Perception is one of the psychological operations that can be analyzed from the point of view of microgenetic theory. Our study tests the basic premise of microgenesis theory – the existence of recurrent stages of visual information processing. The event related potentials in two variants of a cued GO/NOGO task (contrasting images of Animals and Plants in the first variant, and contrasting images of Angry and Happy faces in the second variant) were studied during the first 300 ms following stimulus presentation. The independent component analysis was applied to a large collection of ERPs. The functional independent components associated with visual category discrimination, comparison to working memory, action initiation and conflict detection were separated. Information processing in the ventral visual stream (the temporal independent components) occurs at two sequential stages with positive/negative fluctuations of the cortical potential as indexes of the stages. The first stage represents the comparison of the pure physical features of the visual input with the memory trace. The second stage represents the comparison of more sophisticated semantic/emotional features with the working memory. The two stages are the results of interplay between bottom-up and top-down projections in the visual ventral stream.

Keywords: microgenetic theory, event related potentials, stages of information flow, ventral visual stream, independent component analysis
THE MICROGENETIC MODEL OF PERCEPTION

The microgenetic model of perception was proposed over 25 years ago on the basis of clinical case material (Brown, 1988). The theory was radical when first proposed, while the new, revolutionary model is merely a gathering consensus on the microgenesis account re-formulated in an experimental vocabulary (Pąchalska, MacQueen & Brown 2012a, b; Kropotov & Mueller 2012; Bachman 2009; 2010; 2017; Pachalska, Kaczmarek & Kropotov 2014).

Microgenetic theory reverses the perceptual process that has been dogma in neurology for over a century. The standard connectionist model describes how sensory data are thought to arrive in the visual cortex, where specialized cells, or feature detectors, receive information regarding lines and angles. A preliminary construct is then assembled to a three-dimensional object in a transition from V-1 to V-4, where the resultant construct is associated to systems in limbic-temporal lobe for recognition, i.e., matching to memory images, and to parietal lobes for updating the object in relation to its changing spatial environment. Colour and motion detectors add to the mix. Basically, the seen properties of an object, its shape, colour, movement, etc., are inserted in the brain as mechanisms or components that extract those same properties from the object, and then reassemble it from the elements into which it has been decomposed. The object is then projected into external space (see: Brown 2005; Pachalska, Kaczmarek & Kropotov 2014).

Microgenetic theory argues that a perception begins in the upper brainstem with a two-dimensional construct organized about the space of the body (Brown 1989; 2005; 2014; 2015). About one third of the fibres of the optic nerve go to the upper brain stem, a substantial connection that was formerly thought to mediate the pupillary reflex (Kropotov 2009, 2016; Pachalska, Kaczmarek & Kropotov 2014). The claim is that this input fashions an initial configuration, in which action and perception are part of the same construct1, which is then transmitted, in the direction of forebrain evolution, to successive planes of limbic growth (Brown 1989). From the clinical standpoint, in the passage through limbic formation there is a relative suspension of input, so that the emerging pre-object can pass through systems of affective relations and experiential and personal meaning. At this phase, there is an egocentric or volumetric space. The image is fluid, dreamlike and hallucinatory.

Space is foreshortened with a palpable quality. The image is extra-personal yet felt as intra-psychic. The image and its space then pass to systems in the parietal lobe where, perhaps by way of thalamo-cortical projections, the configuration is further constrained to a three-dimensional object-centred Euclidean space (Brown 1989). The gestalt-like object is external but not yet detached, and is still experienced as part of personal space. In some respects, the phase of the proximate space of the arm’s reach is similar to action space which deposits

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1 The evolution from the cyclical structure of a sensory-motor reflex arc to a simultaneous act-object, which distributes into action and perception over levels surrounded by physical tiers of sensory constraints and motor keyboards, is described in Brown (1991).
in the body (Pąchalska & MacQueen 2008). The relation of the limb to the object is important (e.g., hallucinations tend to disappear when the person reaches for them). Typically, we ask the patients with parietal lesions to draw or manipulate objects to bring out the dysfunction (Pachalska, Kaczmarek & Kropotov 2014). This space is also the action-perimeter of the congenitally blind (Brown 1989). Finally, the object receives the massive input at V-1, with analysis of the gestalt into its featural detail, full exteriorization, detachment and modulation from the self or rather from the system of self consistent with the direction of brain and organism evolution (see: Fig. 1).

The perceptible world, according to microgenetic theory, is realized through V-1. It is lost when V-1 is destroyed, as in cortical blindness or hemianopia, though earlier phases in the perception are still preserved. This was first shown by Bender and Krieger (1951) in what came to be called ‘blindsight.’ Semantic information can be extracted from blind fields by priming techniques. In highly original work, Tony Marcel (after Brown 2005) demonstrated the ability to access word meanings with presentations to the blind field.

The microgenesis of visual perception (see: Fig. 2), showing levels of object and space realization with corresponding stages of sensory constraint (Brown, 1988, for anatomical details). The constraints are physical, and do not enter the object-formation. The process is wholly internal or endogenous.
According to microgenetic theory during the process of perception, one object will be perceived by the brain in the form of three images. And thus:

1. The midbrain (the most primitive part of the brain) – sees something big, something that moves, is a dangerous object (or not), edible (or not), etc. (= Gestalt); This part of the brain sees the world of objects and movements, which it classifies into simple categories: dangerous - harmless, edible - inedible, big - small, moves - does not move etc. Action and perception are inseparable parts of the same process: for the frog it is that it sees a fly, and the fact that it pulls out its tongue to catch it is one and the same. Movements are holistic, axial, stereotypical, and irrevocable;

2. The limbic system – see, for example, „someone pretty, nice, which reminds me that ... there is a pleasure principle“ here: common objects, places, people are classified as pleasant, nice, well-liked or not. It is the world of dreams, observations are closely related to memory in an emotional colour.
3. The cerebral cortex – sees a person who has such-and-such characteristics and can be identified or not (in the absence of information). It is only in the cortex that the details emerge and a world of full awareness is created.

It should be emphasized that these three pictures do not represent three different, subsequent moments of perception, for each previous one is replaced by the next. Older floors are not “outdated”, they do not become “out of date”. Both the action and the perception on the lower parts of the brain provide a framework within which the subsequent higher parts of the brain processes its data. It follows that even the most sophisticated behaviour contains traces of the behaviour of a primitive being. Let us remind you that this is possible due to the conversion of a specific mental state (Pąchalska, Kaczmarek & Kropotov 2017).

Speaking of which microgenetic theory from the very beginning claimed that sensation did not go into the assembly of an object, but constrained (sculpted) a process that is wholly endogenous (Brown 1989). An external object is an image at the outermost reach of the mind. While in the classical model, archaic structures come into play at a post-perceptual stage, microgenetic theory is consistent with the direction of brain evolution. The mind/brain state consists of a rapid transition from core to surface with multiple tiers of physical sensation acting to delimit the process so that the object that actualizes is the only one possible, given the limits on its development by sensation as the object adapts to its niche in the external world

The standard, cortical in-processing, approach entails a construction or assembly of sensory bits into larger complexes, while microgenesis is a specification model in which sensation acts to constrain an endogenous image. One is a briccolage of elements, the other an elimination of the irrelevant in the service of adaptation. The former is a synthesis of multiplicity as parts are assembled into wholes. The latter analyses wholes (potential) into parts. One combines multiplicity into unity, the other leads from unity to diversity. As in evolution, where exuberant form is trimmed away by the environment so only the fittest survive, the final object is realized by the elimination (failure to individuate) of all other routes of development save that which occurs (see: Brown 2005). This classical approach can be compared to modelling with clay, as opposed to the microgenetic account, which is like sculpting out of marble, as Michelangelo said, to chip away what is unnecessary to expose the form hidden in the block (Pąchalska, Kaczmarek & Kropotov 2014). This account developed from studies of normal and pathological language, which were then extended to action, memory, feeling, and other aspects of cognition. A strength of the model is its coherence across cognitive domains. It is also consistent with, indeed it has inspired, an account of subjective time, change, agency, the derivation of drive to value, and many other topics in the theory of the mind.

It should be noted that in going from limbic formations to V-1, one also goes from long-term to working to iconic memory (see below), from potential to actual, from past to present, from subject to object – or self to other – and from mind to world (Brown 1989). On this view, the world is like the skin of the mind. Like a
multi-layered skin in which cells at the surface die off to be replaced by those from below, the mind also sheds its surface objects. An act of cognition that is mediated by brain tissue derived from primitive ectoderm creates objects that perish for the next round of actualization. V-1 realizes the final phase of an object, but embedded within that object are antecedent phases, including the limbic space of dream. An object is not the endpoint of a conveyer belt or assembly line, but is a mental state, or act of thought, that incorporates all of the phases in its generation. These phases – antecedent to the object, not secondary to it after it has been perceived - account for the context, memory, feeling and experience that stand behind and are part of the perception.

In this process, which occurs in a fraction of a second, there is also a transition from context to item or from whole to part. Sculpting involves the elimination or inhibition of cells and connections, while whole-part transitions involve the delimitation of actualities. There is continuity from patterns in evolution to those in morphogenesis, and from the latter to the microgenetic process. The morphogenetic processes of parcellation and neoteny lay down “force lines” that become the process of cognition (Brown & Pachalska 2003). This implies that mental process is a form of growth. The analysis goes from wholes to parts, in which the parts become wholes for another whole-part transition. The wholes are not mere sums, and the parts differ qualitatively at each phase. The whole-part transition is the fundamental algorithm of the mind/brain state.

The mental state is a bottom-up surge in milliseconds over evolutionary growth planes. An object has a certain temporal thickness that incorporates these phases; it takes some “time” for the object to develop from base to surface or from mind to world in the system, though subjective time does not exist until the process is completed. It is questionable whether the before/after of the succession of phases exists before the traversal is complete and the entity becomes what it is in a minimal duration of existence. The “temporal lag” in perception, like the readiness potential and other studies in action, point to the fact that acts and objects are not “on-line” with the physical world (Pąchalska, MacQueen & Brown 2012).

The transition from limbic planes toward V-1 is also the transition from hallucination, to illusion, to perception. Pathology at the limbic phase exposes constructs that are mediated by this segment, eg., hallucinatory phenomena in perception, affective experience and meaning-relations in errors that occur with focal brain lesions (Pąchalska, Kaczmarek & Kropotov 2014). At the parietal phase, there are illusory phenomena, with distortions of objects. The distinction of hallucination and illusion – ostensibly between an endogenous image and the distortion of a real object – reflects the phase in the process where the disruption has its maximum impact. Hallucination refers to a proximal phase, illusion a distal one. The closer the disruption to the perceptual endpoint the more “physical” the properties of the image. The earlier in the process the disruption, the more psychic, dream-

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1 See Brown (2005) for discussion of the temporal extensibility that evolves from elementary entities to the mind/brain, and the relation of process over this extensibility (becoming) to the entity (being) it creates.
like or fantastic the image. This reflects the degree to which sensory constraints delimit the emerging image to model what is “out there” in the physical world. On the microgenetic view, the distinction refers to the degree to which the image objectifies (Brown 2005).

At the level of primary (visual) cortex, pathology gives rise to phenomena that resemble after-images, i.e., palinopsia, where there is a physical quality to the image, such as increasing size with projection distance, lack of constancies, or the image appears as a film over an object rather than replacing it. It is important to note that one cannot hallucinate and perceive in the same locus of space at the same time (Brown 1988). The reason for this is that hallucinatory space is the precursor of object space. An object is a fully realized, fully-constrained, sculpted or adapted hallucination, while hallucination is a disruption within the object-development that reveals experientially-driven phases in the formative process. Fig. 3. is a schematic representation of the progression from dreamless sleep (upper brainstem) through limbic and ensuing stages of hallucination, illusion

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Fig. 3. Microgenetic levels in object formation with reduction of sensory constraint: The normal series of images is on the left side, the pathological series on the right. Source: Brown 2005, with modification
and other forms of imagery. The normal series of images is on the left side, the pathological series on the right.

**TIME, CHANGE AND STABILITY**

Microgenetic theory developed as a clinical model, but gradually became a theory of time and process. The central argument is that the subjective present, about which past and future seem to orbit, originates in the arising of a mind-independent passage from before to after. The past is less tangible, less real than the present, but it is more durable, absorbing the present as it fades into memory so that the future can become actual (Atmanspacher, 2003). Experience seems to go from the present of existence to revival in personal or collective memory, but this is the reverse of the passage of nature, which goes from earlier to later or, in subjective life, from the past to the future. Put differently, psychology assumes a direction going from present to past in the shift from perception to memory, while nature moves in the opposite direction, from past to future. A theory of mind consistent with the process of nature would have the future becoming the present out of the past, rather than having the past deposited by the present.

Temporal order in perception and memory has been conceived as realized within a given mind/brain state, or over a succession of states. Serial order might then involve a concatenation of states with a blurring of the boundaries between them. However, succession alone cannot map directly to passage, i.e., perceived succession in the world does not give the succession in the mind, since objects and entities perish on actualization. The perception of temporal order requires that past and no-longer existent objects recur in memory. However, to attribute serial recall to working or episodic memory merely re-states the problem without explaining it. A succession of perceptual states may be necessary for serial order, but this is not a solution to the consciousness of succession (Pąchalska, MacQueen, Brown 2012b).

Succession is as essential to change as to stability. Object stability occurs when replacements are similar, change when recurrences are novel3. However, we should remember that serial order is required both to see a tree and hear a sonata. For epochal theory, events arise within non-temporal spatial wholes, with the simultaneity within a state replaced by its successor. The perception develops out of memory through the effects of sensory constraints on an infrastructure of memory. The state lapses to its precursors in the incomplete revival (decay) of per-

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3 A perception provokes a novel idea when it releases (disinhibits) an image by the suppression of virtual competitors. In the succession of world-states, change in passage also brings change in sensibility. Novelty in sensation is not in the changing appearances of the world but in the formative process through which objects develop. Perceptions are not the birthing of cognitions but their goal. Every perception conceals a process of creation that is overcome by the sensibility it seeks to realize (Brown 2017). In a word, the novelty of entities in the world is trivially represented by change in passage, while the genuine novelty in physical entities and perceptual objects is buried in the finality of object form, and surfaces as imagery when that finality is incomplete. Relative freedom from the external is necessary for the expansion of novelty to a creative idea. Sensation imports knowledge; it does not install experience but works through the delimitation of possibility. The source of experience is a sensibility that carves possibility into particulars (Pąchalska, Kaczmarek & Kropotov, 2014).
ception in a series of replacements. The transition from simultaneity to succession within a state and the layering of the state in the graded revival of past states, i.e., the orderly regress from a prior object to a present image, transposed to a temporal series within the virtual present, is the basis of serial order in memory and perception (Pąchalska, Kaczmarek & Kropotov 2014).

**CONSCIOUS AND UNCONSCIOUS**

On the microgenetic account, consciousness is always preceded by, and enfolds, an unconscious transition, so that an attenuated mental state could exist without reaching the stage of consciousness. For most psychologists it is the other way around, i.e., experience first passes through consciousness in order to be revived in the unconscious. A memory is the record of a perception, as the imagery of a dream is a memory (true or distorted) of prior conscious experience. On this view (which is not uncommon among those hostile to psychoanalytic excess, in which content in the un-conscious is dependent on, is a copy of and secondary to consciousness, without which, qua unconscious, it would not exist), the unconscious is merely a physiological storehouse of past conscious experience.

For microgenetic theory, unconscious memory underlies and is antecedent to conscious experience (see Fig. 4). Consciousness is an endpoint of an unconscious process – actually, a relation of early to late phases in this process (see: Pąchalska, MacQueen, Brown 2012a). An image develops out of memory to externalize as an object, while a perception sinks or decays beneath consciousness. Microgenetic theory holds that the perceptual rim is uncovered to

![Diagram](image)

**Fig. 4.** The transition, or process of becoming, from core (self) to perception (world) frames a mind/brain state. Consciousness is the relation of early to late or depth to surface in this process. Visual and verbal imagery, including conceptual or intentional feeling, arise at intermediate phases, so long as an external world is realized. The arrow represents sensation acting on the phase of imagery to externalize and adapt the state to the physical world. The phase-transition is non-temporal until it terminates. The mind/brain state and immediate present develop in a fraction of a second, replaced by overlapping states.

Source: Pąchalska, MacQueen, Brown (2012b: 683)
reveal underlying memory or dream, as pre-terminal phases re-actualize to varying degrees of completeness and in conformity with immediate experience. In brief, *instead of perception laying down memory, memory lays down perception.* Further, it is essential to avoid a preoccupation with the contents of the unconscious - memories, images, dreams - for it is the process of unconscious mentation, not the content into which the process deposits, that is common to organisms lacking human consciousness. Content varies, process is uniform.

**THE PERCEPTION OF CHANGE**

The shift from cause to effect has usually been postulated as simultaneous, though for some it is successive. Causal sequence in the world is perceived as a transition of a continuous event or event series. If the process account of this shift is correct, i.e., as the appearance of a transition from one conscious endpoint to another, with change occurring in the derivation of the endpoint in an epoch of consciousness, the causal shift would be simultaneous if occurring within an epoch and successive if occurring across epochs.

Not just the simultaneity of the unconscious can be posited, but that of the mind/brain state as a whole, which is simultaneous over the epoch of its existence. Entities have a temporal extensibility over which they become what they are. In the mind, late phases are not the outputs of early ones which, having been traversed, disappear, but rather early phases are embedded in late ones and all phases actualize together on completion of the final phase. There are conditions in which the core might be the endpoint of the state, say when processes mediating subsequent phases are inactive or destroyed, as perhaps in a coma or dreamless sleep (Pąchalska & MacQueen 2008). There are cases in which an intermediate phase actualizes briefly as a pathological symptom, but a phase *in transition* does not exist in isolation. A phase is not a temporal object. An object is the minimal cycle of phases that constitutes one epoch. Thus, a hypothetical atom is not a collection of slices in the orbit of an electron or the sum of its positions at every slice, but is one complete revolution. Existence is all or nothing, and the existence of the all is simultaneous when an entity becomes the being that it is.

If serial order in consciousness is coupled to the phase-transition leading to consciousness, as deduced from the state on completion, with memories of recent events revived in the order of their occurrence - the transition activating earlier, then later phases in memory up to the final perception - the sequence of activation could provide the basis for a *line in time* from the immediate past to the present endpoint (Brown 2005). When we listen to speech or music, the words and tones continue to resonate for some period of time as each new sound is perceived. This is explained by the strength (degree) of revival – usually cast as decay – of preceding states in novel ones. The earlier events are incompletely revived in relation to their pastness or, perhaps, the feeling of the relative pastness owes to the degree of revival. A transition leading through memory to per-
ception that is apprehended as a horizontal sequence from past to present would explain sequencing in action, music, language, in the world and in the mind (see Fig. 5). Since the duration laid down by the phase-transition enfolds the memorial remnants of prior states that provide the posterior boundary of the now, both perceived and remembered event-series fall within the present duration. In that this account explains order in both memory and perception, it has a parsimony not found in rival theories (Pąchalska, MacQueen, Brown 2012b).

As mentioned, the mental state lays down serial order, yet has a spatial character, actualizing as an epochal whole. The simultaneity or spatial totality of the present epoch distributes into the order it realizes. Regardless of whether temporal order in a mental state develops from the totality of an epoch or an iteration of totalities, in the transition from initial simultaneity (core), through the before and after of the phase-transition, to the now that arises with a conscious endpoint, the state incorporates three modes of time-discourse:

- simultaneity, which entails temporal thickness or extensibility;
- physical passage in the becoming of the mind/brain state, which gives the mind but is itself mind-independent;
- a subjective present (past, future) that gives being or existence to the transition.

The simultaneity (1) that is the spatial whole of the core, or the epoch it generates, leads to and embraces a transition over phases (2) that is the bridge to...
temporal order. This transition, and the duration of the present that is its outcome (3), corresponds to the two series of McTaggart (1927). Since the transition does not exist until it is complete, at which point the entire transition actualizes, every temporal moment or mind/brain state – whether a static picture or an event-sequence – occurs against a backdrop of simultaneity.

Ordering depends not on perceived succession but the implicit role of succession in the layering of memory and the *replacement* of one state by the next. But is it possible that serial order is just the perception of linkage made fluid by the rapidity of shifts? This assumes that a mental state, as an epochal whole, is simultaneous through its phases, with change in the causal shift from one epoch to the next, i.e., in the linkage of states, not their replacement or overlap. We are conscious of the final contents of a state, not the transition from state to state or depth to surface, nor are we aware of interstices in the linkage. Even if temporal order is not dissociable from oncoming and antecedent states, any account based on rapid succession must return to events *within* the state itself.

Consider the phase-transition *within* the state in relation to replacement *across* states. If order is laid down in the distribution of spatial objects, or if it is derived serially from the outpouring of the core, the array of objects in the world would be a static grouping with a leading edge of change, i.e., micro-events fused to an event-sequence in the overlap. An object would then be an incipient event that becomes continuous when the next state appears. The perishing of the state would support the anticipation of the next and avoid reality appearing to the mind as a stroboscopic succession of pictures. If the clock duration of a mental state (say, 50-100 milliseconds in norm) is insufficient to generate serial order within the state, like the flash of a tachystoscope (stroboscope), it might permit a perception of forward momentum. Order and continuity would then depend on the overlap of recurrences.

Is conscious succession – the sequence of events in observation, or the motion of the world in perception - an illusion of causal transition? Is it like the *phi* phenomenon, in which illusory change results from the rapid replacement of static images? A series of causal pairs may explain fusion from one state to the next, but not the memory of preceding pairs to give a continuous event or narrative. In a motion picture, the impression of continuity in the viewer's mind requires a frequency of around 40 milliseconds per frame, which is close to the estimated duration of a mental state, thus the rate postulated for the replacement. This rate is likely governed by a pacemaker and is relatively constant, but there are individuals with brain damage in whom events appear to be speeded up or slowed down. The acceleration and deceleration of events in pathological cases, as in the speed of a film projector, might reflect the frequency of replacement (Pachalska, Kaczmarek & Kropotov 2014; 2017).

The conclusion of this line of thought is that states are not concatenations of stochastic images, but rather superimpositions on the remnants of predecessors that are embedded as memorial residues (Fig. 5). The graded decay of memory is its graded revival in conformance with the occurrent state.
In order to understand temporal order in perception, it is essential to understand the relation of perception to memory, with special attention to working memory. An incomplete perception has the character of a memory. The decay of perception to working memory, which is dogma in psychology (see: Baddeley 2003) is ordinarily conceived as the transfer of perception to a store that retains many of the physical features of the original stimulus. One problem with this theory is that it posits a trace that is degraded rather than one that is incompletely revived. The persistence of a dead past is the heart of the problem under study. As soon as an object is past, it no longer exists except as an echo in memory. The concept of perception as externalized memory, or forgetting as incomplete revival, puts the relation of memory and perception in a different light. On this view, the transition is from long-term to working memory to perception. The trajectory is the opposite of that assumed in psychology. A perception grows out of phases in memory uncovered as incomplete recurrences within a momentary actuality.

The claim here is that serial order in memory underlies serial order in perception. The recall of the order of past events, so-called episodic memory, develops in a setting (some would say out of a store) that is simultaneous until it partitions (Brown 2005). Whether memories are conceived as associative chains, circuits, networks or configural potentials, whether they are localized or distributed, until they are activated they are dormant possibilities, not actualities or existents. An event in memory is a potential for activation (Kropotov 2009). The search for the memory store, trace or engram, has a long and disappointing history. This is because the accuracy of recall is determined by the extent to which the phase-sequence of the initial encounter is revived. In what other sense can we even write of the existence or temporal location of the memory of a long-forgotten face that is suddenly revived in a chance encounter?

In what sense is a memory in the brain waiting to be activated? On the other hand, how does something come into existence from non-existence?

A difference between episodic memory, in which an event is ordered in time, and semantic memory, which is for knowledge rather than events, that is, for thought or language rather than perceptual experience, is that episodes become parts of categories, shifting their allegiance from occurrence to family resemblance (Pąchalska, Kaczmarek & Kropotov 2014). An event absorbed in a category, say by repeated exposure, loses its exceptionality. The recurrence strips the event of episodic context for the relational system of thought. If we travel a certain route only once, we may remember it as an event in time. If we travel the same route every day, it becomes part of our knowledge, and is recalled as a specific occasion only if something unexpected happens. The unexpected creates novelty by decontextualizing an event from a family of like-occurrences.

The temporal locus of a memory can be accurate in immediate recall, as in hearing and recalling a telephone number, but even here it is imperfect, and it becomes more fallible over time. In amnesia, with the shrinkage of past (and
Do events in episodic memory have markers or relational indices of the perceptual history of their occurrence? To assign a temporal tag to events, or postulate a scanning device Lashley (1951) offers a mechanism as much in need of explanation as what it purports to explain. In citing the Würzburg school, Lashley implied a hierarchic system of unconscious schemata or constructs out of which serial order of mental process develops. His example of the final word of a lengthy sentence disambiguating the meaning evoked the problem of languages such as German, in which a sentence may not be understood until the final verb (see also Tulving 2002). This suggests that an episodic sequence in memory, i.e., the temporal order of past events in a mental state, or the basis on which we say A came before B, and B before C in the past, is the same problem as the temporal order – A, B, C - of ongoing experience (Fig. 6).

The early unconscious phases associated with long-term memory, character and the self are revived in the oncoming state before the present state concludes. Since the epoch does not exist until the transition is complete, phases trailing in the derivation would recur in the forward edge of the overlap, indeed, these phases would be continuously modified by ensuing states before they become actual4. This is a solution to the non-existence of the unconscious, for while un-

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4 William James (1890) was the first to postulate overlap in the succession of mental states, which he termed pulses of cognitive consciousness. If the overlap is for early phases, later ones will perish before the tip of the oncoming state arrives (see: Fig. 3).
Conscious phases never exist, they are constantly being replaced before existence is possible, while conscious phases exist but are continuously perishing. The paradox is that the non-existent survives and is perpetually transformed, while existents are novelties that do not mutate, for they are replaced as they arise (Brown 2017).

Pąchalska, Kaczmarek and Kropotov (2014), on the basis of neurophysiological findings, stated that within the working memory buffer, breaking through the time from unconsciousness to the consciousness, imagined notions - more or less distinct – are fractally organised into a clearer vision of the image (see Fig. 7 bottom). These mental states arise several times from undisclosed processes, with the use of working memory, perception and imagery (see Fig. 7 top), to the threshold level of consciousness (admission), proceed to exceed this threshold (development) and then rise even higher to the manifestation of full consciousness and the conscious imagining of the work (culmination). For example, in the case of visual art, once a vision emerges from which the artist (the conscious Self) is satisfied to a degree, one which ensures the so-called reward system (see Pąchalska, Kaczmarek and Kropotov 2014), the transition from thinking to action begins. Initially, a sketch is born in which the artist paints various visions of the object/subject to be painted.

Fig. 7. How the image is created
At this time the brain performs a series of complex operations confronting what is already drawn or painted (perception), with an image that is not yet there, but is planned in the mind and is to be painted (imagination) and which is saved for a short time and yet still verified in the buffer memory (working memory) (see Fig. 7). The creative process can now proceed further.

EMOTION

The problem of how emotion relates to thinking, the “heart” to the “head,” is a perennial one in psychology. Freud (2004) promoted the view that conflict arises within the psyche between that which one wants to do (drive, feeling) and that which one thinks or knows one should do (conscious thought, moral values). In many ways, one might even say, his “discovery” of the unconscious was an attempt to solve this old problem rather than to pose a new one. More recent psychological theories, by reducing the phenomenal field down to behaviour or information processing have submerged or marginalized the problem of emotion, which is left to more psychotherapeutic theories and humanistic psychology. The latter, in turn, implicitly or explicitly view thinking as a barrier to (healthy) feeling, and we are back where we started, with the valences reversed (Pąchalska, MacQueen, Brown (2012b).

Microgenetic theory – and this has been implicit in much of the foregoing discussion – places emotion almost literally in the centre of the process by which drive articulates into objects and acts. The role of emotions is illustrated in Fig. 8.

First, there is pure subjectivity: a core self that wants to survive and strives to avoid pain and discomfort. Then, at the instinctual core, a core or unconscious (Ucs) self forms, and gradually there is opposition between the subject and the objectified portion of the subjective field, i.e., a core subject at one pole, and at the other, the object world, but the object world is not the world of outer events but the objectified segment of a subjective field. Then, out of the Ucs core, a Cs self develops, with an articulation of inner and outer space. Inner space partitions to the Cs self and images. Outer space (that is, the objectified part of the subject’s field) also undergoes partition to objects and their affective tone.

An emotion, from the microgenetic perspective, is an inner or subjective feeling, generated by the same process that deposits or actualizes an act or object, namely, the micro-temporal process that leads from the archaic core of the mind/brain state to its outcome at the neocortical surface. The development of an object, action or thought creates feeling within the developmental process. This process, along with the feeling that is its manifestation, constitutes the becoming of the object, while the final object, idea or memory that “contains” the process leading to it is its being, i.e., the epoch or category that enfolds the feeling. The process that generates a mental content, including perception, creates an internal feeling that, with intense emotion, can spill over to external physiology. The relation of feeling to the final object depends on the phase in the process that receives the major emphasis in the transition. The quality and the intensity of an emotion are determined by an emphasis at a given level and the context
at a phase within the actualization process. According to the phase that is dominant for a given cognition, there is a different emotion and a different intensity. In general, enhancement at a deep or early phase gives strong emotions in relation to core needs, while enhancement at a terminal or surface phase gives emotions referred to the object, such as value or worth. At intermediate phases, one has emotions within the category of desire (want, wish, like, dislike, hope, fear, etc.). At an early phase, emotion discharges in the body. At an intermediate phase the emotion, though internal, is directed to a pre-object or image. At a distal phase, the emotion is referred to, *is ingredient in*, the external object (Pačhalska, MacQueen, Brown 2012a).

Roughly, microgenetic theory looks at perception as a temporally evolving process in which a current instant of perception grows out from the preceding one and is a part of the following one (see. Fig. 5,6,8).
Here we present neurophysiological data that enable us to unfold the dynamics of perception into spatially and temporally separate components.

WHAT IS KNOWN FROM NEUROSCIENCE

We start with what is already known regarding perception from the neuroscience point of view. Knowledge about brain mechanisms of perception comes from psychophysical studies (such as measuring reaction time in respond to visual stimuli, analysis of different visual illusions), neuropsychological studies (such as assessing visual deficits after local brain damage in patients and in animals), neurophysiological studies in animals (such as recording single neuron activity and local field potentials in response to visual stimuli), and neurophysiological studies in man (such as analyzing fMRI and ERPs) (see: Kropotov 2009, 2016; Pąchalska, Kaczmarek, Kropotov 2014, 2016).

Briefly the neuroscience basis of visual perception can be formulated as follows: damage to the lateral and inferior temporal areas leads to visual object agnosia whereas local lesions in occipital-parietal cortical areas produce optic ataxia, simultagnosia and visuospatial neglect (Pąchalska, Kaczmarek, Kropotov 2014, 2016). These differential visual impairments suggest two functionally specialized pathways: the ventral and dorsal streams. Single-unit recording studies in animals show increase of visual receptive fields as well as increase in selectivity of neuronal responses to complex object features in the ventral stream (Kropotov 2009; 2016). Responses of many neurons are invariant over various transformations such as retinal position, size etc. In contrast, the dorsal stream is associated with representation of spatial relationships between objects as well as their relationships with the subject. Despite functional segregation the two streams are interconnected and form a joint network in organizing perception.

The two streams spatially diverge from the striate cortex, which receives the feed forward input from the thalamus. However the thalamic input constitutes only a small fraction of the whole synaptic connections in this area while most of synapses are formed by long distance connections from multiple sources (Douglas & Martin, 2007; Kropotov, Ponomarev, Hollup et al. 2011).

ERPS DATA: LITERATURE SEARCH

ERPs data support the neuroscience idea that information processing in the ventral and dorsal visual streams is formed by feed forward (bottom-up) and feedback (top-down) projections from higher order cortical areas including the frontal lobes. For example, (Foxe & Simpson, 2002) provided evidence that the widespread system of sensory, parietal, and prefrontal areas is activated in less than 30 ms (with shorter latency of the dorsal stream activation in comparison to the ventral stream) suggesting that the P1 and N1 waves of ERPs reflect relatively late processing, after the initial volley of sensory afference through the visual system and involving top-down influences from parietal and frontal regions.
However, each ERP wave represents a sum of potentials generated by several spatially and temporally distributed sources (Kappenman & Luck, 2012). In order to separate such sources a group independent component analysis can be applied to the collection of ERPs obtained in a large number of subjects performing a visual discrimination task (Kropotov & Ponomarev2009; Pachalska, Łukowicz, Kropotov et al., 2011). The data were obtained in 1000 healthy subjects within the frames of a HBI database project (Kropotov & Mueller, 2009; 2012). These data provide a unique possibility to dissociate different temporal stages of information processing in the ventral and dorsal streams.

### GROUP INDEPENDENT COMPONENT ANALYSIS: METHODOLOGY

The goal of Independent Component Analysis (ICA) applied to a large collection of ERPs is to utilize the differences in scalp distribution between different generators of ERP activity to separate the corresponding activation time courses (Makeig, Bell, Jung et al., 1996).

We presume that the locations of the main sources of ERP are relatively stable across a normal population but amplitude and latencies of the sources vary substantially. The components are constructed by optimizing the mutual independence of all activation time curves, leading to a natural and intuitive definition of an ERP component as a stable potential distribution which cannot be further decomposed into independently activated sources.

In our approach ICA was performed on the full “ERP scalp location” multiply by “Time series” matrix. Assumptions that underlie the application of ICA to individual ERPs are as follow (Makeig, Bell, Jung et al., 1996; Onton & Makeig, 2006):

1. **summation of the electric currents** induced by separate generators is linear at the scalp electrodes;
2. **spatial distribution of components’ generators** remains fixed across time;
3. **weights of components vary independently** across different task conditions and across different subjects.

Briefly, the method implemented is as follows: The input data are the collection of individual ERPs arranged in a matrix $P$ of 19 channels (rows) by $T$ time points (columns) in which $T$ is a product of $N$ (the number of subjects) and the number of time intervals in the epoch of analysis for the two task conditions. The ICA finds an “unmixing” matrix $(U)$ that gives the matrix $S$ of the sources (ICs) when multiplied by the original data matrix $(P)$,

$$S=UP$$

where $S$ and $P$ are $19\times T$ matrices and $U$ is $19\times 19$ matrix. $S(t)$ are maximally independent. In our work matrix $U$ is found by means of the Infomax algorithm, which is an iteration procedure that maximizes the mutual information between $S$.  

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According to the linear algebra,

\[ P = U^{-1}S, \]

where \( U^{-1} \) is the inverse matrix of \( U \) (also called the mixing matrix), and the \( i \)-th column of the mixing matrix represents the topography of \( i \)-independent component; \( S \) represents the time course of the \( i \)-independent component.

The ICA method (Makeig, Bell, Jung et al., 1996) was implemented in the analysis software written by V.A. Ponomarev. The topographies and activation time courses of the components were tested against the corresponding results obtained by means of “InforMax” software in EEGLAB, a freely available interactive Matlab toolbox for processing continuous and event-related electrophysiological data (http://sccn.ucsd.edu/eeglab). The topographies of the independent components are presented as topographic maps, while the time courses of the components (also called “activation time courses”) are presented as graphics with time corresponding to the \( X \)-axis.

In this paper we are going to focus on ERP components associated with stages of visual processing. We designed two types of the cued GO/NOGO task. In the first experimental condition stimuli were images of plants (\( P \)) and animals (\( A \)) presented in various pairs such as: \( A-A, A-P, P-P \) trials with instruction to press the button as fast and as precisely as possible to the \( AA \)-pair. In this task \( A-A \) pair is the Match condition and \( A-P \) pair is the Mismatch condition. In the second experimental condition stimuli were images of angry (\( AF \)) and happy (\( HF \)) faces presented in various pairs such as: \( AF-AF, AF-HF, HF-HF \) trials with instruction to press the button as fast and as precisely as possible to the \( AF-AF \)-pair, so that the \( AF-AF \) pair is the Match condition and the \( AF-HF \) pair is the Mismatch condition. The interstimulus interval within pairs was 1000 ms, the interval between trials was 3000 ms. The number of healthy subjects that participated in the first experiment was 247, the number of subjects that participated in the second experiment was 143. The age of the subjects varied from 17 to 50 years old.

GROUP INDEPENDENT COMPONENT ANALYSIS: RESULTS

The application of ICA to a collection of GO/NOGO ERPs in contrasting Animals/Plants, and Angry/Happy faces enabled us to separate seven independent components explaining more than 90% of the signal variance. Here we confine analysis with 4 components generated correspondingly in occipital, temporal, parietal and prefrontal areas (Fig. 9).

The occipital component (Fig 9 top) is generated in the primary and secondary visual cortical areas. This component appears to reflect the fastest information processing in the cortex. Indeed this component reaches its first positive peak as fast as 96 ms both for the presentation of Animals and Faces. The time dynamics of this independent component resembles the conventional visual P1/N1 component.
waves commonly found in visual recognition tasks (see, for example, Hillyard, Anllo-Vento, 1998). The Mismatch – Match difference shows two peaks at 150 and 240 ms for both conditions. Amplitude of the component in the Match condition is higher for faces, but the Mismatch – Match difference wave is smaller for faces. The time course of the component appears to reflect two stages of the category discrimination operation (see also Kropotov2009; 2016).

The left temporal component (Fig. 9 bottom) is generated in the left temporal cortex. A symmetrical right temporal independent component has similar properties and is not presented here as a result of a lack of space. The positive fluctuations of the left temporal component in both conditions show two peaks with latencies at 120 and 240 ms respectively. These positive fluctuations are followed by negative fluctuations with peak latencies at 170 ms and 300 ms respectively. The temporal independent components appear to correspond to bilateral occipitally-temporally distributed N170 waves described in numerous studies on the ERP correlates of object processing in visual recognition tasks (Itier & Taylor, 2004). The Mismatch – Match difference wave shows two peaks at 160 and 260 ms. These peaks are differently modulated in Animal/Plant and Angry/Happy
face conditions: the first peak disappears while the second peak just slightly decreases in amplitude. The temporal component represents information processing within the ventral visual stream and is associated with the process of comparing the current stimulus with the working memory (see Kropotov 2016; Pąchalska, Kaczmarek & Kropotov 2017). As shown in this study the comparison operation evolves in two different stages: the rough comparison of physical properties at the first stage is followed by more detailed (including behavioural meaning) comparison at the second stage.

Completely different information processing takes place in the dorsal visual stream. This is represented by the parietal component (Fig. 10 top). This component is generated in the parietal cortex. It shows a strong positive fluctuation in the Match (GO) condition. This late positive wave is absent in the Mismatch (NOGO) and is associated with action initiation. Our data support the neuroscience fact that one goal of information processing in the dorsal stream is to be involved in action initiation.

The frontal component is generated in the anterior cingulate cortex. The temporal pattern of this component is different from that found in the ventral and dor-
sal streams (Fig. 10 bottom). The Mismatch condition in Animal/Plant or Angry/Happy face contrast is produced almost identically in amplitude and latency negative fluctuations with a peak latency of 280 ms. The component reflects some non-sensory operation which takes place 20 ms after the comparison operation in the ventral visual stream. We can speculate that this component reflects the action monitoring operation (for experimental data in support of this suggestion see Brunner, Hansen, Olsen et al. 2013).

CONCLUSION

This study is one of a few attempts that experimentally tests the basic premise of microgenetic theory: the existence of recurrent stages of information processing. The application of an Independent Component analysis to a collection - of substantial number, of individual multi-channel ERPs in two variants of the cued GO/NOGO task enabled us to decompose the ERP waves during the initial 300 ms into functionally distinct components. According to sLORETA these components are generated in the occipital, left and right temporal, parietal cortical and frontal areas. The temporal component reflects information processing in the ventral visual stream. This is associated with two sequential activation patterns. Each activation pattern includes a positive wave followed by a negative wave. In the Mismatch condition the positive peak is followed by an additional positive fluctuation which reflects the comparison operation. At the early stage the additional positivity is associated with comparing the physical features of the stimuli with the memory trace. At the late stage the additional positivity at the left temporal component is associated with the operation of comparing semantic features of the stimuli with the working memory. This operation seems to initiate the conflict monitoring operation taken place in the anterior cingulate cortex. The latest stage of information processing in the dorsal stream is associated with action initiation.

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