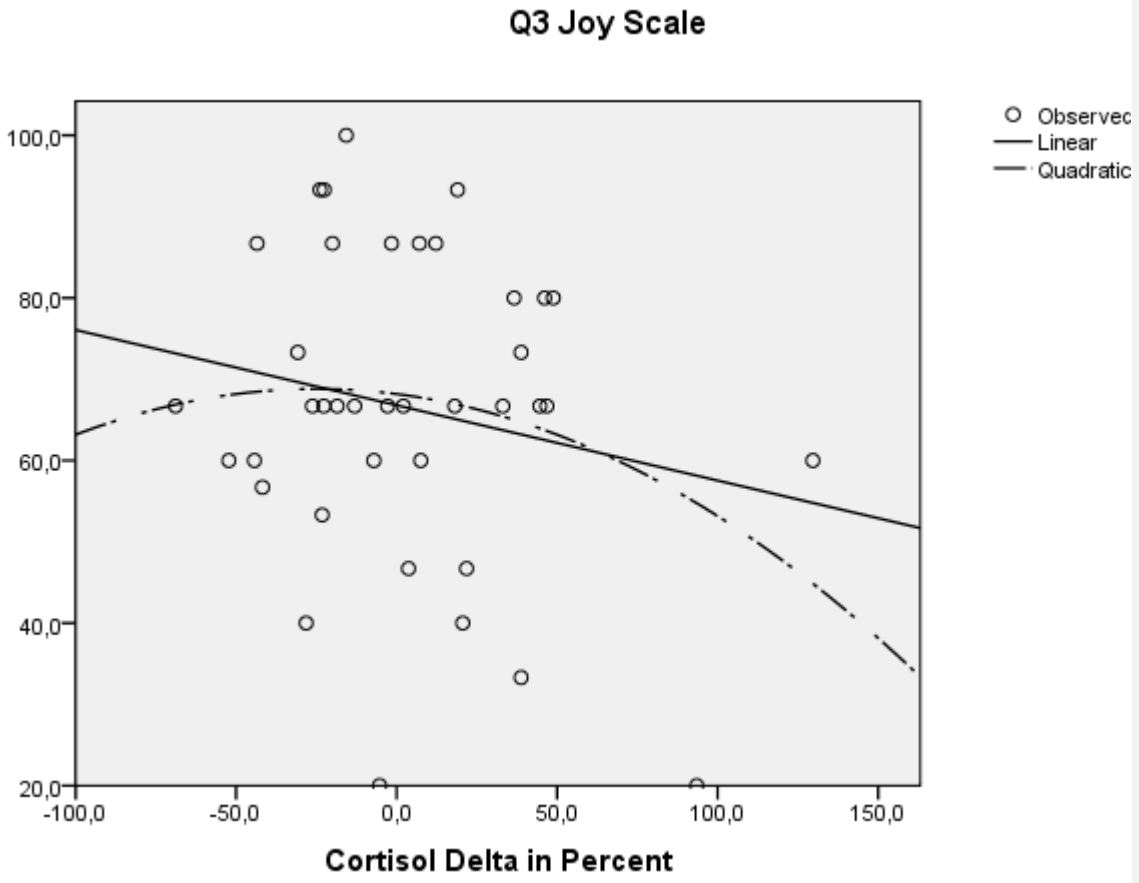
FIRST RESULTS – Does stress always feel bad? Yes?

Regression – curve fit: Cortisol delta % as indipendent, self-rated wellbeing as dependent variable

Dependent Variable:Joy-Index

	Model Summary					Parameter Estimates		
Equation	R Square	F	df1	df2	Sig.	Constant	b1	b2
Linear	,035	1,322	1	37	,258	35,600	-,046	
Quadratic	,052	,977	2	36	,386	36,324	-,024	,000



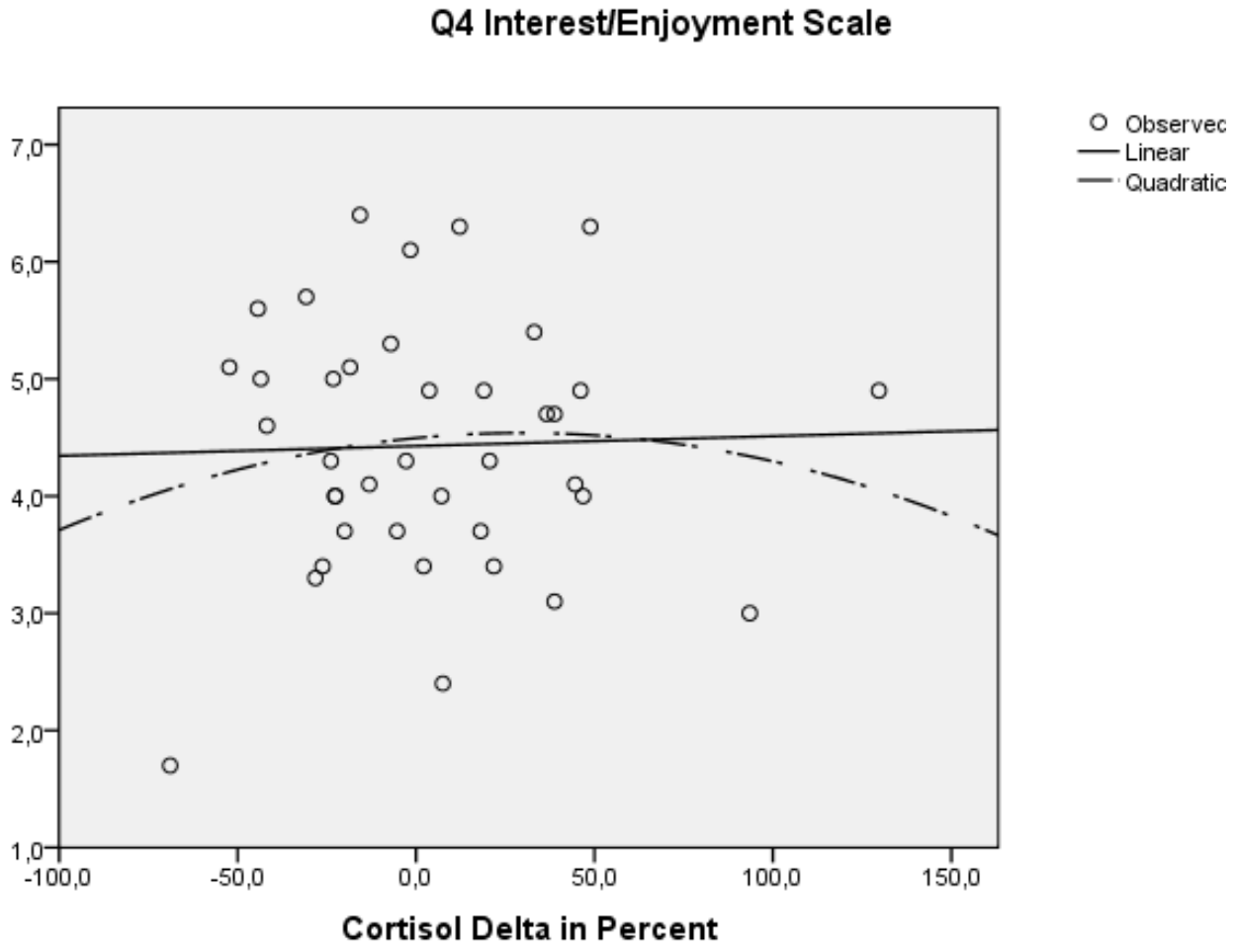


FIRST RESULTS – Does stress always feel bad? NO! Not if is of interest!

Regression – curve fit: Cortisol delta % as indipendent, self-rated wellbeing as dependent variable

Dependent Variable:Q4 Interest/Enjoyment Scale

Equation	Model Summary					Parameter Estimates		
	R Square	F	df1	df2	Sig.	Constant	b1	b2
Linear	,001	,036	1	37	,851	4,427	,001	
Quadratic	,014	,250	2	36	,780	4,495	,003	-4,918E-5



FIRST RESULTS – Is there a connection between group size and stress?

Anova: Factor group size, cortisol delta % and creativity as dependent variables

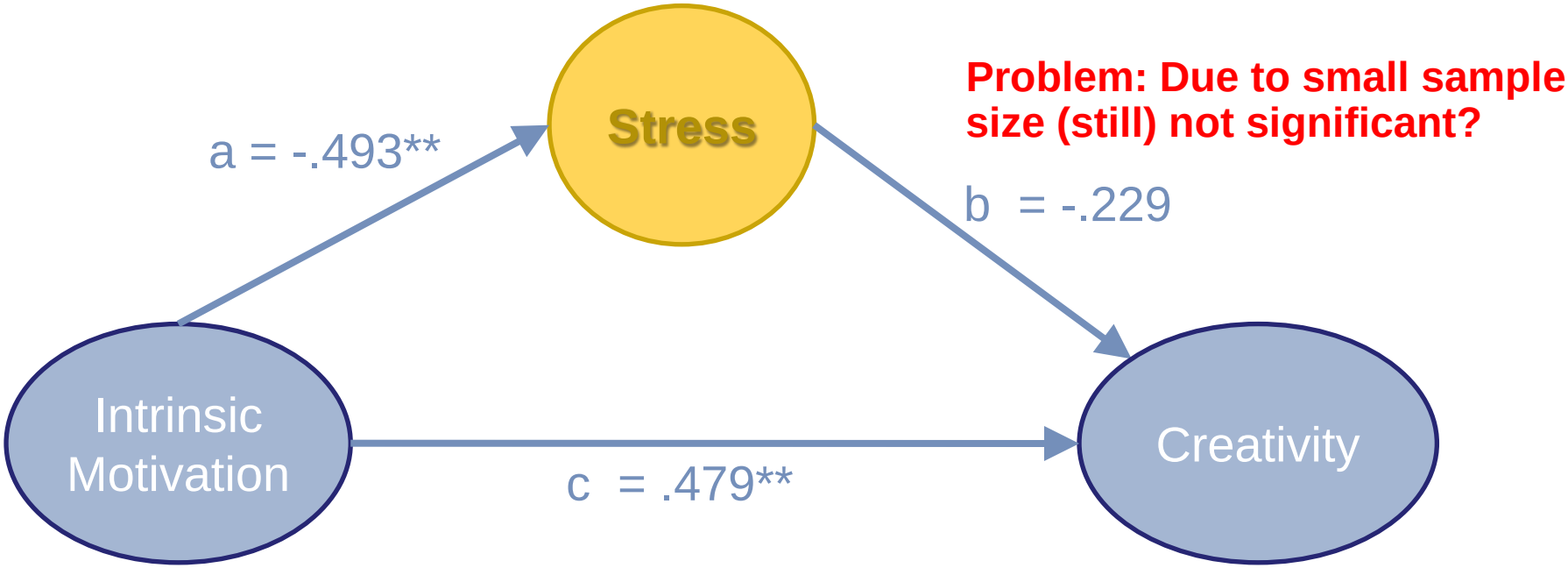
		Sum of Squares	df	Mean Square	F	Sig.
Cortisol Delta in Percent	Between Groups	1892,877	4	473,219	,278	,890
	Within Groups	57937,719	34	1704,051		
	Total	59830,596	38			
Q2 Avg Creativity	Between Groups	8,072	4	2,018	2,226	,084
	Within Groups	35,355	39	,907		
	Total	43,428	43			
Q3 Total Score	Between Groups	3623,356	4	905,839	3,608	,014
	Within Groups	9791,499	39	251,064		
	Total	13414,855	43			

Mediation of creativity-decreasing effect of lowered intrinsic motivation?

Mediation model – revised

Step 1: Calculate correlations

Step 2: Calculating regression analysis (regressing creativity to intrinsic motivation and stress)



Mediation of creativity-decreasing effect of lowered intrinsic motivation?

Mediation model – revised

Step 1: Calculate correlations

Step 2: Calculating regression analysis (regressing creativity to intrinsic motivation and stress)

Step 3: Sobel test: using SPSS syntax of Preacher, K. J., & Hayes, A. F. (2004), including bootstrapping

```
INDIRECT EFFECT And SIGNIFICANCE USING NORMAL DISTRIBUTION
          Value      s.e.  LL 95 CI  UL 95 CI         Z  Sig(two)
Effect   -,0050    ,0853    -,1723     ,1622   -,0588     ,9531

BOOTSTRAP RESULTS For INDIRECT EFFECT
            Data      Mean      s.e.  LL 95 CI  UL 95 CI  LL 99 CI  UL 99 CI
Effect    -,0050     ,0002     ,0851    -,1555     ,1895    -,2190     ,2969

NUMBER OF BOOTSTRAP RESAMPLES
     5000

FAIRCHILD ET AL. (2009) VARIANCE IN Y ACCOUNTED FOR BY INDIRECT EFFECT:
     ,0524
```

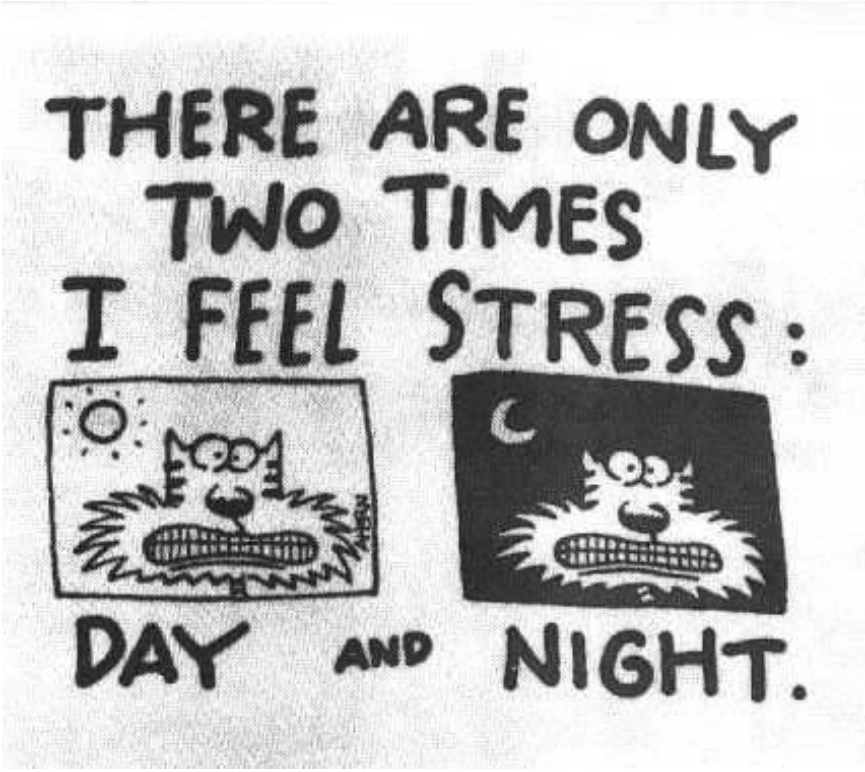
→ **No significant reduction of path Creativity-Intr.Mot. by Stress!**

Discussion

So, what do YOU think about the relation between stress and creativity, after all?

Discussion

What does the results imply for the creative potential of chronically stressed people?



Discussion

What does the results imply for allday creativity?

Discussion

Interesting Questions:

- What is the relation between cortisol and the conditions? Did the „stressing“ work?
- How do poeple „feel“ stress – is there something like „eustess“? (relation between cortisol values and joy-scale of PSQ / interest enjoyment-scale of IMI?
- How about the correlation between Cortisol and PSQ?
- Does an overall stress-index constituted from cortisol- and PSQ-values make sense? Would it more clearly reflect an actual stress-level? **From current data rather not!**
- What does the change in cortisol say about the stress system of the respective person?
- Is there a connection between groupsize and stress-level (in terms of psychosocial stress / stress mediated via group pressure)?
- Does stress better explain the crowding effect within creativity research?