



An Integrative Model of Psychotherapeutic Interventions Based on a Predictive Processing Framework

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Abstract

There are numerous approaches to psychotherapy with distinct underlying theories. Yet, it is unlikely that any of these is conclusive because they broadly yield similar therapeutic effects. A different approach attempts to derive the common factors from the specific treatments and proposes that these common factors primarily promote therapeutic effects. But although generally promising, these common factors have not been integrated into a more fundamental explanatory framework that also considers the effectiveness of specific factors. Therefore, an integrative model of psychotherapeutic interventions is still missing. The aim of this paper is to help fill that gap by applying the theory of predictive processing to interventions from various psychotherapeutic approaches, including cognitive behavioural therapy, client-centred therapy, and psychoanalysis. The analysis results in the predictive processing model of psychotherapeutic interventions (3PI model for short). The new model reveals that psychotherapy comprises two main functions: to provide a safe and positive environment to which the patient can adapt, and to facilitate the process of updating a dysfunctional generative model. Further, it shows that common factors primarily promote the first function, while specific factors mainly support the second function, offering a new perspective to the debate on common and the specific factors.

Keywords Psychotherapy · Predictive processing · Common factors · Specific factors · Psychopathology

Introduction

In 2012, the American Psychological Association (APA) passed a resolution recognizing the effectiveness of psychotherapy (APA, 2012). The resolution begins with a definition of psychotherapy adopted from the Norcross (1990), saying that psychotherapy is the informed and intentional use of clinical methods and interpersonal attitudes derived from established psychological principles for the purpose of helping people change their emotions, cognitions, behaviours, and/or other personal characteristics in directions that the participants consider desirable. The resolution then cites

a large number of studies showing that psychotherapy works for various diagnostic conditions and for all age groups (i.e. children, adults, and older adults). To highlight two findings: (1) across studies, psychotherapy has an average effect size of about 0.80, which is a large effect size in the behavioural sciences (Wampold, 2010; Wampold & Imel, 2015); and (2) the average client who receives psychotherapy is better off than 79% of the clients who are not treated (Campbell et al., 2013; Prochaska & Norcross, 2013).

So, with this resolution, the APA officially recognized that while psychotherapy does not work perfectly or with all clients, it is remarkably effective. However, the resolution is silent on why psychotherapy is effective. More specifically, it is silent on what the therapeutic mechanisms are behind the effective clinical methods and interpersonal stances derived from established psychological principles. In fact, in the psychotherapeutic field, we find different approaches derived from different theories that postulate different therapeutic mechanisms. It is interesting to note, however, that despite their different and sometimes even conflicting theoretical underpinnings leading to specific factors (i.e. interventions specific to one approach), these approaches often

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produce similar therapeutic effects – a finding that has come to be known as the dodo-bird verdict (Wampold & Imel, 2015). The APA (2012) resolution also makes a brief reference to this finding when it states that variation in outcomes is influenced more by patient characteristics as well as clinician and contextual factors than by specific diagnoses or specific treatment ‘brands.’

Because of the dodo-bird verdict, some authors have argued that the specific factors of psychotherapeutic approaches are not responsible for the therapeutic effects (Gaab et al., 2016; Wampold & Imel, 2015). Rather, psychotherapy is effective mainly because of common factors that most psychotherapeutic approaches share but that are usually underappreciated (Gaab et al., 2016; Jopling, 2001). Consistent with such an idea of why psychotherapy is effective are approaches such as the contextual model (Wampold & Imel, 2015), the generic model (Orlinsky, 2009) or the model of Frank (1961), which emphasise common factors. But then again, these approaches have also been subject to criticism. Some authors argue that despite the undoubted importance of common factors, differences between specific factors should not be neglected as some appear to be more effective for particular conditions than others (Mulder et al., 2017).

In addition to the problem of psychotherapeutic approaches underestimating the effectiveness of either common or specific factors, it is also argued that the working mechanisms by which common and specific factors operate are still unclear (Cuijpers et al., 2019). The presumed therapeutic mechanisms of prominent specific factors have been heavily criticised or even empirically disproved (Blease, 2015; Leder, 2017). And while common factor approaches such as the contextual model suggest specific pathways (the real relationship, expectations, and specific ingredients), these pathways have not been integrated into a more fundamental explanatory framework. Taken together, then, what is missing is an integrative model of psychotherapeutic interventions that combines common and specific factors and provides an explanatory framework for both.

The purpose of this paper is to present and discuss how the *predictive processing model of psychotherapeutic interventions* (3PI model for short) may fill this gap. There are three reasons predictive processing is a promising theory to achieve this goal. First, predictive processing has the necessary scope to provide the framework for an integrative model of psychotherapeutic interventions. Second, there is a growing number of studies that examine psychopathologies from a predictive processing perspective (for a review, see Friston, 2023). Third, a few authors have already applied predictive processing on specific psychotherapeutic approaches, such as cognitive behavioural therapy (Barrett et al., 2016; Hauke & Lohr, 2022; Krupnik, 2019) or

psychoanalysis (Holmes & Nolte, 2019; Rabeyron, 2022). Moreover, predictive processing has also been applied to common factors (Krupnik, 2023; Villiger, 2022). However, an integrative model of various common factors and the specific factors of different psychotherapeutic approaches is still lacking.

The paper is divided into three sections: Section “A Unified Theory of Perception, Cognition and Behaviour” introduces the theory of predictive processing; Section “A Predictive Processing Application to Psychopathology” presents research that links predictive processing with psychopathology; and Section “An Integrative Model of Psychotherapeutic Interventions” applies predictive processing to psychotherapy and its common and specific factors, leading to the 3PI model.

A Unified Theory of Perception, Cognition, and Behaviour

When searching for a theory that provides the framework for an integrative model of psychotherapeutic interventions, we first have to define what the framework must include. As mentioned in the introduction, psychotherapy can be defined as a method that aims to modify patients’ perceptions (including emotions), cognitions, and behaviours in directions that they consider desirable. Consequently, the framework must include the following components: (1) the mechanisms behind perception, cognition, and behaviour; (2) an explanation of how these mechanisms can lead to psychopathology; and (3) possible ways to utilise these mechanisms through psychological interventions to achieve therapeutic effects. A theory in cognitive science that has become increasingly influential appears to fulfil those lofty requirements: predictive processing.

Traditionally, the brain has been perceived as a passive stimulus-driven organ. In this view, the visual cortex, for instance, is composed of a hierarchy of neural feature detectors, with neural population responses that are driven by bottom-up stimulus features (Egner et al., 2010). The brain transforms the energetic input from our visual sense into a coherent image through a kind of step-by-step process, beginning with the simplest features that increase in complexity until the picture is complete (Clark, 2015).

Bayesian approaches to brain functioning invert this traditional understanding, suggesting that the brain is not a passive stimulus-driven organ but an active probabilistic prediction machine (Clark, 2016; Hohwy, 2013). Among such Bayesian approaches to the brain, predictive processing is the most influential and best researched one (cf. Friston, 2023). It has been supported by a wide range of theoretical and experimental studies, both with respect to

primary sensory processes (Rauss et al., 2011) and higher-level cognitive processes (Deco et al., 2011), as for example decision-making and naturalistic speech comprehension (Shain et al., 2020). In addition, evidence has been collected with different methods, most commonly with functional magnetic resonance imaging (fMRI), but also electroencephalography (Friston, 2019), transcranial magnetic stimulation (Cretu et al., 2019), physiological recordings of single neurons (cf. Carbajal & Malmierca, 2018), and computational simulations (Wacongne et al., 2012).

How does the brain work from a predictive processing perspective? Instead of using bottom-up sensory input to build a model of what is out there, the brain tries to predict the bottom-up sensory input from its best models of what is likely to be out there (Hohwy, 2013). Consequently, what we perceive is not the direct product of the bottom-up sensory input but the product of recurrent cascades of top-down predictions. These top-down predictions comprise probabilistic expectations which are mostly sub-personal and hierarchically organised, meaning that they track features on different spatial and temporal scales (Clark, 2015). The process is inferential, utilising prior knowledge about the momentary context and the world more generally. In order to determine what we perceive, the recurrent cascades of top-down predictions are compared with the bottom-up sensory input. Possible mismatches that arise from these comparisons lead to prediction error signals which are sent forward, ascending the hierarchy. Such prediction error signals then get minimised by altering the prediction or the sensory input. All these different processes run concurrently and steadily across multiple levels of a processing hierarchy (Clark, 2015, 2016). To summarize, predictive processing describes the brain as a probabilistic prediction machine whose purpose is to continually minimise the mismatch between bottom-up sensory inputs and top-down predictions about these sensory inputs (Clark, 2016; Hohwy, 2013).

A key aspect of prediction error minimisation to explore further is inference. On the one hand, the brain can adjust its predictions and bring them into line with the sensory input. In so doing, it updates its generative model. This process is called perceptual inference. On the other hand, the brain can maintain its original prediction and act on its environment (including the body) in such a way that the altered input becomes consistent with the prediction. This process is called active inference (Pezzulo et al., 2015). It is important to note that perceptual inference and active inference are not mutually exclusive. Which type of inferences applies predominantly in the face of a prediction error depends on the assigned precision of the sensory input and the assigned precision of the prediction. Consequently, a constant second-order assessment called precision estimation is employed when using the acquired generative model.

Precision estimation assigns weighting to various aspects of the incoming sensory signal and to specific predictions at all levels of processing. In turn, the weightings indicate the varying reliability, in context, of the sensory inputs currently available and of divergent aspects of the generative model (Clark, 2015, 2016). Finally, we can describe attention as the process of optimising precision estimates. This is because attention can be thought of as the selective sampling of sensory data that have high-precision (signal to noise) with respect to the model's prediction (Feldman & Friston, 2010). In other words, attention names the process by which organisms increase the weighting on estimated prediction error units that provide the most reliable sensory information regarding a current task, threat, or opportunity (Clark, 2016).

Perception, cognition, and behaviour are profoundly unified and continuous in the theory of predictive processing. All three depend on top-down predictions, bottom-up sensory input, and strategies to minimise prediction error (which depend on the estimated precision assigned to them). Thus, predictive processing cannot only be applied to exteroception (sensory input from outside the body), but also to interoception (sensory input from inside the body). For example, the Embodied Predictive Interoception Coding model outlines this process (Barrett et al., 2016). It proposes that the brain maintains energy regulation in the body efficiently through allostasis, a process that satisfies predictions of the body's needs before they are required. The predictions initiate changes in the body's internal systems. Interoception refers to the sensations that emerge from those changes. Importantly, this includes subjective awareness, feelings, and emotions (cf. Duquette & Ainley, 2019; Seth, 2013).

A Predictive Processing Application to Psychopathology

In the last decade, numerous studies have discussed psychopathology from a predictive processing perspective (for a review, see Friston, 2023). These studies examined mental disorders such as depression (Barrett et al., 2016; Kube et al., 2020), post-traumatic stress disorder (PTSD) (Linson & Friston, 2019), psychosis (Griffin & Fletcher, 2017; Sterzer et al., 2018), autism spectrum disorder (Clark, 2016; Palmer et al., 2017), anorexia nervosa (Gadsby & Hohwy, 2020), and addiction (Miller et al., 2020). This paper will not elaborate on how predictive processing has been applied in each of these specific mental disorders. Instead, this section presents how the mechanisms of predictive processing can lead to psychopathology in a more general sense.

The general idea is that psychopathology represents aberrant belief updating, leading to false inference (Friston, 2023). When examining such aberrant belief updating more closely, we can take two different perspectives. One perspective focuses on mistakes in statistical learning (Gadsby & Hohwy, 2020), while the other perspective focuses on how adaption to an (past) environment leads/led to an inefficient internal model (Barrett et al., 2016). Importantly, these two perspectives (internal vs. external) are not mutually exclusive but ultimately complementary.

Let's first look at where mistakes in statistical learning can be made. When there is a discrepancy between top-down predictions and bottom-up sensory input, the emerging prediction error can function as a learning signal in the revision of the internal model. Whether the prediction error leads to a revision depends on the ratio between two factors. If the brain assigns high precision to a prediction error, it becomes more difficult to characterise the error as mere noise and ignore it. In contrast, when sensory input is perceived as volatile and uncertain, the brain can more easily ignore inconsistencies with the sensory input and stick with the prior prediction. The level of precision of the prediction-generating model is also decisive; the more precise the model is assumed to be, the less likely it is to be updated.

For instance, autism spectrum disorder has been linked to a strong prior prediction for high precision of sensory input (de Cruys et al., 2014) or a strong prior belief in low volatility of sensory input (Palmer et al., 2017). In both explanations, sensory prediction errors are highly weighted. This complicates establishing abstract models because predictions rarely fit the data appropriately. For symptoms associated with psychosis, such as hallucination, the opposite can happen. One hypothesis relates hallucination to overly precise prior predictions that are not sufficiently controlled by sensory input (Clark, 2016; Corlett et al., 2019). However, hallucination has also been connected to weakened prior beliefs (Horga et al., 2014; Shergill et al., 2014). Sterzer et al. (2018) explain this seeming contradiction by suggesting that different prior predictions may be specified for different sensory modalities and their integration. Moreover, the role of weakened and overly precise prior predictions in psychosis may be intertwined with the hierarchical organisation of perception.

Depression provides another example of how overly precise prior predictions combined with attenuated sensory prediction errors can distort statistical learning. The generative model of people with major depressive disorder predominantly predicts negative events and experiences (Rief & Joormann, 2019). The high precision of these predictions makes it difficult to update them by means of contradictory sensory input (i.e. positive experiences). The result is a self-fulfilling prophecy: by predicting that an event will

be negative, the experience will tend to be negative, which in turn confirms the generative model that includes the prediction that the event will be negative (Kube et al., 2020). Furthermore, an additional behavioural mechanism can strengthen prior predictions. Common symptoms of depression are reduced activity and increased withdrawal, which limits opportunities for new sensory inputs to initiate updating of the generative model (Barrett et al., 2016).

While these explanations for depression are grounded in overly precise negative predictions, there is also a route to depressive moods that builds more strongly on the role of sensory input. One proposal suggests that positive emotions contextualise events that resolve uncertainty and confer a feeling of control, whereas negative emotions induce expectations of unpredictability (Joffily & Coricelli, 2013). Accordingly, chronic negative mood can stem from overly high precision in the prediction of a chaotic, uncontrollable world. The sensory input is assessed as being highly volatile (indicating mainly noise) with no basis for inferring patterns that would reduce uncertainty.

As discussed, there are many ways in which statistical learning can go astray and result in a mental disorder. Yet, the erroneousness of statistical learning alone cannot always be attributed to the onset of a mental disorder. In some cases, the environment plays an essential role too. For instance, if you are in an environment that is truly uncontrollable (e.g. being kidnapped, living in a war zone, etc.), high precision in the prediction of an unpredictable world is justified. As a result, negative mood is not the product of a mistake in statistical learning, but an appropriate reaction (which does not make the feelings any less severe). Given the environment remains constant, negative mood is likely to become chronic. However, since this is an expected reaction according to the circumstances, this is not necessarily indicative of psychopathology. Instead, psychopathology may only begin after the environment improved and symptoms did not, meaning that predictions did not (yet) adjust to the new environment (Paulus et al., 2019). Or, if you are exposed to multiple environments (which is usually the case), psychopathology can also begin when you erroneously apply the predictions you learned in an uncontrollable environment to your other, more controllable environments.

How can we explain this context rigidity of predictions? In the uncontrollable environment, minimisation of prediction errors leaves a relatively large error untreated. Therefore, the brain is inefficient at reducing prediction error, implying that it uses an inefficient internal model (Barrett et al., 2016). Over time, this inefficient internal model leaves its neurobiological marks in the brain's structure. As a result, the inefficient internal model is applied in a new/different environment, even though it is not appropriate here. For example, adverse childhood experiences such as neglect

or traumatic events are related to later functional and structural abnormalities in the brain's core networks that predate the onset of depression (Ansell et al., 2012; McLaughlin et al., 2014). These examples indicate that these abnormalities may be connected with uncalibrated predictions (Barrett et al., 2016).

To summarise, predictive processing provides a well-equipped toolbox to describe the underlying mechanisms of psychopathology. Its wide scope as a unified theory of perception, cognition, and behaviour positions it a promising framework from which a principled, unifying nosology can be established (Friston, 2023; Gadsby & Hohwy, 2020; Parr et al., 2018). Accordingly, if predictive processing can help explain the development and preservation of mental disorders, it should also be able to explain how these mental disorders can be treated.

An Integrative Model of Psychotherapeutic Interventions

In the most general sense, from the perspective of predictive processing, psychotherapy should correct aberrant belief updating and thereby facilitate prediction error minimisation. But what does that mean more specifically? The previous section showed that there are two perspectives on aberrant belief updating, leading to two types of (closely intertwined) sources of psychopathology: overly precise prior predictions and rigidity in adjusting to a new/different environment (Paulus et al., 2019). So, psychotherapy must address these two types of sources. Regarding overly precise prior predictions, psychotherapy should aim to help people scrutinise their generative model and thereby weakening the precision of inaccurate and dysfunctional predictions (this is a rather direct way to correct aberrant belief updating). Regarding rigidity in adapting to a new/different environment, psychotherapy should facilitate a safe and positive environment to which people can adapt and thus gradually overcome their inefficient internal model (this is a rather indirect way to correct aberrant belief updating). Of course, these two aims of psychotherapy are not independent of each other (e.g. a safe and positive environment likely supports the critical examination of the generative model). For this paper, however, they are discussed separately. The predictive processing concept of psychopathology and the role of psychotherapy within it constitute the first part of the 3PI model.

As mentioned in the introduction, from a theoretical psychotherapeutic perspective there is an important division into two: common factors and specific factors (Mulder et al., 2017). While common factors are shared across psychotherapeutic approaches, specific factors comprise intervention

techniques that differ between treatments. Common and specific factors can contribute to the environmental and updating aspects of psychotherapy, leading to four combinations. While there are interactions between these combinations, they will not be detailed in this paper. Finally, we will consider common and specific factors from the three major psychotherapeutic approaches (cf. APA, 2009): psychodynamic therapies (especially psychoanalysis), cognitive behavioural therapy (CBT), and humanistic therapies (especially client-centred therapy).

Environment and common factors. Participating in psychotherapy is linked to expectations. Normally, people expect that psychotherapy will have therapeutic effects. The decision to begin psychotherapy itself may therefore lead to a form of remoralisation and the expectation that conditions will improve (Wampold, 2015). In addition to these conscious expectations, the setting (e.g. visiting a psychiatry office, interacting with a doctor, or seeking treatment) is likely to elicit unconscious expectations of remedial effects. Research on placebo effects has repeatedly shown that remedial expectations can lead to self-fulfilling effects (e.g. for a meta-analysis of placebo analgesia, see Forsberg et al., 2017). Interestingly, this is true even in open-label placebo trials, where people know they are taking a placebo (for a review, see von Wernsdorff et al., 2021). So, it seems that open-label placebos can work like deceptive placebos, however, only if people are given a rationale for why placebo effects are powerful (Locher et al., 2017).

Predictive processing has become a widely used model for explaining placebo effects (cf. Milde et al., 2023). If we apply this literature to the way in which expectations can promote therapeutic effects in psychotherapy, we arrive at the following hypothesised mechanism: Psychotherapy increases the precision of predictions of recovery, initiating inferential processes. Incoming sensory input that contradicts dysfunctional predictions is no longer interpreted as mere noise, but as a sign of recovery, resulting in a corresponding experience. Accordingly, dysfunctional predictions are slowly replaced by induced predictions of recovery that include a different sampling of input sources. In addition, predictions of recovery with high precision initiate a self-fulfilling prophecy by active inferential processes that steer perception, cognition, and behaviour to make the predictions come true (cf. Villiger, 2022).

The relationship between therapist and patient is another essential contextual aspect of psychotherapy (Wampold, 2015). Optimally, it radiates safety, confidence, positivity, and support. Several key characteristics of the therapist-patient relationship contribute to this. First, the therapist interacts with the patient in an appreciative, empathic, and caring manner. Second, disclosure of difficult material does not disrupt the social bond. Third, the interaction is

confidential (barring specific statutory limits). Employing these characteristics, the psychotherapeutic setting provides a supportive and controllable environment with minimised uncertainty that often differs from the patient's previous or other environments. Through regular exposure to this environment, the patient can adapt to it; the insufficient internal model stemming from previous uncontrollable environments can slowly be updated and thereby improved. In other words, context rigidity of adverse predictions can be overcome by establishing a context that contradicts previous environments as much as possible. At some point, sensory prediction errors grow large enough to initiate the updating process (cf. Hauke & Lohr, 2022; Villiger, 2022).

The establishment of a controllable and supportive environment can occur in a passive manner (i.e. the framework conditions of psychotherapy) and an active manner (i.e. the techniques employed by the therapist). A subtle way how a therapist can actively enhance the patient's felt controllability is reaching a goal consensus with the patient regarding psychotherapy outcomes or setting up a treatment contract together (Tryon et al., 2018; Yeomans et al., 2017). Both signalise that the therapist does not overrule the patient, leading to a larger sensory prediction error when holding up the prediction of an uncontrollable environment (cf. Krupnik, 2023).

Common ways to demonstrate a supportive environment are mirroring, reformulating, and active listening. Most therapeutic approaches involve at least one of these three related techniques (Weiste & Peräkylä, 2013). Mirroring implies that the therapist selects and repeats a key portion of the patient's utterance (Ferrara, 1994). In so doing, the therapist affirms value to the utterance as something to pursue further. Reformulating occurs when the therapist rephrases the patient's utterances to establish clarity. This allows the therapist to present their understanding of the patient's utterances and provide the patient the opportunity to respond to or confirm understanding (Knol et al., 2020). Active listening, which goes back to Rogers (1951, 1995), is similar to reformulating in that the therapist reproduces what the patient has said. However, unlike reformulating, the therapist paraphrases the patient's utterances in their own words. Regardless of these slight differences, mirroring, reformulating, and active listening have a similar contextual effect: they signal the therapist's desire to understand the patient. Most prominently, this gets emphasised in active listening whose purpose is to show unconditional acceptance and unbiased reflection of the patient's experience. In this way, the patient notices that the therapist is truly interested in them and their problems, is not judgemental, and tries to support them. Through a predictive processing lens, active listening strengthens the prediction of a supportive relationship and safe environment. The same is true in the

case of mirroring or reformulating (although maybe to a lesser extent).

Environment and specific factors. Client-centred therapy is grounded in the environmental aspects of psychotherapy (Rogers, 1951, 1995). In short, it involves the following theory behind psychotherapeutic effects: when a therapist (at least partly) successfully demonstrates (1) unconditional positive regard, (2) empathic understanding, and (3) congruence, then therapeutic effects appear automatically. Therefore, the 'only' objective of a client-centred therapist is to establish and, in this way, expose the patient (referred to as the 'client' in this therapeutic approach) to a controllable, positive, empathic, supportive, and genuine environment. The patient's adaption to this environment then initiates and reinforces self-development. Over time, the therapeutic environment contradicts previous environments extensively enough to initiate the updating of the prior predictions.

The technique of active listening highlights the emphasis of the environment in client-centred therapy. On the one hand, active listening is non-directive; the therapist only paraphrases the patient's utterances, giving the patient full control in directing the conversation. On the other hand, as the term active listening suggests, the therapist signals understanding both through responding and listening. Therefore, the therapist's behaviour demonstrates an accepting, supportive, and controllable environment. As a matter of fact, it could be argued that active listening is not a technique but an attitude. This is different from mirroring or reformulating which are more directive and less comprehensive than active listening. As a consequence, active listening in the Rogerian sense can be regarded as a specific factor for establishing a controllable and supportive environment.

Updating and common factors. Mirroring, reformulating, and active listening do not only have contextual effects; they also help patients delineate their perception of the world and themselves, and thereby clarify the structure of their generative model. Mirroring highlights what the therapist considers the most important elements of what the patient has said, giving more attention to them. Through inquiry and further understanding, the therapist works to extract the generative model to facilitate updating. In reformulating, the therapist attempts to rephrase the patient's experiences in a more precise manner using generic and somewhat abstract psychological terms. Reformulations invite the patient to focus their descriptions more on the subjectivity of their own experience. This may call into question the applicability of the therapist's reformulation, requiring further reflections by the patient about their own experience (Bercelli et al., 2008). The reformulation itself launches an inquiry to scrutinise the patient's generative model. Moreover, the therapist can then continue the inquiry by working with the patient's formulated response (Weiste & Peräkylä, 2013).

In the case of active listening, the therapist points attention to specific aspects of what the patient has told in an indirect way. First, the therapist can hardly paraphrase everything the patient has uttered and therefore has to select and, in this way, highlight certain parts as well. Second, the words the therapist uses when paraphrasing might create new associations in the patient's generative model.

In the just described processes, the focus on and examination of patients' interoception is of particular importance. Giving careful attention to bodily sensations and reactions within the secure space of the therapeutic relationship offers a route to what Duquette and Ainley (2019) call 'mentalising interoception.' Mentalising interoception occurs through interpreting bodily cues, which may be the only consciously accessible aspect of deeply hidden dysfunctional priors. The approach has the potential to update patients' dysfunctional responses to emotions, enhance emotional understanding, reduce cognitive distortions, and foster emotional awareness (see also Duquette, 2020).

Psychoeducation is another common factor with the potential to initiate updating processes. Over the course of the first few treatment sessions, the therapist usually provides an adaptive explanation for the patient's difficulties. The adaptive explanation offers a narrative as to how the patient can overcome or cope with their difficulties. This leads to constructing an expectation that participation in and successful completion of therapy tasks, whatever they may be, will be helpful in dealing with their problems, which strengthens the patient's expectation that they have the ability to do what is needed (Wampold, 2015). Providing the patient an adaptive explanation for their difficulties reinforces a sense of mastery and self-efficacy, which facilitates the initiation of change (Bandura, 1999). In predictive processing terms, psychoeducation raises the precision of predictions comprising manageability and improvement, and reduces that of foreboding predictions. These altered precision estimates have the effect that the world including one's own situation becomes more controllable, which reduces uncertainty. In fact, psychoeducation might have a similar function in psychotherapy as giving a convincing rationale about why placebos work has in open-label placebo studies (Locher et al., 2017).

Updating and specific factors. There are many psychotherapeutic interventions from different psychotherapeutic approaches that aim to help the patient update their generative model through perception, reflection, or action. Let's begin with a prominent behavioural technique utilised in CBT: exposure therapy. Exposure therapy is applied to treat several mental disorders (e.g. generalized anxiety disorder, social anxiety disorder, obsessive-compulsive disorder, PTSD, or specific phobias). In exposure therapy, the therapist guides the patient through increased (mental) exposure

to the stimulus that causes fear or anxiety until those feelings have markedly decreased. The relevant stimulus can be a situation (e.g. sitting in a bus), a thought or memory (e.g. 'If I do not wash my hands again, something bad will happen.'), or interoceptive sensations (e.g. increased heart rate). Gradually, such exposures should attenuate mental disorders until no 'abnormal' anxiety or fear remain (Maercker, 2000). From a predictive processing perspective, the mechanism behind exposure therapy is straightforward. The patient is repeatedly exposed to a stimulus they predict to cause something substantially negative, resulting in fear or anxiety. By persevering, sensory prediction errors indicating that nothing negative is occurring become larger and eventually initiate an updating process. As a result, fear or anxiety decreases.

Techniques such as Socratic questioning or downward error interviewing comprise the cognitive components of CBT (Leder, 2017). Both techniques try to identify dysfunctional automatic thoughts and their underlying core beliefs. Core beliefs are assumed to be at the most basic level of cognitive processing. They filter our sensations and thereby enable us to make sense of them, guiding all cognitive activity (Beck, 1967; Westbrook et al., 2011). Now, in the context of affective disorders, these core beliefs are dysfunctional, leading to a dysfunctional filtering of sensations. Through Socratic questioning and downward error interviewing, the therapist helps the patient access, scrutinise, and update their dysfunctional core beliefs. Updating core beliefs ultimately initiates an update of automatic beliefs (via an update of intermediate beliefs and assumptions). If successful, sensations filter through an updated system that does no longer cause affective symptoms. This theoretical background of CBT aligns well with predictive processing. Core beliefs can be thought of as predictions that have a high degree of abstraction and are therefore at the very top of the processing hierarchy. As a result, they are basic elements of the generative model. Inquiring techniques of CBT help to identify and update these predictions, unveiling their low precision by directing attention to disconfirming evidence.

Mindfulness and acceptance-based interventions are elements of the 'third wave' of CBT (Hayes & Hofmann, 2017). Unlike in the original version of CBT, these interventions do not underscore the content of beliefs and thoughts as the primary cognitive target. Instead, they place emphasis on adapting the patient's reactions to cognitions as they occur, with the goal to 'separate' the self from the thought and decreasing its impact on current psychological functioning (Bissell et al., 2018). In a mindfulness intervention, the patient merely observes thoughts as they come and go without judgment. As this happens, patients engage in mindful awareness of their bodies and environment; for example, patients may concentrate on their breathing, feel

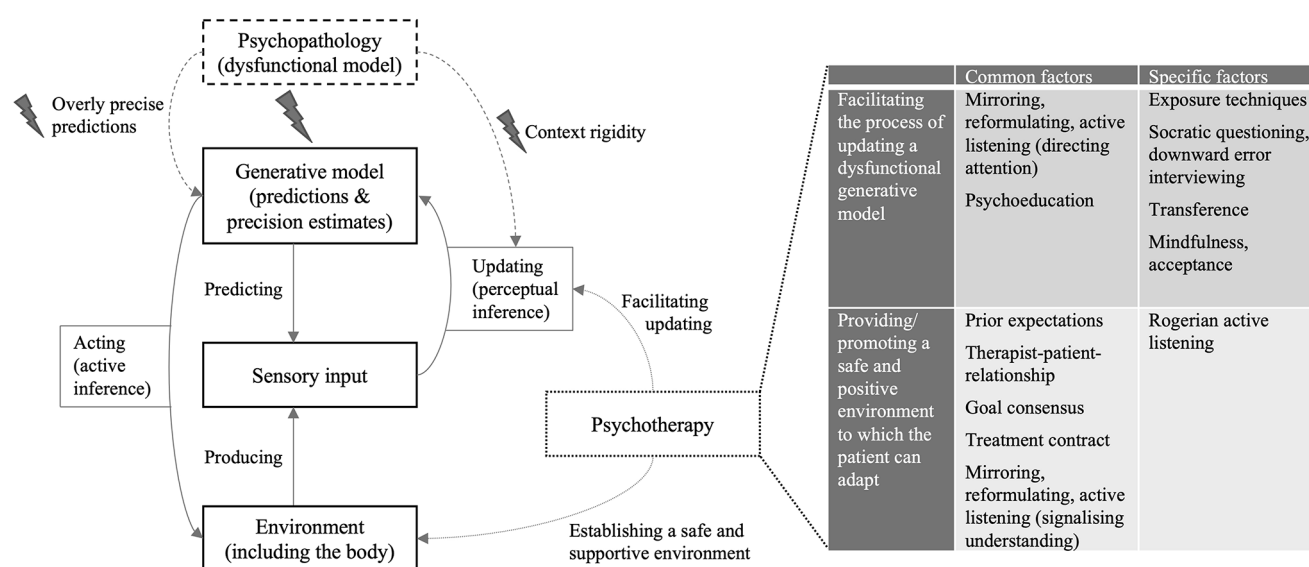


Fig. 1 Predictive processing model of psychotherapeutic interventions (3PI model). *Note* The brain's generative model tries to predict the sensory input, which is the product of the environment (including the body). Prediction errors can be resolved by acting on the environment such that the sensory input adjusts to the prediction (active inference) or by updating the model (perceptual inference). Psychopathology goes along with a dysfunctional generative model, resulting in false inference: the model has overly precise priors that prevent updating and thereby lead to context rigidity. Psychotherapy aims to correct

aberrant belief updating and does so through two mechanisms: directly by scrutinising overly precise predictions and the updating process; and indirectly by providing a safe and supportive environment, which produces respective sensory input that at some point overrides overly precise predictions. A closer look at psychotherapeutic interventions reveals that common factors primarily provide a safe environment and specific factors mainly scrutinize and update the dysfunctional generative model (the list of common and specific factors in the figure is not exhaustive)

the air flowing in and out of their nose, or notice how their body makes contact with the chair or floor. This process halts or prevents self-reinforcing, maladaptive cognitive loops. In terms of predictive processing, mindful awareness directs attention to the bottom-up sensory input, increasing its precision. Consequently, prediction errors between such bottom-up sensory input and dysfunctional top-down predictions become more likely to be minimised through updating the maladaptive predictions.

Finally, transference is one of the key procedures of psychoanalysis (Holmes, 2021; Holmes & Nolte, 2019). Transference occurs when the patient's prior experiences and relationships are unconsciously transferred to the present therapeutic situation. For example, feelings that the patient had about their parents can be unknowingly projected onto the therapist. Part of the psychoanalytic process is to expose these transferences and initiate reflection on the prior experience or relationship. The reflection should assist the patient to overcome unconscious conflicts. In predictive processing terms, the patient applies a generative model on the psychoanalytic session and the psychoanalyst, which was acquired in a previous experience or relationship. This indicates a rigidity to updating the generative model, which is comprised of inflexible predictions that the patient uses to interpret their interactions. By analysing and contextualising the generative model that evokes transference, the underlying

predictions become visible and can then be reconsidered and re-evaluated. Eventually, this process leads to an updating process.

Of course, there are many more specific factors that are dedicated to updating predictions than presented in this paper. For instance, there are other psychoanalytic techniques such as free association or dream analysis that have already been linked to predictive processing (Holmes & Nolte, 2019; Rabeyron & Massicotte, 2020). In addition, there are more than the three psychotherapeutic approaches discussed in this paper. But unfortunately, it is not possible to provide an exhaustive list of specific psychotherapeutic interventions, as this would go far beyond the scope of this paper.

To summarise, we can distinguish two targets of psychotherapy: to facilitate the process of updating a dysfunctional generative model and to provide or promote a safe and positive environment to which the patient can adapt. By combining these two targets of psychotherapy with common and specific factors, we can assign each psychotherapeutic intervention to one of the four combinations. Together, the combinations constitute the second part of the 3PI model, with common factors primarily providing a safe environment and specific factors mainly scrutinising and updating a dysfunctional generative model. The complete 3PI model is shown in Fig. 1.

Conclusion

Predictive processing provides a framework that fulfils the requirements which an integrative model of psychotherapeutic interventions must achieve; (1) it describes the mechanisms behind perception, cognition, and behaviour; (2) explains how these mechanisms can lead to psychopathology; and (3) presents possible ways to utilise these mechanisms through psychological interventions to achieve therapeutic effects. The predictive processing model of psychotherapeutic interventions (3PI model for short) presented in this paper identifies the two main functions of psychotherapy and assigns individual common factors and specific factors to one of these functions. In doing so, the model offers a new perspective to the debate on common and specific factors by combining the two within a larger explanatory framework.

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