

Što su emocije? – Suvremene neuroznanstvene teorije

/ *What Are Emotions? – Contemporary Neuroscientific Theories*

Mirko Čorlukić¹, Jelena Krpan²

¹Specijalna bolnica za zaštitu djece s neurorazvojnim i motoričkim smetnjama, Zagreb; ²Sveučilište u Zagrebu, Filozofski fakultet, Odsjek za psihologiju, Zagreb, Hrvatska

/¹Special Hospital for Children with Neurodevelopmental and Motor Disorders, Zagreb; ²University of Zagreb, Faculty of Humanities and Social Sciences, Zagreb, Croatia

¹<https://orcid.org/0000-0002-7607-1150>

²<https://orcid.org/0000-0002-2696-8955>

Prikazujemo četiri neurobiološko-psihološke teorije emocija kojih su autori neuroznanstvenici. Emocije su jedan od temelja ljudskog ponašanja bez kojih ne možemo zamisliti čovjeka, društvo, psihičke poremećaje ni psihoterapiju. Teško da se može naći neki psihički poremećaj da u njega nisu uključene emocije kao uzrok psihičke boli. U radu prikazujemo doprinose suvremene afektivne neuroznanosti važne za razumijevanje čovjeka i psihoterapijske prakse.

/ In this paper we will present four neurobiological and psychological theories of emotions proposed by neuroscientists. Emotions form the foundations of human behavior, without which we cannot imagine man, society, mental disorders, or psychotherapy. It is difficult to find a mental disorder which does not include emotions as a cause of suffering. We will present the contributions of modern affective neuroscience important for understanding both man and psychotherapy.

ADRESA ZA DOPISIVANJE /

CORRESPONDENCE:

Mirko Čorlukić

Krijesnice 25

10000 Zagreb, Hrvatska

Tel: +385 98 1767 477; e-pošta: mirko.corlu@gmail.com

KLJUČNE RIJEČI / KEY WORDS:

Afektivna neuroznanost / *Affective neuroscience*

Emocije / *Emotions*

Homeostatski osjećaji / *Homeostatic feelings*

Psihoterapija / *Psychotherapy*

TO LINK TO THIS ARTICLE: <https://doi.org/10.24869/spsih.2020.50>

UVOD

Istraživanje emocija kao psihološkog fenomena ima svoju dugu povijest, no u ovom smo se radu odlučili prikazati novije neuroznanstvene doprinose jer smatramo da je um, kao temelj mentalnih fenomena, nedovoljno istraživati samo iz perspektive psihologije već je nužan

INTRODUCTION

The study of emotions as a psychological phenomenon has a long history, but in this paper we have decided to present only the latest neuroscientific contributions. We have done so because we believe that it is insufficient to study the mind as the basis of mental phenomena

i neuroznanstveni pogled. Nažalost, povijesni pregled neuroznanstvenog istraživanja emocija bio bi preopširan za opseg ovog rada pa zainteresirane čitatelje upućujemo na sljedeće članke: „*Brain and emotion: Cognitive neuroscience of emotions*” (1), “*Affective Neuroscience: Past, Present, and Future*” (2) te “*Historical pitfalls and new directions in the neuroscience of emotion*” (3). Smatramo da će autori predstavljeni u ovom članku pružiti osuvremenjen okvir teorijskih znanja o afektima, koja će omogućiti bolje razumijevanje psihoterapijskog rada kao i opće psihologije ponašanja ljudi. Rad započnemo kratkim prikazom Pankseppove teorije s posebnim osvrtom na nedostatke u njegovoj teoriji, koje ćemo elaborirati u raspravi. U ovom su radu dani skraćeni prikazi relevantnih neuroznanstvenih teorija emocija te je za njihovo temeljitije studiranje potrebno proučiti izvornu literaturu. Ipak, vjerujemo da će i ovaj kratki prikaz pomoći stručnjacima u psihoterapijskom, psihijatrijskom i savjetodavnom radu.

Pankseppovih sedam emocionalnih sustava

Jaak Panksepp tvorac je termina afektivna neuroznanost. U svojim se istraživanjima poglavito oslanjao na MacLeanov koncept trijuskog mozga (4,5), doduše uz odgovarajuće razlike s obzirom na lokalizaciju procesa.

Općenito govoreći, ljudski se um ili, kako ga Panksepp zove, um-mozak može podijeliti na tri sustava (6). Prvi je primarni afektivni sustav koji uključuje senzorne, homeostatske te emocionalne afekte. Na višoj razini nalazimo sekundarni bihevioralno kondicionirajući sustav koji se nalazi u podlozi implicitnog učenja i pamćenja te je posve nesvjestan. Tercijarni kognitivno-jezični sustav je najsloženiji. Uključuje kognitivne funkcije, planiranje i refleksiju te regulaciju emocija i slobodnu volju. Sačinjen je dominantno od kortiko-talamičkih područ-

from the perspective of psychology alone. A neuroscientific view is also necessary. Unfortunately, a historical overview of neuroscientific research on emotions would be too broad for the scope of this paper, but we refer interested readers to the following articles: “Brain and emotion: Cognitive neuroscience of emotions” (1), “Affective Neuroscience: Past, Present, and Future” (2), and “Historical pitfalls and new directions in the neuroscience of emotion” (3). As for the authors featured in our paper, we believe they provide an up-to-date framework of theoretical knowledge about affects, which will allow for a better understanding of psychotherapeutic work as well as the general psychology of human behavior. Our paper begins with a brief presentation of Panksepp’s theory with special reference to its shortcomings, which will be further developed in the discussion. This paper provides an overview of relevant neuroscientific theories of emotion, but it is necessary to study the original literature for a more thorough understanding. However, we believe that this brief account will also help professionals in psychotherapy, psychiatry, and counseling.

Panksepp’s seven emotional systems

Jaak Panksepp is the author of the term “affective neuroscience”. In his research, he mainly relied on MacLean’s triune brain concept (4,5), albeit with the appropriate differences in terms of process localization.

Generally speaking, the human mind, or as Panksepp calls it, the mind-brain, can be divided into three systems (6). The first is the primary affective system which includes sensory, homeostatic, and emotional affects. At a higher level, we find the secondary behavioral conditioning system. It underlies implicit learning and memory and is completely unconscious. The tertiary cognitive-linguistic system is the most complex. It includes cognitive function, planning and reflection, emotion regulation,

ja. U njemu se odvija sva mentalizacija te se tu nalazi više sebstvo. Tako je primarni sustav emocionalno-nagonski te pruža temelj životu, sekundarni sustav utemeljen je na znanju i učenju, dok je tercijarni utemeljen na samo-refleksiji.

Panksepp smatra da postoji sedam primarnih emocionalnih sustava smještenih u supkortikalnim regijama. One su uglavnom homologne, posebno kod sisavaca, pri čemu svaka emocija ima različiti neuroanatomski korelat te shodno tome i različitu fiziologiju (6). Najstariji od tih sustava je sustav POTRAGE. On je ujedno i u podlozi svih drugih sustava te ga odlikuje sustavna želja za eksploracijom te anticipacija uzbuđenja. On potiče neokorteks na izvođenje ponašanja koja će zadovoljiti naše želje i potrebe. BIJES je sustav koji se aktivira kada dođe do frustracije, tj. kada dođe do blokade sustava POTRAGE. U kognitivnom smislu BIJES se očituje u obliku ljutnje i mržnje. To se najbolje primjećuje u socijalnim sukobima gdje se otkriva još jedan kognitivni aspekt BIJESA – ljubomora. Sustav koji čuva čovjeka od boli i smrti naziva se STRAH. Nalazi se blizu sustava BIJESA te zbog njihove interakcije njegova aktivacija može dovesti do reakcije „bori se ili bježi“ („*fight-or-flight*“). POŽUDA je sustav najbliži konceptu libida u klasičnoj psihoanalizi. Njezino neregulirano pobuđivanje vodi do različitih neurotskih smetnji i parafilija te antisocijalnih ponašanja. Majčinska ponašanja i osjećaji pod kontrolom su sustava BRIGE. Temeljni zadatak ovog sustava je osigurati emocionalni rast u interpersonalnim odnosima te pomaganje drugima (bilo poznatima, bilo strancima). On je važan za pozitivan učinak psihoterapijskog tretmana. Sustav PANIKA/ŽALOST u osnovi je formiranja privrženosti. Kako se aktivira pri separaciji nalazi se u podlozi depresivnih smetnji i fobija (7,8). Konačno, Panksepp izlaže sustav IGRE primjećujući kako i ljudi i životinje osjećaju radost pri igri. Taj sustav igra važnu ulogu u

and free will. It consists mostly of corticothalamic regions. It is where most of the mentalization process takes place and also where the higher self is located. Thus, the primary system is emotionally-instinctive and provides the foundation for life, the secondary system is based on knowledge and learning, while the tertiary is based on self-reflection.

Panksepp believes there are seven primary emotional systems located in subcortical regions. They are mostly homologous, especially in mammals, whereby each emotion has a different neuroanatomic correlate and consequently different physiology (6). The oldest of these systems is the SEEKING system. It underlies all other systems and is characterized by a systematic desire for exploration and excitement anticipation. It encourages the neocortex to perform behaviors that will satisfy our desires and needs. RAGE is a system activated when it comes to frustration, i.e. when the SEEKING system is blocked. In a cognitive sense, RAGE manifests itself in the form of anger and hatred. This is best observed in social conflicts, where another cognitive aspect of RAGE is revealed – jealousy. The system that protects man from pain and death is called FEAR. It is located close to the RAGE system and, because of their interaction, its activation can lead to a “fight-or-flight” reaction. LUST is a system most similar to the concept of libido in classical psychoanalysis. Its unregulated stimulation leads to various neurotic disturbances, paraphilia, and antisocial behaviors. Maternal behaviors and feelings are controlled by the CARE system. The basic task of this system is to ensure emotional growth through interpersonal relationships and helping others (both familiar and unfamiliar). It is essential to achieving the positive effect of psychotherapeutic treatment. The PANIC/GRIEF system provides the foundation of attachment. As it is activated during separation, it creates a basis for depressive disturbances and phobias (7,8). Finally, Panksepp introduces the PLAY system by noticing how both humans and animals feel joy while partici-

socijalnoj adaptaciji pojedinca te omogućuje epigenetske konstrukcije viših funkcija socijalnog mozga.

Pankseppovi emocionalni sustavi dijelom se preklapaju s Damasiovim akcijskim programima, koji razdvajaju nagone/motivaciju i emocije. Pankseppova teorija emocija može se shvatiti kao teorija emocija prvog reda, što znači da se svjesnost emocija javlja paralelno s tjelesnim uzbuđenjem i ponašanjem, dok drugi autori zagovaraju teoriju emocija višeg reda (Damasio, Barrett, LeDoux) koja razdvaja ponašanje i fiziologiju od osjećaja emocije koji se javlja tek nakon aktivacije generalne kognicijske mreže (GNC) (9,10).

Interoceptivna teorija i homeostatski osjećaji

Inspiriran jednom od najpoznatijih teorija emocija Williama Jamesa, Antonio Damasio postulira svoju neuroznanstvenu teoriju emocija koja počiva na pretpostavci da je percepcija tjelesnih stanja ključna za razvoj emocija. Razlikuje afekte, emocije i osjećaje (11). Afekt je krovni termin koji podrazumijeva i emocije i osjećaje. Emocija je neuralna reakcija na određeni podražaj, bilo vanjski, bilo unutrašnji, koja se ostvaruje putem aktivacije određenih neuralnih puteva. Osjećaji su mentalna iskustva promjene u tjelesnom stanju. Posljednja dva fenomena nalaze se na kontinuumu procesiranja koji uključuje tri moguća stupnja: emocionalno stanje koje može biti nesvjesno, osjećajno stanje čija reprezentacija također može biti nesvjesna te osviješteno osjećajno stanje (ili temeljna svijest). Iz toga jasno proizlazi kako osjećati nešto i imati svijest o tom osjećaju nisu ekvivalentna stanja. Za Damasia je upravo ta razlika ključna u definiranju odnosa između emocija, osjećaja i svijesti, a ona se očituje u njihovoj povezanosti s tijelom (12).

Ovdje je bitno naglasiti da za Damasia ne postoji dualizam uma i tijela, tj. racionalnog i

patung in playful activities. This system plays an influential role in the social adaptation of the individual and enables the development of epigenetic structures of higher social brain functions.

Panksepp's emotional systems partly overlap with Damasio's action programs, which separate drives/motivations and emotions. Panksepp's theory can be understood as a first-order emotion theory, which means that emotion awareness occurs in parallel with physical arousal and behavior, while other authors advocate a higher-order emotion theory (Damasio, Barrett, Adolphs, LeDoux) that separates behavior and physiology from the feelings of emotion which occur only after the activation of the General Network of Cognition (GNC) (9,10).

Interoceptive theory and homeostatic feelings

Inspired by William James's famous theory of emotion, Antonio Damasio postulates his neuroscientific theory based on the assumption that the perception of bodily states is crucial to the development of emotion. He differentiates between affects, emotions, and feelings (11). Affect is an umbrella term that includes both emotions and feelings. Emotions are neural responses to a particular stimulus, either external or internal, achieved through activation of specific neural pathways. Feelings are mental experiences of changes in the physical condition. The latter two phenomena spread across a continuum of processing with three possible degrees: an emotional state that may be unconscious, a state of feeling whose representation may also be unconscious, and a state of conscious feeling (or fundamental consciousness). It becomes clear that feeling something and being aware of that feeling are not equivalent states. For Damasio, that distinction is crucial in defining the relationship between emotions, feelings, and consciousness, and it manifests in their connection with the body (12).

This chronological order can be demonstrated by a banal example. During an encounter with

emocionalnog. Za njega um i tijelo nastupaju kao jedinstvena organizmička jedinica, te se prethodno spomenuta percepcija tjelesnog stanja ne promatra kao objekt odvojen od uma ili tijela već kao mentalni aspekt te jedinstvene organizmičke jedinice (12). Priroda tog „odnosa“ uma i tijela lijepo je oslikana u strukturi smještenoj na produljenoj moždini poznatoj pod nazivom „*area postrema*“ gdje ne postoji krvno-moždana barijera. Isto vrijedi i za ostale cirkumventrikularne organe smještene u telencefalonu. Upravo na tim mjestima tijelo ima direktan pristup živčanom sustavu kao što i živčani sustav ima direktan pristup tijelu (13). Isto vrijedi i za dualizam racionalnog i emocionalnog. Emocije su potrebne za kvalitetno rasuđivanje kao što i emocionalna neravnoteža može otežati kvalitetno rasuđivanje. Još jedan relativno zanemaren aspekt jedinstva uma i tijela očituje se u funkcioniranju enteričkog živčanog sustava. Radi se o formaciji od oko 300 milijuna neurona smještenih u gastrointestinalnom traktu. Većina tih neurona je intrinzična, tj. ne projicira se u centralni živčani sustav. Enterični i centralni živčani sustav nezavisni su u djelovanju, ali mogu komunicirati (13).

Nastavljajući se na logiku jedinstva uma i tijela Damasio se poziva na kontinuirani evolucijski razvoj emocija koji je usko vezan s pojmom homeostaze. Upravo je težnja za stabilnim unutrašnjim uvjetima glavni motivator ponašanja različitih organizama, od bakterija pa do samog čovjeka. Tako Damasio uvodi dvije vrste osjećaja: spontane ili homeostatske osjećaje te izazvane osjećaje. Homeostatski osjećaji potječu iz pozadinskog tijeka tjelesnih procesa i signaliziraju trenutačno stanje života kao dobro, loše ili nešto između. Signalizacija o kvaliteti stanja života naziva se valencija i ona je konstitutivni element svakog afekta. Osjećaji ovdje postaju mentalna reprezentacija homeostaze. Izazvani osjećaji posljedica su širokog raspona emotivnih odgovora na

an angry superior, a mental representation of the superior appears in the mind of the employee. The body of the employee responds to the representation by changing bodily states: increasing heart rate, sweating, altering facial expression, etc. This response constitutes an emotion. The feeling will only occur when the mind detects the changes in the bodily state and compares them with the mental representation. Neither emotions nor feelings relate to the outer object. Instead, they relate precisely to the perception of the bodily states.

Here it should be emphasized that, for Damasio, there is no dualism of mind and body, i.e. the rational and emotional. He sees both the mind and the body as a single organism, and the aforementioned perception of the physical state is seen not as an object separate from the mind or the body but as a mental aspect of this particular unit of the organism (12). The nature of this “relationship” between mind and body is nicely exemplified in a structure located in the medulla known as the “*area postrema*” where there is no blood-brain barrier. This also applies to circumventricular organs located in the telencephalon. It is precisely in these places that the body has direct access to the nervous system, just as the nervous system has direct access to the body (13). The same holds for the dualism of the rational and the emotional. Emotions are needed for good reasoning but an emotional imbalance can thwart proper reasoning. Another relatively disregarded aspect of the unity of mind and body manifests itself in the functioning of the enteric nervous system. This is a formation of about 300 million neurons located in the gastrointestinal tract. Most of these neurons are intrinsic, i.e. they are not projected to the central nervous system. The enteric and the central nervous system are independent in action but can communicate (13).

Expanding on the logic of the unity of mind and body, Damasio draws upon the continuous evolutionary development of emotions as closely related to the concept of homeostasis. It is precisely

senzorne podražaje ili pak aktivacije akcijskih programa. Akcijski programi setovi su instinktivnih akcija potaknutih promjenama u unutrašnjoj ili vanjskoj okolini organizma. Njihova je funkcija održavati homeostazu (13,14). Oni uključuju promjene u radu unutrašnjih organa, promjene u radu poprečno prugastih mišića te promjene u kogniciji. Dije se na nagone (npr. gladi), motivacije (npr. igra) ili emocije u širem, konvencionalnom smislu. Igraju važnu ulogu u društvenim odnosima. Sreća, strah, ljubomora, zavist i ostali osjećaji definiraju socijalni kontekst te su značajni kako za pojedinca tako i za društvo, a većina aspekata homeostaze vezanih uz socijalna ponašanja ovise o supkortikalnim regijama tako da se jasno očituje interakcija biološkog i socijalnog. Ako se radi o širokom odgovoru na senzorne podražaje vjerojatnija je blaga promjena u stanju organizma, dok će, ako se pak radi o aktivaciji nagona, motivacija ili emocija, doći do velikih promjena te je moguć i mentalni preokret (13,14). Interesantno je da LeDoux (15) koristi sličnu podjelu, naglašavajući da su nagoni/motivacija krugovi za preživljavanje („*survival circuits*“) ili bihevioralna reakcija na opasnost, a osjećaj i spoznaju emocije uključuju drugi kognitivni krugovi. Dakle, ne trebamo imati emociju da bi se ponašali na neki način, dovoljno je imati nagon/motivaciju.

Sam emocionalni odgovor, neovisno o tome kako je izazvan, potječe iz točno određenog neuralnog sustava. Parabrahijalna jezgra, jezgra solitarnog trakta, periakveduktna siva tvar te gornji kolikuli mapiraju tjelesna stanja dok hipotalamus, periakveduktna siva tvar, amigdala te ventralni strijatum (*nucleus accumbens*) stvaraju emocionalni odgovor. Na razini korteksa insularni i somatosenzorni dijelovi također mapiraju tijelo te tako pružaju supstrate osjećaja (16). Određena vrsta podražaja aktivirat će određenu regiju, a neke od tih regija djelovat će direktno, dok će neke

the aspiration for stable internal conditions that predominantly motivates behaviors of different organisms, from bacteria to man himself. Thus, Damasio introduces two kinds of feelings: spontaneous or homeostatic feelings and induced feelings. Homeostatic feelings spring from bodily processes and signal the current state of life as good, bad, or something in between. Signaling the quality of life states is called valence and it is the constitutive element of each affect. Feelings become a mental representation of homeostasis. Induced feelings are the result of a wide range of emotional responses to sensory stimuli or activation of action programs. Action programs are sets of instinctive actions triggered by changes in the internal or external environment of the organism. Their function is to maintain homeostasis (13,14). They include changes in the workings of internal organs, changes in transverse muscle tissue, and changes in cognition. They are divided into drives (e.g. hunger), motivation (e.g. play), or emotions in a wider, conventional sense. Action programs play an important role in social relationships. Happiness, fear, jealousy, envy, and other feelings define the social context and are important for both the individual and the society, and most aspects of homeostasis related to social behavior depend on the subcortical regions, so the interaction of the biological and the social is clearly manifested. If there is a broad response to sensory stimuli, it is more likely that mild changes will occur in the body's condition, while if drives, motivation, or emotion are activated, major changes can occur and a mental upheaval is possible (13,14). Interestingly, LeDoux (15) uses a similar division, emphasizing that drives/motivation are survival circuits or behavioral reactions to danger, while feeling and awareness of emotions include other cognitive circuits. Therefore, we do not need to have an emotion to behave in a certain way – it is enough to have the drive/motivation.

The emotional response itself, regardless of how it was induced, stems from a specific neural system. The parabrachial nucleus, the tractus soli-

zahtijevati posredovanje korteksa. Aktivacija tih regija posve je nesvjesna. Ti emocionalni odgovori razlikuju se od situacije do situacije u obliku primarnih visceralnih promjena u različitim tjelesnim sustavima (krvožilni, endokrini, probavni, imunološki, respiratorni, itd.), količinama izlučenih neurotransmitera, itd. Emocionalni odgovori nisu kopija svojih prethodnika te podliježu do neke mjere okolnim faktorima. Tako, primjerice, njemački studenti prije ispita osjećaju „leptiriće u trbuhu“, dok kineski studenti osjećaju glavobolju (13).

Osim prethodno nabrojanih makroskopskih supstrata emocija, postoje i oni mikroskopski. To se najbolje očituje u činjenici da se većina informacija o tjelesnim stanjima prenosi ili putem C vlakana koja su posve nemijelinizirana, ili pak putem A delta vlakana koja su slabo mijelinizirana. Zbog evolucijske prednosti ubrzanog prenošenja impulsa putem mijeliniziranih vlakana, naizgled se čini neobično da bi tako važan regulacijski sustav kao što je homeostaza ostao nezahvaćen mijelinizacijom. No, nemijelinizirana vlakna omogućuju evolucijski stariji oblik efaptičkog prijenosa koji karakterizira lateralni prijenos impulsa. Ona omogućavaju slobodnu razmjenu iona. Evolucija je zapriječila mijelinizaciju onda kada je dostupnost iona membrani bila važnija od brzine prijenosa (16). Dorzalna grana vagusa, glavnog živca zaduženog za prijenos visceralnih signala, nemijelinizirana je.

Mentalne reprezentacije tijela koje potječu iz homeostatskih osjećaja tvore integriranu reprezentaciju cijelog organizma koju Damasio naziva proto-sebstvo. Proto-sebstvo nalazi se primarno u supkortikalnim strukturama što odgovara evolucijskom slijedu jer se radi o starijim strukturama koje dijelimo s mnogim životinjama. U trenutku interakcije proto-sebstva i okoline javlja se svijest i tek tu možemo govoriti o osviještenom osjećaju ili pojmu temeljne svijesti (16-18). Ta svijest daje organizmu tre-

tarius nucleus, the periaqueductal gray matter, and the upper colliculi map the state of the body while the hypothalamus, the periaqueductal gray matter, the amygdala, and the ventral striatum (nucleus accumbens) create an emotional response. At the cortical level, the insular and somatosensory parts also map the body and thus provide the substrates of feelings (16). A certain type of stimulus will activate a particular region, and some of these regions will act directly while some will require mediation of the cortex. The activation of these regions is completely unconscious. These emotional responses differ from situation to situation in the form of primary visceral changes through different bodily systems (vascular, endocrine, digestive, immune, respiratory, etc.), quantities of secreted neurotransmitters, etc. Emotional responses are not a copy of their predecessors and are subject to environmental factors, to an extent. Thus, for example, German students feel “butterflies in their stomach” before an exam while Chinese students feel headaches (13).

In addition to the previously mentioned macroscopic substrates of emotion, there are also microscopic ones. This is best seen in the fact that most of the information about bodily conditions is transmitted either via C fibers that are completely unmyelinated or using A delta fibers that are poorly myelinated. Because of the evolutionary advantage of accelerated impulse transmission through myelinated fibers, it seems unusual for such an important regulatory system, such as homeostasis, to remain unaffected by myelination. However, unmyelinated fibers allow for an evolutionary older form of ephaptic transmission characterized by lateral transmission of impulses. They allow free ion exchange. Evolution prevented myelination when the availability of ions to the membrane was more important than the transfer rate (16). The dorsal branch of the vagus, one of the major nerves responsible for the transmission of visceral signals, is unmyelinated.

Mental representations of the body originating from homeostatic feelings form an integrat-

nutačni osjećaj sebstva te je i ona zajednička mnogim drugim organizmima.

Osjećaji, a samim time i emocije, preuzimaju ključne funkcije u regulaciji homeostaze. Također, konstitutivne su u razvoju svijesti. Prisutne su u svim aspektima života, te ih je nemoguće odvojiti od razmišljanja ili bilo kakvog oblika kreativnosti te imaju snažan utjecaj na proces donošenja odluka.

Damasiova teorija preklapa se s Berrettinom teorijom u obliku interoceptora i tijela, tj. homeostatskih osjećaja (koje Barrett naziva afekti) i njihove oštre diferencijacije od emocija. Obje teorije smatraju da je za emocije potrebna i kortikalna aktivacija, a ne samo supkortikalane jezgre, za razliku od Pankseppa (13, 19).

Emocije kao konstrukcije

Psihologinja Lisa Feldman Barrett u svojoj teoriji emocija propitkuje klasičnu paradigmu emocija kao reakcije čvrsto definiranog limbičkog sustava (3,19). Ona smatra da emocije nisu lokalizirane u određenim anatomskim strukturama ili krugovima, već da ih mozak stvara u velikim mozgovnim mrežama, široko distribuiranima u mnoštvu supkortikalnih i kortikalnih regija. Za razliku od klasične paradigme emocija koja naglašava supkortikalne strukture moždanog debla i limbičkog sustava, Barrett ističe da se emocije dizajniraju iz trenutka u trenutak na «zahtjev» tijela i interakcije s okolinom. Drugim riječima, bez (određenih dijelova) korteksa nema emocionalnog stanja te je time kognicija uvedena u afektivnu neuroznanost. Također naglašava da emocije nemaju biološku esenciju, tj. čvrst neuralni potpis ili otisak prsta, kao što nemaju ni druge mentalne kategorije (planiranje, sjećanje, odlučivanje). Ne radi se o esenciji već o konstrukciji (10).

Barrett smatra da je neispravno emocije smatrati univerzalnima (poput ideja o 5 ili

ed representation of the entire organism that Damasio calls the proto-self. The proto-self is primarily found in subcortical structures which correspond to the evolutionary sequence because they are older structures we share with many animals. Consciousness emerges at the moment of interaction between the proto-self and the environment, and it is only here that we may speak of a conscious feeling or the concept of core consciousness (16-18). This awareness gives the organism a momentary sense of self, and it is also common to many other organisms.

Feelings, and thus emotions, take on key functions in regulating homeostasis. They are also constitutive in the development of consciousness. They are present in all aspects of life and have a strong influence on the decision-making process, and it is impossible to separate them from thinking or any form of creativity.

Damasio's theory overlaps with Barrett's theory in terms of interoceptors and the body, i.e. homeostatic feelings (which Barrett calls affect) and their sharp differentiation from emotions. Both theories posit that emotion also requires cortical activation, not just subcortical nuclei, unlike Panksepp (13,19).

Emotions as constructions

In her theory of emotions, psychologist Lisa Feldman Barrett questions the classic paradigm of emotion as the reaction of a strongly defined limbic system (3,19). She believes that emotions are not localized in certain anatomical structures or circles. Instead, the brain creates them through large brain networks, widely distributed through a multitude of subcortical and cortical regions. Unlike the classic paradigm of emotion that emphasizes subcortical structures of the brain, Barrett points out that emotions are designed from moment to moment as "requested" by the body-environment interaction. In other words, there is no emotional state without (certain parts) of the cortex, and thus cognition is introduced into

7 bazičnih emocija) te navodi da uz tjelesnu jezgru afekta, neophodnu za emociju, postoje i kognitivna konstrukcija, socijalno učenje pojedinih emocija, te su one dijelom kulturološki oblikovane. Ne postoje primarne i sekundarne emocije, već samo različite palete emocija. Primjerice, neke pacifičke plemenske kulture nemaju emociju tuge i žalosti (premda i one imaju depresivne reakcije i poremećaje), već u svojem jeziku to stanje opisuju kao neku infektivnu bolest. Također ističe da kod životinja možemo istraživati afekte (homeostatske osjećaje) i ponašanje, ali ne i emocije, jer čak ni majmuni nemaju tako razvijene neuralne kognitivne kapacitete, ni socijalno-jezičnu kulturu da bi mogli graditi sofisticirane koncepte emocija. Drugim riječima, jezično kodiranje je važno za emocije kao i za sposobnost apstraktnog mišljenja i stvaranja socijalnog realiteta. Jedino ljudski mozgovi mogu izgraditi, održavati i crpiti svoju (civilizacijsku) snagu iz socijalnog realiteta (19).

Barrett time naglašava umjetnu granicu između različitih subdisciplina neuroznanosti – afektivne, kognitivne i socijalne. Provodeći meta-analizu velikog broja istraživanja emocija u ljudi kroz snimanje mozga, zaključuje da je teško izdvojiti zasebne anatomske strukture i neuralne krugove koji se mogu vezati isključivo za generiranje određenih emocija (izolirano od kognicije i socijalnog ponašanja), i precizno diferencirati u uzorcima moždane aktivnosti određene emocije, recimo strah i bijes ili žalost i radost. Tu postoji puno potpunih i djelomičnih preklapanja. Uspoređuje mozak s kuhinjom u kojoj imamo desetak istih namirnica (brašno, sol, šećer, itd.) s kojima se po potrebi može stvoriti jedno, drugo ili pak mnoštvo jela. U njezinoj teoriji ne ističu se neke velike razlike između emocije i kognicije. Smatra se da u pravilu ljudi mogu imati kogniciju bez emocije, no da je emocija uvijek vezana za kognitivni koncept i šire razumijevanje situacije i socijalnog

afektive neuroscience. She also emphasizes that emotions do not have a biological essence, i.e. a firm neural signature or fingerprint. That is a trait common to other mental categories (planning, memory, decision making). It is not about essence; it's about construction (10).

Barrett finds the idea of universal emotions (e.g., 5 or 7 basic emotions) inappropriate and states that alongside the bodily core of affects essential for an emotion there are also cognitive constructions and social learning of certain emotions and that they are partially culturally-shaped. There are no primary and secondary emotions, but only a variety of emotional palettes. For instance, some Pacific tribal cultures have no emotion of sadness and sorrow (although they have depressive reactions and disorders), but in their language, they describe this condition as an infectious disease. She also points out that in animals we can investigate affects (homeostatic feelings) and behavior, but not emotions, because not even monkeys have such developed neural cognitive capacities nor social-linguistic culture to build sophisticated concepts of emotion. In other words, linguistic coding is important for emotions as well as the ability to think abstractly and the creation of social reality. Only human brains can build, sustain, and draw their (civilizational) strength from social reality (19).

Barrett thus emphasizes the artificial boundary between the various sub-disciplines of neuroscience – affective, cognitive, and social. By conducting a meta-analysis of a multitude of research in humans through brain imaging, she concludes that it is difficult to distinguish between separate anatomical structures and neural circuits that can be linked exclusively to the generation of certain emotions (isolated from cognition and social behavior). She also concludes it is difficult to precisely differentiate between certain emotions (e.g. fear and anger or sorrow and joy) in brain activity patterns. There are many full and partial overlaps. She compares the brain to a kitchen with about a dozen of the

realiteta. Emocija je kao bilo koja druga mentalna kategorija (19).

Mnoge sinapse stvorene su po pravilu «mnoštvo prema jednom» ili po pravilu «jedan prema mnoštvu». Posljedica toga je da su neuroni čak i iste skupine (čak i supkortikalni poput amigdala) te njihovi krugovi stvoreni za mnogostrukih svrhe. Drugim riječima, mozak stječe svoju kompleksnost kapacitetom da različite reprezentacije (npr. različiti skupovi neurona) stvaraju primjere iste kategorije (npr. ljutnja) u različitim kontekstima. U istraživanju emocija to znači da su pojedine emocije (npr. strah) kreirane pomoću mnogostrukih spacijalno temporalnih uzoraka u različitoj populaciji neurona. Stoga je manje vjerojatno da svi slučajevi jedne emocionalne kategorije dijele skupove temeljnih osobina, kao što su pojedinačna facijalna ekspresija, uzorci aktivacije autonomnog živčanog sustava ili anatomski određenog seta neurona („*neural fingerprints*“) (10).

Još jedno važno obilježje Barretine teorije, slično Damasiovom gledištu, je postojanje veze mozak – tijelo preko interoceptora i mozgovne regulacije resursa tijela („*body budgeta*“) koji održavaju alostazu.

Mozak nije evoluirao da bi bili racionalni, sretni ili točno percipirali, već izvršava svoj temeljni zadatak tako da efikasno osigura resurse za fiziološke sustave unutar tijela kako bi životinja (čovjek) mogla rasti, koristiti prilike, zaštititi se, preživjeti i reproducirati. Taj čin zove se alostaza. Ona nije stanje tijela, već proces kojim mozak regulira tijelo prema analizi troškova i koristi („*cost-benefit*“). Što god da mozak radi - misli, osjeća, percipira, stvara emocije – on također regulira autonomni živčani sustav i ostale tjelesne sustave kao resurse koji se troše pri traženju i osiguravanju dodatnih resursa. Alostaza je regulacija internog miljea pomoću anticipacije fizioloških potreba prije njihova javljanja. Da bi mozak mogao efektivno regulirati tijelo u svijetu, on

same ingredients (flour, salt, sugar, etc.) with which a multitude of meals and desserts can be created. In her theory, there are no significant differences between emotion and cognition. It is generally believed that people can have cognition without emotion, but that emotion is always linked to a cognitive concept and a wider understanding of social reality. Emotions are like any other mental category (19).

Many synapses are created according to the rule of “many-to-one” or “one-to-many” mapping. Consequently, even neurons in the same group such as subcortical neurons of the amygdala and their circles are created for multiple purposes. In other words, the brain gains its complexity through degeneracy, the capacity for different representations (e.g. different sets of neurons) to produce examples within the same category (e.g. anger) in different contexts. In researching emotions, this means that particular cases of emotion (e.g., fear) are created by multiple spatial-temporal patterns in different populations of neurons. Thus, it is less likely that all cases of one emotional category share a set of basic features, such as individual facial expression, autonomic nervous system activation patterns, or anatomically determined neural fingerprints (10).

Another important feature of Barrett’s theory, similar to Damasio’s point of view, is the existence of a brain-body connection via interoceptors and the body budget, which maintain allostasis.

The brain has not evolved so that we could perceive accurately or be rational or happy. It performs the basic task of effectively providing resources for the physiological systems within the body to allow for the animal to grow, protect itself, survive, and reproduce. That is called allostasis. It is a process by which the brain regulates the body by cost-effectiveness analysis. What it is not, is a bodily state. Along with thinking, feeling, perceiving, or creating emotions, the brain also regulates the autonomic

održava internalni model tijela u svijetu (okolišu) (3).

Ta regulacija objašnjava zašto su, u sisavaca, regije koje su odgovorne za implementiranje alostaze (amigdala, ventralni striatum, insula, orbitofrontalni korteks, anteriorni cingularni korteks, medijalni prefrontalni korteks, hipotalamus i jezgre moždanog debla, kolektivno zvane «visceromotorne regije») obično smatrane regijama koje sadrže neuralne krugove za emocije (17,19). Tu treba dodati i generator (nagonskih ili bihevioralnih) uzoraka (*pattern generators*) koji implementira sekvence akcija za koordinirano bazično biološko ponašanje. Akcija je pojedinačni pokret, no ponašanje je događaj. Vidimo ga u pseudo afektivnom ponašanju dekortikaliziranih životinja.

Premda se u psihologiji većinom govori o emocijama kao odgovorima na neki vanjski događaj u okolini jedinke, u stvari unutarnji model mozga uključuje, ne samo relevantne statističke regularnosti u vanjskom svijetu, već i statističke regulacije internalnog miljea – interoceptore (20-22).

Fiziološka stanja jedinke se konstantno mijenjaju tijekom dana te njihova neposredna prošlost determinira trenutačne aspekte senzornog svijeta koji uzastopno utječu na vlastitu nišu u neposrednoj budućnosti. Ukratko, osjećaji primarno niču preko interoceptora, visceralnih stanja trenutačne homeostatske regulacije internalnog miljea tijela, oni su dnevna dinamika organizma koja je stalno pod utjecajem interoceptivne mreže mozga koja predikcijski gleda na tijelo, simulacijama testira ulazne senzorne informacije iz tijela i ažurira reprezentaciju tijela u okolišu. Ti osjećaji najčešće su u pozadini svijesti, stvaraju temelj svakodnevnog raspoloženja te su neophodni gradivni element za emocije (10,23).

Komunikacija mozga i tijela neophodna je za nastanak afekata (emocija). Kako će mozak

nervous system and other body systems as resources that are being consumed while seeking and providing additional resources. Allostasis is the regulation of the internal mile by anticipating physiological needs before their emergence. For the brain to effectively regulate the body in the world, it maintains an internal model of the body inside the world (the environment) (3).

This regulation explains why in mammals regions responsible for the implementation of allostasis (the amygdala, ventral striatum, insula, orbitofrontal cortex, anterior cingulate cortex, medial prefrontal cortex, hypothalamus, and the nuclei of the brain stem, collectively referred to as “visceromotor regions”) are considered regions containing neural circuits for emotions (17,19). Additionally, pattern generators implement action sequences for coordinated basic biological behavior. Action is an individual movement, but behavior is an event. We see it in the pseudo-affective behavior of decorative animals.

Although psychology mostly talks about emotions as responses to an external event in an individual’s surroundings, in fact the inner model of the brain involves not only the relevant statistical regularities in the outside world but also the statistical regulation of the internal mile – interoceptors (20-22).

The physiological states of the individual are constantly changing throughout the day, and their immediate past determines the immediate aspects of the sensory world, which perpetually affects its own niche in the immediate future. Briefly, emotions primarily arise through interoceptors, the visceral states of the current homeostatic regulation of the inner body mile. They are the daily dynamics of the organism, constantly under the influence of the brain’s interoceptive network. The network observes the body predictively, tests the sensory inputs from the body via simulation, and updates the brain’s model of the body inside the world. These feelings are most often in the background of consciousness as a basis of everyday mood, and are a necessary building element of emotions (10,23).

«očitati» signale interoceptora ne ovisi toliko o nekim realnim fiziološkim homeostatskim oscilacijama tjelesnih sustava, koliko o njihovoj predikciji u neprestanim regulatornim oscilacijama – mozak kontinuirano anticipira događaje u senzornom okolišu te tijelu. Ta se predikcija još naziva i aktivna inferencija ili prediktivno kodiranje (24).

U prediktivnom kodiranju senzorna predikcija proizlazi iz motorne predikcije. Simulacije niču kao funkcije visceromotorne predikcije (koje kontroliraju autonomni živčani sustav, neuroendokrini i imunološki sustav) i voljne motorne predikcije, koje zajedno anticipiraju i pripremaju se za akciju koja će biti zahtijevana u nekom neposrednom momentu. Te opservacije pokazuju da je «podražaj– reakcija» model uma netočan, kaže Barrett. Nadalje, pokazuje se da mehanicistički detalji prediktivnog kodiranja pružaju drugi duboki uvid. Mozak implementira internalni model pomoću *koncepta*, kojim *kategorizira* senzacije kojima daje smisao. Predikcije su koncepti, a kompletirani koncepti su kategorizacije koje održavaju fiziološku regulaciju, vode akciju i konstruiraju percepciju (i pažnju). Značenje senzornog događaja uključuje visceromotorni i motorni akcijski plan kojim se organizam nosi s događajem (19,20).

Mozak konstruira svaku emociju u *on-line* konceptu, ali prema određenim ciljevima i kontekstu situacije. Prema tome emocije nisu refleksi, već su konstrukcija, ovisna ne samo o biologiji tijela i mozga, već i o procesu učenja (razvoja) i psiho-socijalnim kontekstima koji su često promjenjivi.

Tako Barrett zaključuje da u svakom budnom trenutku mozak koristi sveukupna prošla (naučena, ne infantilna) iskustva organizirana kao koncepte da bi vodio akciju (ponašanje) i dao osjetima značenje koje se neprestano kategorizira i time diferencira emocije (25). Tako, um nije samo funkcija odnosa mozga-tijela, već i umova-mozgova-tijela drugih

The communication between the brain and the body is essential for affects (emotions). How the brain “reads” the interoceptor signals does not depend so much on real physiological homeostatic oscillations of the physical system as much as their prediction in continuous regulatory oscillations. The brain continuously anticipates events in the sensory environment and body. This prediction is also called active inference or predictive coding (24).

In predictive encoding, sensory prediction stems from motor prediction. Simulations emerge as a function of visceromotor predictions which control the autonomic nervous system, the neuroendocrine and the immune system, and volitional motor predictions, which together anticipate and prepare for an action that will be required at an immediate moment. These observations show that the “stimulus-reaction” model of the mind is inaccurate, according to Barrett. Furthermore, it appears that the mechanical details of predictive coding provide another deep insight. The brain implements the internal model using *concepts* by which it *categorizes* meaningful sensations. Predictions are concepts, and complete concepts are categorizations that maintain physiological regulation, drive actions, and construct perceptions (and attention). The significance of the sensory event includes the visceromotor and the motor action plan that cope with the event (19, 20).

The brain constructs every emotion in an online concept, but with references to certain goals and the context of the situation. According to this, emotions are not reflexes but constructions, largely dependent not only on the biology of the body and the brain but also on the process of learning (development) and on psycho-social contexts that are often changeable.

Thus, Barrett concludes that in every waking moment the brain uses overall past (learned, non-infantile) experiences organized as concepts to guide actions (behavior) and give the senses constantly categorized meaning (25).

ljudi, fizičkog okruženja, kulture i socijalnog realiteta.

Emocije kao funkcionalna stanja

Damasiov doktorand Ralph Adolphs i njegov suradnik David J. Anderson ističu dva problema u vezi emocija (26). Prvi je taj kako su ljudi skloni sebe same smatrati emocionalnim ekspertima. Uzrok toga je dostupnost samog fenomena emocije koji sačinjava veliki dio ljudskog iskustva i često je sveden isključivo na subjektivni doživljaj. Međutim, pri kardiovaskularnim problemima ne oslanjamo se na vlastite osjećaje i senzacije, već na znanje (i dijagnostičke uređaje) kardiologa. Naše socio-kulturno okruženje potiče dojam ekspertnosti jer smo neprestano izloženi emocijama drugih bilo u stvarnosti ili putem medija. Ipak, subjektivno doživljavanje i mišljenje o emocijama ne mora biti točno, već može biti rezultat pretjeranih uopćavanja, krive intuicije, pre naglašavanja ili socijalnih očekivanja. Drugi problem je utjecaj našeg pervazivnog zdravorazumskog shvaćanja emocija na znanstvena pitanja o tom polju. Naglašavaju kako njihov pristup nije teorija, već razmišljanje o načinu pristupanja istraživanju emocija gdje zahtijeva jasnije i preciznije definiranje te kauzalna objašnjenja. Na tom putu razotkriva neke mitove o emocijama. Primjerice, smatraju pogrešnim razdvajati emocije na primarne i sekundarne isto kao dijeliti emocije s obzirom na kategoričku vrstu (26).

Ideja da se primarne emocije ne mogu miješati ni preklapati jedne s drugima te imaju stabilne identitete i funkcije a da ne dijele gradivne komponente netočna je, jer nam neuroznanstvena istraživanja pokazuju suprotno. Narativna priroda ljudskog mozga je da stalno kreira različite priče i uvjerenja čvrsto se oslanjajući na njih bez obzira bile one točne, djelomično točne ili potpuno netočne.

Daljnja diskutabilna ideja je da su emocije potaknute nekim vanjskim podražajem. Ta slika

The mind is therefore not merely the function of the brain-body, but also the brain-bodies of other people, the physical environment, culture, and social reality.

Emotions as functional states

Damasio's PhD student Ralph Adolphs and his associate David J. Anderson highlight two issues regarding emotions (26). The first is that people tend to consider themselves emotional experts. The reason for this is the availability of the emotional phenomenon that constitutes a large part of the human experience and is often limited to subjective experience. Yet when having cardiovascular problems we do not rely on our feelings and sensations but instead on the knowledge of cardiologists (and diagnostic devices). Our socio-cultural environment encourages an impression of expertise because we are constantly exposed to the emotions of others either in reality or through the media. However, subjective perception and emotional thinking does not have to be true, but may be the result of excessive generalization, false intuitions, over-estimation, or social expectations. The second problem is the impact of our pervasive commonsense understanding of emotions on scientific issues in this field. They emphasize that their approach is not a theory, but a reflection on the mode of engaging in emotional research, demanding clearer and more precise definitions of these causal explanations. In doing so, they reveal some myths about emotions. For example, they consider separating emotions into primary and secondary emotions a mistake, as well as classifying emotions with regard to their categorical type (26).

The idea that primary emotions cannot mix or overlap with one another and instead possess stable identities and functions without sharing their building components is inaccurate. Neuroscientific research shows quite the opposite. The narrative nature of the human brain is to constantly create different stories and beliefs, firmly

čini emocije jednostavnim i gotovo refleksnim fenomenima. Prema toj ideji emocije kontroliraju naše ponašanje, što također vidimo da nije točno jer su ljudi sposobni ponašati se suprotno emociji koju u nekom trenutku osjećaju (npr. unatoč strahu učiniti nešto čega se bojimo). Specifične emocije ne izazivaju fiksirana i specifična ponašanja.

Također postoji ideja da su različite emocije lokalizirane u različitim diskretnim regijama mozga (npr. strah u amigdalama, a bijes u hipotalamusu). Suvremena neuroznanost tvrdi da emocije ovise o znatno više distribuiranim regijama mozga.

Sljedeća pogrešna ideja je viđenje mozga kao stroja unutar kojeg se nalazi čovječuljak koji gleda vanjski svijet, reagira na njega i tada prenosi reakcije na nas. Drugim riječima, naše subjektivno iskustvo emocije je kreirano i utjelovljeno subjektivnim iskustvom minijature verzije nas samih u našem mozgu – takozvani homunkulus. Također je upitno gledati na emocije kao na čisti subjektivni doživljaj. Kako mozak kreira internalne reprezentacije vanjskog svijeta te ih prevodi u misli, osjećaje i akcije, centralno je, te još uvijek otvoreno, pitanje u neuroznanosti (27).

Adolphs i Anderson ističu da su emocije fundamentalno biološki fenomeni te stoga trebaju biti shvaćene u biološkim terminima. Nadalje, treba razlikovati tri temeljito različita stanja koja se često izjednačuju: emocionalno stanje, svjesno iskustvo ili osjećaj emocije i razmišljanje (u konceptima i riječima) o emociji. U svojem radu fokusiraju se uglavnom na prvo te smatraju da se emocije mogu proučavati bez subjektivnih osjećaja, tj. bez mjerenja verbalnog iskaza i bez posezanja za teorijama svijesti. Emocije su implementirane pomoću neuralnih mehanizama koji se mogu otkriti i manipulirati pomoću neuroznanstvenih metoda. Studije na miševima otkrivaju da i relativno male regije mozga, kao što je centralna jezgra amigdala, ne obavljaju unitarnu funkciju, već prije sadrže

relying on them regardless of whether they are accurate, semi-accurate, or completely incorrect.

Another disputable idea is that emotions are triggered by some external stimuli. This view makes emotions seem like simple and almost reflexive phenomena. According to it, emotions control our behavior. However, that is not true because certain human behaviors ignore emotions, and individuals sometimes exhibit behaviors contrary to those emotions (e.g. doing something we are afraid of despite the fear). Specific emotions do not cause fixed and specific behaviors.

Furthermore, there is the idea of different emotions being localized in different discrete regions of the brain (e.g. fear in the amygdala and anger in the hypothalamus). Contemporary neuroscience tells us that emotions depend on significantly more distributed brain regions.

The next misconception is seeing the brain as a machine within which a tiny human is looking at the outside world, reacting to it, and then transmitting the reactions to us. In other words, our subjective experience of emotions has been created and embodied by the subjective experience of the miniature version of ourselves in our brain – the so-called homunculus. It is also questionable to view emotions as purely subjective experiences. Exactly how the brain creates internal representations of the outside world and translates them into thoughts, feelings, and actions is a central, and still unanswered, question in neuroscience (27).

Adolphs and Anderson stress that emotions are fundamentally biological phenomena and therefore need to be understood in biological terms. Furthermore, three distinctly different states (that are often equated) should be distinguished: emotional states, conscious experience or feeling of emotion, and thinking (through concepts and words) about emotion. In their work, they focus primarily on the first and suggest emotions can be studied without subjective feelings, i.e. without measuring the verbal report and without resorting to theories

mногоstruke tipove živčanih stanica koje različito utječu na (čak i u suprotnom smjeru) dano emocionalno stanje.

Kada gledamo emocionalno stanje različito od osjećaja emocije, koncepta emocije i riječi za emocije, oslobađamo se naglaska na iskustvu ili konceptu u kojima se reflektira antropocentrična sklonost u mnoštvu emocionalnih studija. Kada laici govore o emocijama upotrebljavaju različite etikete (strah, tjeskoba, ispunjenost, itd.) koje nas mogu informirati o kulturnoj varijabilnosti te razvojnom aspektu emocionalnih konceptata, no to ne treba izjednačavati sa studijama emocionalnog stanja.

Emocije su adaptivno funkcionalno stanje čiji je stupanj kompleksnosti između refleksa i slobodne volje, premda i refleksi i slobodna volja mogu biti regrutirani u emocionalni odgovor (26).

Treba razlikovati dva svojstva emocija: građevne blokove koji su neophodni u pojavi emocije, nasuprot osobinama, koje su više elaborirana, derivirana i varijabilna svojstva. Primjer za građevne blokove je valencija, sva emocionalna stanja su u relaciji s pozitivnom ili negativnom valencijom, ugodom ili neugodom, nešto što izaziva prilaženje ili izbjegavanje. S druge strane, primjer osobina emocije je socijalna komunikacija, što je vrlo važna osobina pogotovo u sisavaca, jer bilo koja emocija može igrati funkcionalnu ulogu u socijalnoj komunikaciji pod nekim okolnostima i nikakvu ulogu u nekim drugim okolnostima. To je ono što zovemo kontekstualna ovisnost emocija. Osim valencije postoji još nekoliko građevnih blokova: skalabilnost (koliko emocionalno stanje varira u intenzitetu), trajnost (različite emocije imaju različita trajanja te uglavnom traju od nekoliko sekundi do nekoliko minuta), generalizacija (mogućnost da se mnoštvo različitih podražaja veže za jedno emocionalno stanje, što posljedično uzrokuje mnoga različita ponašanja, ovisno o kontekstu), globalna koordinacija (angažira se čitavo tijelo, za razliku od

of consciousness. Emotions are implemented through neural mechanisms that can be detected and manipulated by neuroscientific methods. Studies on mice reveal that relatively small brain regions, such as the central nucleus of the amygdala, do not perform a unitary function, but in reality contain multiple neural cell types that have different effects on (even in the opposite direction) a given emotional state.

When we view the emotional state as different from feelings, concepts of emotion, and words for emotions, we are liberated of the emphasis on experience (or concept) that reflects the anthropocentric tendency in a multitude of emotional studies. When laypersons talk about emotions, they use various labels (fear, anxiety, fulfillment, etc.) that can inform us about cultural variability and the developmental aspect of emotional concepts, but this does not need to equate to emotional state studies.

Emotions are an adaptive functional state whose degree of complexity is somewhere between reflex and free will, although reflexes and free will can be recruited into an emotional response (26).

Two emotional features need to be distinguished: building blocks essential to the appearance of emotion versus traits that are more elaborate, derived, and variable. An example of building blocks is valence. All emotional states stand in relation to positive or negative valence, pleasure or discomfort, causing attachment or avoidance. On the other hand, an example of emotional traits is social communication, which is a very important feature especially in mammals because various emotions can play a functional role in social communication under certain circumstances and no role in other circumstances. This is what we call contextual dependence of emotions. In addition to valence, there are several building blocks: scalability (how much the emotional state changes in intensity), persistence (different emotions have different persistence and mostly last from several seconds to several minutes), generalization (the possibility that a multitude of different

refleksa) i automatizam (jedinствена ljudska pojava gdje emocije imaju veći prioritet nad kontrolom ponašanja, nego što ima voljna namjera, što zahtijeva napor u cilju emocionalna reguliranja).

Na centralno emocionalno stanje utječu određeni podražaji (ulazne senzoričke informacije, interoceptor) posredovani varijabilnim kontekstom i voljnom kontrolom, a izlazne informacije emocionalnog stanja (neke određene emocije) su opažena ponašanja, subjektivni iskaz, psihofiziologija, kognitivne promjene i somatski odgovor. Ti odgovori mogu u svakom trenutku postati novi, daljnji podražaji. Tako funkcionalna koncepcija emocija također ukazuje na kriterije za razumijevanje psihijatrijskih poremećaja. Ponekad emocije nisu adaptivne i emocionalno ponašanje je neispravno, što vidimo u poremećajima poput depresije, fobija, PTSP-a, itd. (27).

Postoje svjesno neprimijećeni senzorni stimuli koji induciraju emocionalno stanje te nesvjesni utjecaji poput kondicioniranja, no ne postoji nesvjesni osjećaj emocije, ako je bilo koje emocionalno stanje aktivno u punom intenzitetu. Eventualno je moguće ne biti svjestan neke potencijalne emocije koja se na trenutak pojavila u vrlo niskom intenzitetu (u začetku) a da se ne razvije u puno emocionalno stanje.

Adolphs naglašava da su emocije određeno funkcionalno stanje mozga. One ne niču iz neurotransmitera ni iz anatomskih struktura poput amigdala. Ako anatomske strukture stavimo u posudu i inerviramo ih neće nastati emocije. Da bi se pojavile emocije kao funkcionalno stanje, anatomske strukture treba staviti u intaktni mozak i tijelo.

No na pitanja što su temeljni neurobiološki mehanizmi koji generiraju emocije te kako određena emocionalna stanja mijenjaju ostala ponašanja, pažnju, memoriju i donošenje odluka, ne može se odgovoriti samo putem razmišljanja o

stimuli bind to one emotional state, resulting in many different behaviors depending on the context), global coordination (the whole body being engaged, as opposed to reflex), and automaticity (a unique human phenomenon where emotions prioritize behavioral control over volitional deliberation, which requires effort to exert emotional regulation).

The central emotional state is influenced by stimuli such as sensory inputs and interoceptors, mediated by variable context and voluntary control. The outputs of the emotional state (of a particular emotion) are observed behavior, subjective report, psychophysiology, cognitive changes, and somatic response. These responses can at any time become new, further stimuli. Thus, a functional concept of emotion also suggests criteria for understanding psychiatric disorders. Sometimes emotions are not adaptive and emotional behavior is incorrect, as seen in disorders such as depression, phobia, PTSD, etc. (27).

There are conscious, unnoticed sensory stimuli that induce an emotional state as well as unconscious influences like conditioning, but there is no unconscious emotion if any emotional state is active in full intensity. It is possible that one may not be aware of a potential emotion that appears transiently at very low intensity (at the beginning) without having to develop into a full emotional state.

Adolphs emphasizes that emotions are defined functional states of the brain. They do not stem from neurotransmitters or anatomical structures like the amygdala. If we put the anatomical structures in a jar and innervate them, they would not produce emotions. To create emotions as functional states, the anatomical structure should be placed in an intact brain and body.

But questions about the underlying neurobiological mechanisms that generate emotions and how certain emotional states change other behaviors, attention, memory, and decision making cannot be answered only by thinking about our own emotions. It should also be not-

svojim emocijama. Također treba napomenuti da samo funkcionalni efekt emocije ima svoju adaptivnu ili neadaptivnu svrhu, to je ono što evolucija «vidi». Kognitivizacija emocija, beskrajna razmišljanja i ruminiranja o emocijama nemaju takav utjecaj na ponašanje, mentalnu stabilnost i sam život (26,27).

RASPRAVA I ZAKLJUČAK

Ove suvremene neurobiološko-psihološke teorije emocija su značajni okvir za opće razumijevanje afekata i njihovih mehanizama te za razumijevanje psiholoških poremećaja, jer je teško naći poremećaj u kojem osjećaji i emocije nemaju značajnu ulogu kao vodeći simptomi na koje se pacijenti žale (8,28). Važno je da ove teorije prikazuju zdravo emocionalno funkcioniranje i stanja disfunkcije.

Svi navedeni autori, kao i mnogi drugi (9,29), ističu da treba odbaciti uporabu termina limbicki sustav. Smatra se da je danas taj termin zastario - nije dobro definiran, nema jedinstvenog dogovora koje strukture u njega ulaze, i nije moguće precizno mapirati svaku specifičnu mentalnu funkciju.

U prikazu je navedeno nekoliko značajki koje treba istaknuti. Prvo, razlika između homeostatskih osjećaja i emocija, koji se i u psihopatologiji često miješaju, daje nam jasniju sliku u konceptualizaciji mozga-uma te pokazuje da nije sve što osjećamo emocija. Premda su osjećaji neophodni «građevni materijal» za emocije, oni im nisu ekvivalentni. Emocije spadaju u akcijske programe te se često nadovezuju i prate nagonско/motivacijska ponašanja (glad, žeđ, traganje, socijalne interakcije, seksualnost, itd.) (13,30,31). Ova diferencijacija pomaže ukidanju panemocionalnosti (da se u životu i psihoterapijskoj seansi u svemu vide emocije) koja vodi do pogrešnih kauzaliteta i korelacija (19). Emocije su povremeni fenomeni u pravilu kratkog trajanja dok su homeostatski

ed that only the functional effect of emotion has its adaptive or non-adaptive purpose; that is what evolution “sees”. Cognitization of emotions, endless thinking, and ruminating about emotions have no such influence on behavior, mental stability, and life itself (26,27).

DISCUSSION AND CONCLUSION

The reviewed contemporary neurobiological and psychological theories of emotions represent a significant framework for a general understanding of affects and their mechanisms. They also contribute to the understanding of psychological disorders, as it is difficult to find a disorder in which feelings and emotions are not included as the predominant symptoms patients complain of (8,28). It is important that the theories encompass both healthy emotional functioning and dysfunctional states.

All the aforementioned authors, like many others (9,29), emphasize that the term “limbic system” should be rejected. The term is considered to be outdated – it is not well-defined, there is no unique agreement on what structures comprise it, and it is not possible to precisely map each specific mental function.

There are several features to highlight in this review. First, the difference between homeostatic feelings and emotions, terms which are often confused in psychopathology, gives us a clearer picture of the mind-brain conceptualization and clarifies that not everything we feel is an emotion. Although feelings are necessary “building blocks” for emotions, they are not equivalent to them. Emotions belong to action programs and are often supplemented and accompanied by instinctive/motivational behaviors (hunger, thirst, pursuit, social interactions, sexuality, etc.) (13,30,31). Differentiating between feelings and emotions helps to abolish pan-emotionality, as emotions are seen in everything in both life and psychotherapy, which

osjećaji stalnost koja je većinom „centrirana“ između tri osjećajne dihotomije (ugoda/neugoda, napetost/opuštenost i energiziranost/iscrpljenost). Dugotrajna stanja određenog raspoloženja su homeostatski osjećaji, prije nego emocije.

Damasio i Barrett drže da su homeostatski osjećaji (za Barrett afekti) stalno prisutni. Na tom tragu Adolphs ističe nužnost valencije i skalabilnosti koje on naziva građevnim blokovima emocija, ali suštinski odgovaraju konceptu homeostatskih osjećaja. Svo troje slažu se da se emocija stvara ili gradi od više različitih elemenata, te da ni jedna emocija nije ultimativno esencijalni fenomen.

Drugo, suprotno Pankseppu, ne treba dijeliti emocije na primarne (bazične) i sekundarne i socijalne, ni taksativno navoditi točan broj koje čovjek treba imati u svom repertoaru. Za mozak-um nema podjele na primarne i sekundarne, to je dogovorni jezični koncept koji nema utemeljenja u neuroznanstvenim istraživanjima, a individualne razlike u emocionalnom repertoaru uvijek postoje te neki ljudi barataju s većim repertoarom emocija, a neki s manjim.

Treće, emocije, koliko god bile „pogonsko gorivo“ našeg uma, u stvari su samo jedan od tri mentalna nazivnika za sadržaje koje možemo imati na (svjesnom) umu – percepcija, kognicija i afekti. Drugi mentalni fenomeni, poput kognicije (mišljenje, učenje i sjećanje, odlučivanje, itd.) su također iznimno važni za razumijevanje funkcioniranja uma. Ne samo da emocije izazivaju misli i ponašanje, već i misli i ponašanje mogu izazivati emocije (20). Postoje kružne petlje među tim pojavama, a naš mozak koristi sve kapacitete uma da bi stvorio optimalnu adaptivnu situaciju u životnim (ne)prilikama (32,33).

LeDoux (9,15) sukladno s ostalim navedenim autorima ističe zastarjelost termina „limbički sustav“ i njegovo izjednačavanje s emocional-

leads to erroneous causality and correlations (19). Emotions are intermittent phenomena, usually of short duration, while homeostatic feelings are largely “centered” between three sensory dichotomies (pleasure/discomfort, tension/relaxation, and energization/exhaustion). Long-term states of a certain mood are homeostatic feelings rather than emotions.

Damasio and Barrett maintain that homeostatic feelings (for Barrett, affects) are constantly present. Along those lines, Adolphs emphasizes the necessity of valence and scalability, which he calls the building blocks of emotions, but that essentially correspond to the concept of homeostatic feelings. All three authors agree that emotion is created or constructed from many different elements and that no emotion is ultimately an essential phenomenon.

Second, contrary to Panksepp’s theory, one should not divide emotions into primary (basic) and secondary or social, nor specify the exact number one should have in one’s repertoire. For the brain-mind, there is no division into primary and secondary; it is a contractual construct that is unfounded in neuroscientific research, and individual differences in the emotional repertoire are always present. Some people possess larger repertoires of emotions while others possess smaller ones.

Third, emotions, despite being the “propulsion fuel” of our mind, are in fact only one of three mental denominators for the content we can have on our (conscious) mind – perception, cognition, and affect. Other mental phenomena, such as cognition, including thinking, learning, memory, and decision making and are also extremely important for understanding how the mind functions. Not only do emotions cause thoughts and behaviors, but thoughts and behaviors can also trigger emotions (20). There are circular loops between these phenomena, and our brain uses all the mind’s capacities to create an optimal adaptive situation through life and both its opportunities and predicaments (32,33).

nim sustavom, kao i MacLeanov trijunski mozak (4) koji se često ponavlja i u suvremenoj literaturi. Emocionalno stanje, svjesnost koncepta emocije i razmišljanje o emociji su tri odvojena fenomena, koji potječu iz kombinacija različitih neuralnih krugova i mreža, a LeDoux smatra da se emocija straha samo odnosi na kognitivnu reprezentaciju, a da ponašanje i neuralni uzorak i fiziologiju i ponašanje treba zvati sasvim drugim terminom (zbrka u verbalnim konceptima i jezičnim kategorizacijama emocija i drugih mentalnih fenomena) – „neuralni krugovi za preživljavanje“ što nije isto što i riječ koja spada u verbalni repertoar „strah“, „tjeskoba“, „bijes“.

Luiz Pessoa ističe da je najbolje emocije gledati ne kao na zasebne fenomene, već kao „pakete“, kognitivno – emocionalne sheme (29). Ističe da bez obzira na privlačnost dihotomija za ljudski um dihotomizirati emocije i kogniciju je pretjerana simplifikacija, stoga Pessoa uvodi kontinuirani okvir u emocionalno-kognitivnom procesuiranju. U takvom dinamičkom okviru, „emocija“ i „kognicija“ mogu se označiti u kontekstu određenog ponašanja, ali se ne može precizno mapirati kompartmentalizacijske dijelove mozga. Emocije-kognicija, unatoč našem subjektivnom doživljaju, nisu nikada u konfliktu, već u kompleksnom kontinuitetu. Nadalje, Pessoa ističe integraciju različitih supkortikalnih i kortikalnih krugova za doživljaj emocije. Primjer te integracije je ventralni emocionalni sustav (amigdalo-orbitofrontalni dio). Te strukture sudjeluju u prepoznavanju emocionalnog podražaja i proizvode trenutačni automatski emocionalni i autonomni odgovor.

Uz ventralni postoji i dorzalni emocionalni sustav (hipokampalno–posteriorno cingularni dio) zadužen za integriranje svjesnosti. Efikasna integracija informacija ventralnog dijela u dorzalni nužna je za transformaciju opaženih objekata u one koji se doživljavaju emocionalno (31). Takvu istaknutu integraci-

LeDoux (9,15), similarly to other authors, considers the term “limbic system” and its equation with the emotional system obsolete, as well as MacLean’s Triune Brain, which is often mentioned in contemporary literature. Emotional state, awareness of the concept of emotion, and thinking about emotion are three separate phenomena that arise from combinations of different neural circuits and networks. LeDoux states that the emotion of fear should only refer to cognitive representation, and that behavior, neural patterns, physiology, and behavior should be described by completely different terms (confusion in verbal concepts and linguistic categorizations of emotions and other mental phenomena) – “neural circuits for survival” is not the same as a word belonging to the verbal repertoire of “fear”, “anxiety”, and “anger”.

Luiz Pessoa postulates that it is best to contemplate emotions not as separate phenomena, but as “packets” or cognitive-emotional schemes (29). Regardless of the appeal of dichotomies to the human mind, dichotomizing emotions and cognition is an over-simplification. Therefore, Pessoa introduces a continuous framework in emotional-cognitive processing. In such a dynamic framework, “emotion” and “cognition” can be labeled in the context of a particular behavior, but the compartmentalization parts of the brain cannot be mapped precisely. Emotions and cognition, despite our subjective experience, are never in conflict, but in complex continuity. Furthermore, Pessoa emphasizes the integration of different subcortical and cortical circuits needed to experience emotion. An example of this integration is the ventral emotional system (the amygdala-orbitofrontal part). These structures participate in the recognition of an emotional stimulus and produce an immediate automatic emotional and autonomous response.

In addition to the ventral, there is a dorsal emotional system (hippocampal – posterior cingulate part) in charge of integrating consciousness. Effective integration of the ventral

ju nalazimo kod svih navedenih autora osim Pankseppa.

Četvrto, emocije esencijalno nisu nesvjesni, već svjesni fenomen; evolucija se za to pobrinula (5,34). Takvo shvaćanje nije isključivo moderna neuroznanstvena pojava već se nadovezuje na psihoanalitičku tradiciju Jacquesa Lacana koja kaže da se potiskivanje može javiti prekidanjem veze između afekta i njemu pripadajuće misli te je misao ta koja može biti nesvjesna, ali nikada afekt (35,36). To se također slaže s nalazom da su emocije velikim dijelom kognitivizirane; više mislimo i pričamo o emocijama nego ih osjećamo. Taj kognitivni aspekt emocije može biti nesvjestan kao što vidimo u psihoanalitičkim psihoterapijama gdje je dio zadatka terapeuta upravo osvjestiti, tj. povezati emociju s njenim disociranim kognitivnim aspektom. Peto, afekti su primarno vezani uz tijelo te tu najbolje vidimo povezanost tjelesnog i mentalnog koja se ogleda i u somatoformnim i konverzivnim poremećajima. Barrett ističe da su tijelo, periferni i središnji živčani sustav snažno povezani u procesuiranju mentalnog, te da osjećaji i emocije nisu samo reakcija na fizičku bol već je to druga strana iste medalje (npr. separacijska bol ili bol u jakoj žalosti). Sterling i Laughlin smatraju da je „temeljni zadatak mozga [je] da regulira internalni milje (tijela)...anticipirajući potrebe i pripremajući se da ih zadovolji i prije nego što niknu“ (37).

Možemo zaključiti da nemamo samo jedan strah, bijes ili žalost već mnoštvo dijelom različitih emocija ovisno o kontekstu doživljaja. Emocije su konstrukcija svijeta, ne direktna reakcija na svijet, te nisu izazvane samo eksteroceptivnim putevima koji zahtijevaju amigdale (38). Emocije bi trebale biti modelirane kao fenomen mozga i tijela u interakciji s kontekstom. Um nije samo funkcija mozga-tijela, već fizičkog okruženja i socio-kulturnog realiteta.

Ovdje bismo istakli da je emocije najbolje gledati u homeostatskim osjećajima i akcijskim

portion of information into the dorsal is necessary for the transformation of observed objects into those experienced emotionally (31). Such prominent integration is found in all of the above authors except Panksepp.

Fourth, emotions are not essentially unconscious, but rather conscious phenomena; evolution took care of that (5,34). This notion is not just a modern neuroscientific phenomenon but rather continues the psychoanalytic tradition of Jacques Lacan, who stated that repression may occur by interrupting the connection between affect and its corresponding thought. A thought can be unconscious while affect cannot (35,36). This also agrees with the finding that emotions are largely cognitively processed; we think and talk about emotions rather than feel them. This cognitive aspect of emotion may be unconscious as we see in psychoanalytic psychotherapies, where part of the therapist's task is precisely to make conscious and link the emotion with its suppressed cognitive aspect, or what Lacan calls "the signifier". Finally, affects are primarily related to the body and it is here that we can best observe the connection between the physical and the mental, reflected in somatoform and conversion disorders. Barrett points out that the body, both the central and peripheral nervous system, is strongly linked to mental processing, and that emotions and feelings are not just a reaction to physical pain but "the other side of the coin", including separation pain or pain during intense sadness, for instance. Sterling and Laughlin believe that "the basic task of the brain is to regulate the internal milieu (of the body)... by anticipating needs and preparing to satisfy them even before they arise" (37).

We can say that we do not have only one fear, anger, or sadness but a multitude of partly different emotions depending on the context of the experience. Emotions are a construction of the world, not a direct reaction to the world, and they are not triggered only by the exteroceptive pathways that require the amygdala

programima koji čine nagone/motivacije i emocije te razumjeti da su to sve diferencirani fenomeni. Recimo nagoni/motivacije mogu pokretati ponašanje bez ikakve emocije, krugovi za preživljavanje („*survival circuits*“) (9,15) mogu aktivirati bihevioralnu (re)akciju u opasnosti, a drugi sustavi mozga-uma stvaraju eventualni osjećaj straha ili bijesa.

Napredak u afektivnoj neuroznanosti u zadnjem desetljeću značajan je te je s drugim granama neuroznanosti, kao što je kognitivna znanost, glavni okvir za stvaranje bolje psihološke teorije uma koja bi obuhvatila i psihoanalitičku psihoterapiju. Nova paradigma uma stvorila bi jasniju sliku i točnija tumačenja kako općih psiholoških fenomena, osjećaja, emocija, kognicije, pamćenja i percepcije, tako i bolje objašnjenje psihoterapijskih procesa i njihove učinkovitosti u liječenju, od psiholoških problema do psiholoških poremećaja (39). Tako bi psihoanalitičku psihoterapiju mogli definirati kao specifičnu, interpersonalnu (socijalnu), verbalnu i neverbalnu, svjesnu i nesvjesnu, afektivnu i kognitivnu komunikacijsku igru kojom postićemo emocionalnu ravnotežu i kognitivni sklad (40).

Što su emocije? Emocije su biološki akcijski programi, utemeljeni na interakciji tijela i mozga pod stalnim utjecajem kognitivne obrade pomoću koncepata i kategorizacija, snažno vezane za memorijske sustave mozga-uma (41), do neke mjere «plastične» tako da su pod utjecajem i procesa učenja i iskustva, te se odvijaju u određenoj socio-kulturi sa svim svojim pozitivnim i negativnim kondicioniranjima.

(38). Emotions should be modeled as a brain-and-body phenomenon interacting with the context. The mind is not only a function of the brain-body, but of the physical environment and socio-cultural reality.

We would like to emphasize that emotions are best viewed through homeostatic feelings and action programs that create drives/motivations and emotions, and that we should understand that these are all differentiated phenomena. For example, action programs can trigger behavior without any emotion, so we can have survival circuits (9,15) as a behavioral (re)action in danger while other brain-mind systems create a possible sense of fear or anger.

Advancements in affective neuroscience in the last decade have been significant and together with other branches of neuroscience such as cognitive science build the main framework for creating a better psychological theory of the mind that would also include psychoanalytic psychotherapy. This new paradigm of the mind would create a clearer picture and more accurate interpretations of general psychological phenomena, feelings, emotions, cognition, memory, and perception, as well as a better explanation of psychotherapeutic processes and their effectiveness in treatment, from psychological problems to psychological disorders (39). Thus, psychoanalytic psychotherapy could be defined as a “specific, interpersonal (social), verbal and nonverbal, conscious and unconscious, affective and cognitive communication play that achieves emotional equilibrium and cognitive harmony” (40).

What are emotions? Emotions are biological action programs based in the interaction between the mind and the body, constantly influenced by cognitive processing through concepts and categorizations, strongly linked to brain-mind memory systems (41), to some extent “plastic” so that they are also influenced by learning and experience processes and take place in a particular socio-culture with all its positive and negative conditioning.

1. Deak A. Brain and emotion: Cognitive neuroscience of emotions. *Rev. Psychol* [Internet]. 2011;18(2):71–80. Available from: <https://hrcak.srce.hr/81460?lang=en>
2. Dalgleish T, Dunn BD, Mobbs D. *Affective Neuroscience: Past, Present, and Future*. Stearns PN, editor. *Emotion Rev* 2009; 1(4): 355-68.
3. Barrett LF, Satpute AB. Historical pitfalls and new directions in the neuroscience of emotion. *Neurosci Lett* 2019; 693: 9-18.
4. Maclean PD. *The triune brain in evolution: role in paleocerebral functions*. New York, London: Plenum Press, 1990.
5. Johnston E, Olson L. *The feeling brain: the biology and psychology of emotions*. New York: WW Norton & Company, 2015.
6. Panksepp J, Biven L. *The archaeology of mind: neuroevolutionary origins of human emotions*. New York: WW Norton & Company, 2012.
7. Panksepp J. Affective reflections and refractions within the BrainMind. *Netherlands J Psychol* 2008; 64(4): 128-31.
8. Solms M. *The Feeling Brain: Selected Papers on Neuropsychanalysis*. London, New York: Routledge, 2015.
9. LeDoux JE, Brown R. A higher-order theory of emotional consciousness. *Proc Nat Acad Sci* 2017; 114(10): E2016-25.
10. Barrett LF. The theory of constructed emotion: an active inference account of interoception and categorization. *Soc Cogn Affect Neurosci* 2017; 12(11): 1833.
11. Damasio A. *Feeling of what happens: body and emotion in the making of consciousness*. London: Vintage, 1999.
12. Damasio A. *Descartes error: emotion, reason and the human brain*. London: Vintage Books, 2006.
13. Damasio A. *The strange order of things: life, feeling, and the making of cultures*. New York: Pantheon Books, 2018.
14. Damasio A, Carvalho GB. The nature of feelings: evolutionary and neurobiological origins. *Nature Rev Neurosci* 2013; 14(2): 143-52.
15. LeDoux JE. *Anxious: using the brain to understand and treat fear and anxiety*. New York: Penguin Books, 2015.
16. Damasio A. *Self comes to mind: constructing the conscious brain*. London: Vintage, 2010.
17. Craig AD. *How Do You Feel?: An Interoceptive Moment with Your Neurobiological Self*. New Jersey: Princeton University Press, 2015.
18. Craig AD. The sentient self. *Brain Struct Funct* 2010; 214(5–6): 563-77.
19. Barrett LF. *How emotions are made: the secret life of the brain*. Boston: Mariner Books, 2017.
20. Seth AK, Friston KJ. Active interoceptive inference and the emotional brain. *Philosophical Transactions of the Royal Society B: Biological Sci* 2016; 371(1708).
21. Critchley HD, Garfinkel SN. Interoception and emotion. *Curr Opin Psychol* 2017; 17: 7-14.
22. Seth AK. Interoceptive inference, emotion, and the embodied self. *Trends Cogn Sci* 2013; 17(11): 565-73.
23. Berridge KC, Kringelbach ML. Neuroscience of affect: brain mechanisms of pleasure and displeasure. *Curr Opin Neurobiol* 2013; 23(3): 294-303.
24. Friston K. The free-energy principle: a unified brain theory? *Nature Rev Neurosci* 2010; 11(2): 27-38.
25. Kashdan TB, Barrett LF, McKnight PE. Unpacking Emotion Differentiation. *Curr Direct Psychol Sci*. 2015; 24(1): 10-6.
26. Adolphs R, Anderson DJ. *The neuroscience of emotion: a new synthesis*. Princeton: Princeton University Press, Cop, 2018.
27. Adolphs R. How should neuroscience study emotions? by distinguishing emotion states, concepts, and experiences. *Soc Cogn Affect Neurosci* 2017; 12(1): 24-31.
28. Zellner MR, Watt DF, Solms M, Panksepp J. Affective neuroscientific and neuropsychanalytic approaches to two intractable psychiatric problems: Why depression feels so bad and what addicts really want. *Neurosci Biobehav Rev* 2011; 35(9): 2000-8.
29. Luiz Pessoa. *The cognitive-emotional brain: from interactions to integration*. London, Cambridge, MA: The MIT Press, 2013.
30. Berridge KC, Kringelbach ML. Pleasure Systems in the Brain. *Neuron* 2015; 86(3): 646-64.
31. Karlović D. *Neurokemija ponašanja s osnovama psihofarmakologije*. Zagreb: Medicinska naklada, 2016.
32. Ginot E. *The neuropsychology of the unconscious integrating brain and mind in psychotherapy*. New York, London: WW Norton & Company, 2015.
33. Pessoa L, Adolphs R. Emotion processing and the amygdala: from a "low road" to "many roads" of evaluating biological significance. *Nature Rev Neurosci* 2010; 11(11): 773-82.
34. Nalbantian S, Matthews PM, McClelland JL. *The memory process: neuroscientific and humanistic perspectives*. Cambridge, Mass: MIT Press, 2011.
35. Fink B. *A clinical introduction to Freud: techniques for everyday practice*. New York: WW. Norton & Company, Inc, 2017.
36. Brown R. Consciousness doesn't overflow cognition. *Front Psychol* 2014; 5.
37. Sterling P, Laughlin SB. *Principles of neural design*. Cambridge: MIT Press, 2017.
38. Amaral D, Adolphs R. *Living without an amygdala*. New York: The Guilford Press, 2016.
39. Satpute AB, Nook EC, Narayanan S, Shu J, Weber J, Ochsner KN. Emotions in "Black and White" or Shades of Gray? How We Think About Emotion Shapes Our Perception and Neural Representation of Emotion. *Psychol Sci* 2016; 27(11): 1428-42.
40. Čorlukić M, Tripković M. Is the Psychoanalytic Paradigm of Mind Still Valid?. *EFPP Rev* 2019; 15: 1-26.
41. Rolls ET. Functions of human emotional memory: the brain and emotion. U: Nalbantian S, Matthews PM, McClelland JL, ur. *The Memory Process: Neuroscientific and Humanistic Perspectives*. MIT Press, 2011, str. 173-91.