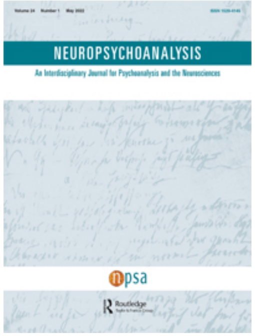

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Are object relations temporal? From the brain's intrinsic neural timescales over temporo-spatial alignment to object relations

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COMMENTARY

Are object relations temporal? From the brain's intrinsic neural timescales over temporo-spatial alignment to object relations

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ABSTRACT
What are object relations? Otto Kernberg raises this question and addresses it in an excellent way recruiting much of current neuroscientific literature. There is a yet deeper dimension, the brain's inner time. Inner time means that the brain constructs its own inner timescales: it has various timescales in its neural activity through which it processes external inputs – the external inputs are thus "filtered" through the brain's various timescales. The brain's timescales are described as "intrinsic neural timescales" (INT) which can be measured by the degree of the correlation of the signal with itself, i.e. autocorrelation window (ACW). The term window describes it well: the brain has several temporal windows through and by means of which it processes and relates to external inputs which, on the psychodynamic level, surfaces as object relations.

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From the brain's intrinsic neural timescales to input processing

Let us better understand the brain's INT. Our environment bombards the brain with a variety of regular and irregular inputs on different timescales. Consider one of the temporally most complex inputs, music. We are able to simultaneously perceive the music's different timescales and, even better, are able to integrate them into one meaningful whole like a melody which, moreover, can be distinguished from the ongoing accompaniment in the background. How can our brain process and integrate such multi-scale inputs? Recent evidence suggests that the brain itself exhibits "intrinsic neural timescales" (INT) (Honey et al., 2012; Golesorkhi et al., 2021a, 2021b; Wolff et al., 2022).

Measured by the autocorrelation window (ACW) (Golesorkhi et al., 2021a, 2021b) the brain exhibits temporal windows (INT) of different lengths or duration in the resting state. Interestingly, unimodal regions like primary sensory cortices show shorter ACW while transmodal regions such as DMN display longer timescales, i.e. long ACW. Hence, the temporal distinction of shorter and longer timescales converges with the spatial topography of uni- and transmodal regions amounting to a core–periphery organization.

What is the role of the brain's INT? A variety of studies by the group around Hasson demonstrated that longer and shorter timescales are related to corresponding temporal differences in the input sequences (Hasson et al., 2015); for instance, single tones are related to neural activity in the unimodal primary auditory cortex while sequences of tones and a whole melody are more related to neural activity in transmodal higher-order regions with the DMN at the top of the hierarchy (Hasson et al., 2015). They, therefore, characterize INT as "temporal receptive windows" as they receive and organize the input sequences by temporal segmentation. This is quite compatible with a recent study showing that the INT change during the transition from rest to task by showing task-specific effects in both uni- and transmodal regions.

Together, these findings suggest a key role of INT in the brain's input processing (Golesorkhi et al., 2021b) and, more generally, the brain's encoding of its external context. The brain's encoding strategy may thus be primarily temporal as based on the brain's INT. Through its own INT, the brain formats the input stochastics in a temporal way through which it encodes the multitudes of inputs in their temporal sequence, i.e. temporal stochastics. This means that the INT encode sequences of inputs including their stochastic relationships in a relative way, i.e. difference-based coding (Northoff, 2014a, 2014b): each single input is encoded relative to, i.e. in difference to the other inputs. The other inputs thus provide the temporal and stochastic context for the single input as content.

From the brain's intrinsic neural timescales to projection in schizophrenia

The content is encoded by the INT in such way that it is intrinsically related to its context. Such difference-based

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coding must be distinguished from another possible encoding strategy, namely stimulus-based coding (Northoff, 2014a, 2014b). In that case, the single input is encoded in an absolute way, as stimulus or input by itself in isolation from the other inputs/stimuli. However, that is not empirically supported by the data (Northoff, 2014a, 2014b) nor is it compatible with the temporal windows of the INT (as these lump or pool and thus relate distinct inputs together; Golesorkhi et al., 2021b). In sum, input encoding and processing as mediated by INT is intrinsically contextual.

The contextual character of input processing as mediated via INT converges well with object relations. Objects are singled out but are related to the ego/self within and through the context they occur. It is the contextual embedding of the object that first and foremost makes possible object relations. Are object relations related to INT and its input processing? No direct support for that can be given currently. However, some indirect support comes from psychiatric disorders like schizophrenia.

Schizophrenia can be characterized by loss of object relations (see also the target paper by Kernberg 2021, in this issue) and abnormally increased projection (see below for more details). These patients are not able to experience and perceive the contextual embedding of inputs and ultimately of external objects. As a consequence, they increase the projection of their own internal self onto the external objects. Is such an abnormal increase in projection with the loss of object relation associated with changes in the brain's INT?

One recent study in schizophrenia including mostly post-acute first-episode subjects showed abnormally long ACW (and high PLE) in several electrodes during a task state involving self-specificity (i.e. enfacement task) (Northoff et al., 2021). They also demonstrated that the degree of change in ACW from rest to task was significantly lower in schizophrenia subjects; that is, unlike in healthy subjects, they barely shortened their ACW during the task. Most remarkably, analogous ACW prolongation during task and its reduced rest-task difference was not observed during a non-self task, i.e. auditory oddball – this suggests a close relationship of ACW with self-specificity as observed in healthy subjects. Moreover, applying a moderation model, they showed that the degree of ACW mediated the relationship between self-disturbance and negative symptoms in schizophrenia participants. These data support the assumption that changes in intrinsic timescales may be related to psychopathological symptoms and, more generally, be relevant for projection and loss of object relations.

From the brain's intrinsic neural timescales to object relations

Together, the neuroscientific findings show decreases in different temporal features of external input processing including temporo-spatial alignment with input processing and differentiation. Importantly, these findings point to a temporal deficit in the neural activity during external input processing: neural activity is no longer temporally organized in a coherent and coordinated way which makes it impossible to phase synchronize to and temporally integrate external inputs (Wolff et al., 2022). As a consequence, neural activity related to external (and ultimately also internal) inputs is temporally fragmented – this is manifest psychologically in the experience of temporal fragmentation (Arantes-Gonçalves et al., 2021).

The loss of input processing is related to what psychodynamically is described as the "loss of object relation" as based on decreased investment of energy (cathexis), i.e. "decathexis of objects" (Hartwich & Northoff, 2018; Northoff, 2011). This has already been pointed out by Freud himself in his famous case of Schreber: "The patient has withdrawn from the people in his environment and from the external world generally the libidinal cathexis which he has hitherto directed onto them. Thus everything has become indifferent and irrelevant to him" (Freud, 1911, p. 74) (see also Hartwich and Northoff in Boeker et al. 2018, p. 184ff for different notions of cathexis in schizophrenia).

The loss of object relations carries major psychopathological implications. If one can no longer perceive externally-oriented contents in a synchronized and integrated way, one's perception turns inwards to internally-oriented contents like delusions and hallucinations: these are the internal substitutes of the missing external perceptual contents the schizophrenic patients assume to be out there in the external world – they are internal "paraconstructions" of a lost external world (Hartwich and Northoff in Boeker et al. 2018, p. 184ff). "Para-constructions" can be viewed as redirection of the cathexis from the external to the internal objects – this is manifest in increased projection of one's own internal self/self-objects to the external environment as in hallucination and delusion.

Conclusion

What does this tell us about object relations? The key role of INT suggested here and thus the brain's inner time does not stand in contradiction to the excellent description of object relations by Otto Kernberg (2021). Instead, it singles out a deeper layer of the brain featured by its inner time, i.e. INT, that first and foremost makes possible the brain's alignment to its external environment as a necessary condition for possible object relations. Such inner-outer temporo-spatial alignment of the brain to its external environment, in turn, can then yield the kind of inner affective and drive processes Kernberg describes so well. Moreover, such temporal underpinning of object relations further supports the need to develop a spatiotemporal account of the neuronal basis of psychodynamic features. Specifically, we assume that such "Project for a Spatiotemporal Neuroscience" (Northoff & Scalabrini, 2021) will be able to link brain and psyche by their shared temporal and spatial features, i.e. topography and dynamic as their "common currency" (Northoff et al., 2020).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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