From mate choice to stereotypes – understanding the perception of facial resemblance in an evolutionary framework

Doctoral theses

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Content

1. Abstract

The aim of this dissertation was to embed the perception of human facial resemblance and the theories related to the judgments associated with the former into an integrative framework. Beside reviewing the available empirical data, the evolutionary explanation, ontogenetic occurrence, phylogenetic origin, and neural mechanisms of the studied phenomena will be discussed. In this summary of the theses, however, the theoretical background will be presented marginally, in connection with the experiments.

In the first experiment, the neural activations, evoked by opposite-sex faces with different attractiveness, were analyzed. The group-level analysis of the female subjects revealed significant activations for increased attractiveness in some brain areas (insula, superior temporal gyrus, hippocampus) which was not observed in the analysis of the whole group and the male cohort. Evolutionary constraints provided selective advantage to those females who followed cautious, risk-avoiding mate choice strategy, and it is possible that brain functioning also reflects this cognitively demanding strategy.

With the second experiment our aim was to find evidence for self-face preference, based on facialmetric measurements. The results are contradictory, the comparison of the 14 face proportions did not support the hypotheses.

In the third study the relation between resemblance, attractiveness, and childhood attachment was tested. Both sexes preferred self-resembling faces, provided they were warped into the most attractive composite. Furthermore, those who had a good relation to their opposite-sex parents during infancy were more willing to choose partners resembling them, compared to those with worse childhood memories.

In the fourth experiment we assumed that following a short, but emotionally intense, negative or positive impression, faces resembling the original faces evoke similar reactions in the subjects. In line with this, the composite which was made of faces either associated with positive descriptions or primed with high valence images, were rated as more trustworthy. There was no significant difference in the performance between the two condition. This overgeneralization might play a role not just in the evaluation of individuals, but in the formation of stereotypes about groups as well.

2. Studies

2.1 Functional neuroanatomical correlates of attractiveness perception

2.1.1 Aims and hypotheses

Several studies showed that facial attractiveness, as a highly salient social cue, influences behavioral responses during social interactions. It was also found that attractive faces evoke distinctive neural activations compared to unattractive or neutral faces.

Our primary aim was to design an event related fMRI face recognition task where individual preferences for facial cues are controlled for. Therefore, prior to the functional scanning, subjects were tested for their face preferences.

The hypotheses were as follows:

1. Attractive faces, in contrast to unattractive faces, evoke enhanced activation in the face-sensitive regions of the fusiform gyrus and the occipital cortex.
2. Attractive faces, in contrast to unattractive faces, evoke enhanced activation in the reward system (orbitofrontal cortex, nucleus accumbens, amygdala, ventral tegmentum).

2.1.2 Methods

Participants

Volunteers from a previous experiment were recruited. Seven males (age: *M* = 25.00 years, *SD* = 5.53 years, range: 19-37 years) and eight females (age: *M* = 20.13 years, *SD* = 1.96 years, range: 18-23 years) were included in the final analysis.

Stimuli

Images from a previous study were used for the experiment. Based on the own particular ratings of each individual, one attractive and one relatively unattractive face were selected for each subject in order to present these in the scanner as stimuli.

The facial images were presented for 2000 ms with varying inter-stimulus intervals, the distribution of which was skewed towards shorter times (range: 1500-10000 ms, mean: 4000 ms). The subjects were exposed 16 times to each face and 8 times to the non-face image during the session.

Participants were asked to push a button when they saw a non-face stimulus. Responses were made during the presentation of the non-face stimuli. The aim of this was – beside sustaining participants' attention – to avoid movement artifacts and activations in the motor area during the presentation of faces.

2.1.3 Results and discussion

Corresponding to our expectations, the areas in which elevated activations were observed in response to attractive opposite-sex faces in contrast to unattractive faces, include occipital and occipitotemporal visual regions (bilateral middle occipital gyri, left fusiform gyrus, left lingual gyrus), parietal areas (precentral gyrus) and frontal areas (anterior cingular cortex [ACC], right inferior frontal gyrus). It was shown that the fusiform gyrus–which is involved in the categorization of objects and the recognition of temporally invariant facial structures –is more active for attractive than for unattractive faces.

Consistent with our results, the ACC was formerly found to be active while responding to sexually arousing stimuli in both men and women. The right inferior frontal gyrus processes emotional communicative signals, hence it plays a role in the assessment of facial emotions.

Though the direct comparison of male and female brain activations did not indicate sex differences, however, the group-level analysis of the eight female subjects revealed significant activations for increased attractiveness in some additional brain areas (insula, superior temporal gyrus [STG], hippocampus).

The insula, in particular, is involved in processes connected with basic emotions and desires; it is also activated by disgusting behaviors; and it enables the representation of current autonomic state. This is essential in the perception of one's own emotional response to different stimuli. In this relation attractive faces can be considered as more arousing than non-attractive ones. Females might be more sensitive to, or emotionally more affected by, these cues with high reproductive relevance.

The BOLD-signal detected in the STG can be explained as the consequence of an enhanced response to attractive faces. Higher activations in female subjects' insula and STG during observation of attractive males is possibly the result of an evaluation process of potential partners, which involves risk assessment based on invariable facial cues and on detection of the male's intentions.

It has been previously suggested that memory processes interact with facial attractiveness throughout all stages from encoding to retrieval. It is possible that the enhanced hippocampal activity is a result of a neural process to integrate aesthetic judgements of novel faces into the prior knowledge of the social world. For females who have to bear the most costly consequences of their bad decisions, this integration might be of crucial importance in case of attractive faces.

This can be explained in evolutionary terms by Trivers' (1972) parental investment theory. Because of their higher investment in offspring, females face higher risks during reproduction. These evolutionary constraints provided selective advantage to those females who followed cautious, risk-avoiding mate choice strategy. It is possible that brain functioning also reflects this cognitively demanding strategy. The specific brain activities of female subjects during the observation of attractive male faces might indicate that they are equipped with a wider set of cognitive processes than males for estimating the mate value of their potential partner.

2.2 Effect of resemblance on attractiveness – a facialmetric study

2.2.1 Aims and hypotheses

Former research showed that facialmetric methods could be useful in studying the relation between resemblance and attractiveness. The advantage of this method is that, by using photos of real individuals, it makes possible to collect objective data from the physical features of faces, and to compare these with the subjective ratings of judges. Though the grade of resemblance is not standardized, nevertheless it can be calculated. Accordingly, the aim of the second study was, using the method based on the measurement between characteristic points of the face, to obtain additional information about self-face preferences. In this study, this question was addressed in mate choice context by using opposite-sex individual photographs. Taking the results of former research into account, we intended to draw the attractiveness related to genetic fitness into the analysis, as this could crucially influence the preference of resemblance.

The following hypotheses were made:

1. The subjects prefer those faces which are more similar to themselves in respect of face proportions.

2. This relation is stronger when they judge faces with a higher overall attractiveness level.

2.2.2 Methods

Participants

Data from altogether 108 volunteers was analyzed, 55 females (age: *M* = 22.660, *SD* = 2.784, 18-29 years) and 53 males (age: *M* = 23.620, *SD* = 2.934, 18-30 years).

Stimuli

Images from a former study were selected, 97 female and 83 male photographs. The images were rated by independent judges (23 females, 5 males) on a 1 to 9 point scale. Based on these ratings, 10 female and 10 male faces with high attractiveness, and 15 male and 15 female faces with moderate attractiveness were chosen from the pool.

Experimental design

Opposite-sex images were presented with DMDX software in randomized order. The experiment consisted of two blocks, each of two parts. In the first part, the subjects task were merely to observe the photographs with moderate attractiveness in their own pace. In the second part, they had to rate the faces on a 1 to 9 point scale by attractiveness. In the second block the faces with high attractiveness were presented, the task in the two parts of this block was identical to that of the first block.

Face measurement

The software *ImageJ* was used to measure the faces. First, 24 characteristic points were designated on each face, then the distance between these points was measured. Altogether 17 distances were measured, from which 14 proportions were calculated (*Table 1*). The stimuli faces and the participants' faces were measured as well.

Table 1. Proportions made from the metrical features of the faces

No.	Face proportion	No.	Face proportion
1.	Mouth-forehead/face length	8.	Jaw width/Face width
2.	Nose length/face length	9.	Mouth width/Face width
3.	Jaw length/face length	10.	Eye width/Face width
4.	Face width/face length	11.	Eye height/Eye width
5.	Outer eye corner/Face width	12.	Lip fulness/mouth width
6.	Pupils/Face width	13.	Nose-jaw/face length
7.	Nose width/Face width	14.	Inner eye corner/Face width

Then, the average face proportions of the male and female participants were calculated. The values of both male and female subjects, and the stimuli faces, were modified using these sex-specific proportions. These values reflected, according to our intentions, the difference between the face proportions of the particular subject and the average male or female face proportions, respectively.

Subsequently, based on the ratings of the participants, the images where selected from the pool which were found the most and the least attractive by each individual subject. The level of similarity between the subjects and the stimuli faces was calculated by subtracting the proportions–formerly modified with the sex-specific proportions–from each other. The lower absolute value indicated higher resemblance.

Data analysis

In the first step, a two level repeated measures variance analysis was conducted (Table *2*). On the proportions indicating that the attractiveness level or the sex of the subjects had an effect at least on a 0.1 significance level, further statistical tests were made (repeated measures ANOVA and paired-samples *t*-test separately on the data of the two attractiveness categories).

Table 2. Analysis design of the repeated measures ANOVA testing the relation between the attractiveness category, scores, and the degree of resemblance (as the dependent variable). Beside these two levels the sex of the participants (as a grouping variable) was taken into the analysis as well.

	II. Ratings	
	1. High score	2. Low score
I. Attractiveness category		
1. Moderately attractive images	Resemblance	
2. Attractive images		

2.2.3 Results and discussion

The results do not give solid underpinning for the hypothesis assuming that people prefer faces with a higher degree of resemblance, nor the prediction that this effect was stronger in more attractive faces. However, some data tend to the predicted direction. From the 14 face proportions four decrease (inner eye corner/face width, face width/face length, eye height/eye width, mouth-forehead/face length), and four increase he attractiveness of the images (jaw width/face width, nose-jaw/face length, pupils/face width, pupils/face width). It is hard to detect any pattern in respect to the effect of sex. Besides, the data are inconclusive in terms of whether the preference for similarity is more pronounced in the more attractive face category.

In a previous study which used similar methods, the face proportions of females' fathers and of males formerly rated as attractive by these particular female subjects, were compared. A crucial difference between the two studies is that in the referred experiment same-sex faces were compared, whereas the very goal of the recent study was to obtain information about the resemblance of opposite-sex faces with objective methods. An obvious disadvantage of this method is that the female faces rated as attractive by male participants show significant differences in features influenced by sex hormones (such as jaw width, lip fulness etc.). Consequently, with a direct comparison of facial features, a male preference for differences, and not for similarities, could be expected. The same is more or less true for female preferences, though often they prefer not just masculine, but feminine features of male faces as well.

Another important question is to what extent is it possible to capture the very features important in face perception by measuring facial proportions? The method used here is more suitable for capturing configural features of faces, as the relative distance between, or the width and height of, particular face details are measured, while no information about the shape is obtained. However, beside processing holistic features of the faces, the component information are important as well. Taking these facts into account, it could be useful to consider to pay more attention to these facial properties when analyzing resemblance. It could be worth to repeat the recent study with a different metrical method.

2.3 Testing the theories of sexual imprinting and phenotype matching with an image manipulation technique

2.3.1 Aims and hypotheses

The main reason to initiate this study was that the two concepts discussed here–sexual imprinting and self-referential phenotype matching theories–has not yet been tested with the same experimental design. Scholars studying self-face preferences have different opinions about and are engaged for what input is used for perceiving resemblance. Hence, it is hard to decide which of the studies using different methodologies have more convincing results, and which theory is more precise in predicting human behavior.

An other important theoretical issue when discussing adaptive consequences of mate choice is the distinction between the quality of genes and the compatibility of genotypes. The choice for “good genes” represents the application of an absolute criterion, whereas genes that are a “good fit” are different to each individual, depending on their own genetic composition. The selection pressures impelling to find good genes and genes which are distinct in an optimal proportion, however, are were not of equal strength during evolution, therefore, it is likely that there is an interaction between the two features.

An important part of the sexual imprinting theory is the assumption that learning processes are at work during the development of adult face preferences. The influence of childhood attachment on face preferences also has empirical support in adults and children. Therefore, one of the aims of the recent study was to control for the childhood quality of attachment between the participants and their parents.

Motivated by the above considerations, we designed an experimental paradigm where the relation between resemblance, attractiveness, and childhood attachment can be tested simultaneously. The hypotheses were as follows:

1. Self-resemblance is preferred and this preference is greater in attractive than unattractive faces.

2. Opposite-sex parent-resemblance is preferred and this preference is greater in individuals with a better childhood attachment.

2.3.2 Methods

Participants

Digital photos were gathered from 96 participants and their parents. The total amount of participants in the study were 54 females (M = 21.41, SD = 2.42, between 17 and 27 years) and 42 males (M = 24.17, SD = 4.95, between 18 and 37 years).

Stimuli

Images were used which were rated by attractiveness by independent judges (as in *Chapter 2.2*). For the attractive and unattractive female composites eight attractive and eight unattractive composites were used, respectively. For the two faces with intermediate attractiveness, the former individual images were combined, that is four attractive and four unattractive faces were used to construct an intermediate composite.

The computer software *Psychomorph* was used to construct composite faces. Reference points and lines were put on characteristic features of each images (eye corner, mouth, chin etc.), which are used by the software to calculate the average of the coordinates and hue values for the composite image.

The next step was the transformation of the composites to make them similar to the individual faces. The intermediate values between the individual and the composite faces will be calculated indirectly, using a reference face. This is in each case a same-sex and same-age composite face. In this particular experiment, only the shape of the composites was modified in 50%, color and texture remained the same. The stimuli were created by transforming opposite-sex composite faces to resemble either the subjects, their parents, or an unknown individual chosen randomly from the sample.

Experimental design

The transforms were then arranged into pairs separately within the four attractiveness categories. Volunteers were exposed to 24 opposite-sex image pairs (six pairs for all four facial types) and instructed to choose the one from each pair they prefer more as a potential partner. After the test, the subjects also had to rank the four untransformed composites on a scale from 1 (least attractive) to 9 (most attractive). Finally, the subjects were asked to complete the short form of the EMBU retrospective attachment questionnaire.

2.3.3 Results and discussion

The one sample Chi-square test of the frequency data revealed that both sexes preferred self-resembling faces, provided they were warped into the most attractive composite (whole group: χ^2 = 10.89, p = 0.001; males: χ^2 = 5.49, p = 0.019; females: χ^2 = 5.45, p = 0.020). Regarding other image pairs, no preference for parental faces was found.

A paired-samples (McNemar) Chi-square test showed that attractiveness category had a significant effect on this choice in the whole group (χ^2 = 7.85, p = 0.005), and in females (χ^2 = 5.28, p = 0.022), but not in males (p = 0.180).

When the scores of the EMBU-scale were included into the analysis as grouping variables, the independent samples Chi-square test conducted on the male group revealed that subjects with low maternal rejection (i.e., with good memories from childhood) chose mother-resembling faces more frequently than others (χ^2 = 9.741, p = 0.002); their scores on the maternal emotional warmth scale influenced their choices in a similar manner (χ^2 = 11.268, p = 0.001). Besides, it was found that female subject's scores on the paternal rejection sub-scale influence the probability of choosing a father-resembling face (χ^2 = 8.702, p = 0.003), lower scores predicting the choice of the fathers face.

In accordance with our first prediction, we found that both males and females choose self-resembling faces, provided they were transformed to composites which were found attractive by the subjects. The analysis of childhood attachment and choice of parental faces revealed a pattern corresponding to the second hypothesis – namely, the preference for the opposite-sex parents' face.

These results indicate that preference for self-resemblance interacts with attractiveness in such a way that when facial cues reflect high genetic quality, the more subtle markers of genetic similarity become also important.

In agreement with the second hypothesis and the predictions of the sexual imprinting theory, those who had a good relation to their opposite-sex parents during infancy were more willing to choose partners resembling them. Males with low scores on the maternal rejection sub-scale and high scores on the maternal emotional warmth sub-scale of the EMBU questionnaire chose mother-resembling transforms more often than the other subgroup, whereas female subjects with low scores on the paternal rejection sub-scale showed a biased preference for paternal faces, compared to the high rejection group. All significant results indicate that those who were emotionally closer to their opposite-sex parent in childhood and received less rejection and more encouragement, are more willing to choose parent-resembling mates.

2.4 Generalization of social judgments and associative learning – a study of stereotype formation

2.4.1 Aims and hypotheses

As a result of the generalization processes of the mind, daily experiences with our acquaintances have major influence on our attitude towards other, unknown people. This affects several areas of everyday life, from judgments about trustworthiness to mate choice decisions. Prejudices towards them often arise during the very first encounter, reflecting our past experiences with others.

Recent experiments suggest that negative or positive judgments about formerly unseen faces emerge quite easily, which subsequently influence the judgment of faces resembling these. It is possible that, similar to the influence of intense emotional relation with our parents on mate choice decisions, short duration stimuli evoking intense emotions could affect the judgment of unknown faces.

However, it is still debated whether the generalization happens and the face preferences emerge automatically, or due to higher level, conscious processes; is there a difference in the formation of stereotypical social judgments when the source of information is provided by priming, or explicit behavior descriptions?

In sum, our goal was to study the generalization of social judgments and emotions associated with particular people. The main question is whether following a short, but emotionally intense, negative or positive impression, faces resembling the original faces evoke similar reactions in the subjects. The hypotheses were as follows:

1. Composite which was made of individual images associated with positive perithreshold stimuli, or behavioral description, respectively, will be rated by the majority of the participants as more trustworthy.

2. Judgments about individual faces can be transferred more successfully to composite faces, if subjects are provided with explicit, socially relevant information, in contrast to emotionally intense, but indirect priming.

2.4.2 Methods

Participants

Two different experimental paradigms were designed. From the 60 subjects (age: *M* = 27.27, *SD* = 8.92, 19-53 years) participating in the learning task 36 were female (age: *M* = 26.89, *SD* = 9.8, 20-53 years) and 24 male (age: *M* = 27.83, *SD* = 7.57, 19-52 years). From the 45 subjects (age: *M* = 29.73, *SD* = 11.81,18-57 years) participating in the learning task 25 were female (age: *M* = 27.6, *SD* = 11.93, 19-57 years) and 20 male (years: *M* = 32.4, *SD* = 11.39, 18-54 years).

Stimuli

From an image pool collected for a previous experiment 10 male faces with average attractiveness were selected, based on the ratings of 30 independent judges. This set was randomly divided into two groups. From the 5 images of the two groups composite faces were made with the same method as described in the previous study (*Chapter 2.3.2*).

From a pool of 52 sentences, based on the ratings of 25 participants, ten negative and ten positive sentences were selected. These referred to behavior at the workplace, relation with family and friends, trustworthiness and norm violation. From these sentences ten pairs were created. Furthermore, images with valence value above 6 and below 4, and with intensity value above 6, were selected from the IAPS image pool.

Study 1. – Learning

The experiment consisted of three phases. In the *learning phase*, individual faces were presented on a screen to the subjects, each associated either with a negative, or a positive, pair of sentences. The participants were instructed to watch the faces carefully and try to memorize the descriptions. This was followed by the *recognition phase*, when the previous faces were presented again in a randomized order. The subjects had to decide whether to trust or not to trust in the presented individuals. If their answer was different from our expectations, they were returned to the first phase, until the learning was complete.

In the third, *evaluation phase* the participants had to decide which of the two composite faces–made from the faces associated either with negative, or positive descriptions–they find more trustworthy.

Study 2. – Priming

The experiment consisted of an *attentional* and an *evaluation phase*. In the first phase a fixation cross appeared for 2000 ms, followed by one of the IAPS images for 200 ms, and one of the individual facial images with 2000 ms exposure. The random presentation of the priming and the target stimuli was then repeated twice. The evaluation phase was identical to the last phase of the learning experiment.

2.4.3 Results and discussion

The results of the one-sample Chi-square test showed that in the learning experiment the subjects found that particular composite more trustworthy which was made of the faces with positive descriptions (χ^2 = 4.267, df = 1, p = 0.039). Similarly, in the priming experiment the majority chose that composite which was made of the faces preceded by high valence, that is pleasant stimuli (χ^2 = 6.422, df = 1, p = 0.011). According to the results of the two-samples Chi-square test, there was no significant difference in the performance between the two conditions (χ^2 = 0,352, df = 1, p = 0.553).

These results seem to support the first hypotheses. People are able to include the experience with others into their social decisions in a relatively short time. These impressions are summed and stored in the memory, and are projected to unknown individuals having facial features similar the formerly seen ones. Moreover, it seems that not even information of social kind is necessary to this generalization.

On this ground it might be justifiable that low level cognitive processes play important role in these decision-making processes, including associative learning. This seems to be underpinned by the result which showed that, contrary to the second hypothesis, no difference was found between the performance of the subjects in the priming and the learning conditions.

People resembling close acquaintances and kin are more likely to be found more attractive and trustworthy. In social decisions all the huge amount of experiences with others play crucial role; their appearance, facial features, behavioral styles could affect the attitude to unknown others. This overgeneralization might play a role not just in the evaluation of individuals, but in the formation of stereotypes about groups as well.

3. Summary and conclusions

According to a basic tenet of evolutionary psychology, the recurring adaptational problems during evolution resulted in so called “Darwinian algorythms”. Domain-specific psychological mechanisms, organized into modules, evolved for different aims. The nature of these modules, and how they are embedded into the neural systems of the brain, however, is still a riddle; for a quite long time in the history of evolutionary psychology, it was hard to detect any intention to make its connection with neuropsychology tighter.

From the studies presented in the recent dissertation, some important conclusions might be made. People are able and willing to project the knowledge about their acquaintances to unfamiliar ones who resemble these known individuals. This happened when the subjects were exposed to self- or parent-resembling faces. It turned out that this kind of generalization works even in short-term: behavioral descriptions learned in an experimental situation influenced crucially the rating of the composites made of previously seen facial images. We may assume that the same generalization processes worked in both situation, the difference was only in the duration of the conditions: faces resembling rejecting parents are less preferred; the rumor that someone takes advantage of his friends trustfulness may affect the trust in people who are similar to him in appearance. Moreover, not even conscious awareness of social knowledge is necessary: this effect can be evoked with images with negative or positive emotional content which lack any social information.

On this ground we suppose that emotional content is critical component in the response to resemblance. Childhood attachment influences social judgments the same way as descriptive information heard from others, or preference and avoidance based on associative learning. Cognitive models of face perception highlight that, beside visual identification, an affective response is important as well to successfully recognize faces. In a neuropsychological approach the same can be formalized as brain areas directly responsible for face recognition (inferior occipital gyrus, STS, fusiform gyrus) work together with areas responsible for emotions (e.g., amygdala) in the process of face perception.

A possible future direction is the analysis of what effect the intensity of the emotional component has on the generalization of social judgments. Furthermore, beside the process of generalizing facial features, it might be worth to study the mechanism of the formation of judgments about facial expressions, using evolutionary framework as the grand narrative, hoping that evolutionary and cognitive sciences together could be more successful in revealing and explaining the processes in the human mind.

4. Publication list

Publications which served as the basis of the dissertation:

accepted:

Kocsor, F., Feldmann, A., **Bereczkei, T.,** & **Kállai, J.** (2013). Assessing facial attractiveness: individual decisions and evolutionary constraints. *Socioaffective Neuroscience & Psychology*, *3*(0). doi:10.3402/snp.v3i0.21432

under review:

Kocsor F.; Bereczkei T.: Phenotype matching, sexual imprinting, and cues of good genes (submitted to Plos One)

in preparation:

Kocsor F.; Bereczkei T.: Facing stereotypes – cognitive basis of making stereotypical social judgments related to facial appearance.

Other publications:

accepted:

Meskó, N., Láng, A., **Kocsor, F.**, (2014).The Hungarian Version of Sociosexual Orientation Inventory Revised (SOI-R): Sex and Age Differences. Interpersona, *8*(1), doi:10.5964/ijpr.v8i1.130

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Meskó N., Láng A., **Kocsor F**., Rózsa K. (2012). A szexuális elköteleződés mérése. A szocioszexuális orientációs kérdőív (SOI-R) magyar változata. *Magyar Pszichológiai Szemle*, 67 (4) 727-749.

Kocsor, F., Rezneki, R., Juhász, S., & Bereczkei, T. (2011). Preference for Facial Self-Resemblance and Attractiveness in Human Mate Choice. *Archives of Sexual Behavior*, *40*(6), 1263–1270. doi:10.1007/s10508-010-9723-z.

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Kocsor F. – Rezneki R. (2010). Agresszió. In: Bereczkei T. – Paál T. (szerk.): *A lélek eredete – Bevezetés az evolúciós pszichológiába*. Gondolat Kiadó, Budapest.

Bereczkei T. – **Kocsor F.** (2010). Kultúra. In: Bereczkei T. – Paál T. (szerk.): *A lélek eredete – Bevezetés az evolúciós pszichológiába*. Gondolat Kiadó, Budapest.

under review:

Kállai J.; Feldmann A.; **Kocsor F**.; Karádi K.; Kerekes Zs.; Janszky J.: Where is my self and my body? Self image recognition in context of ego- and allocentric frame of references: an fMRI study.

Kállai J.; Feldmann A.; Karádi K.; **Kocsor F**.; Kerekes Zs.; Hartung I.; Kövér F.; Ávila, C.: Rush impulsivness and reward sensitivity: Neural network pattern analysis of two-factor model of impulsive behavior in Go/No-go task in a non-clinical sample.