



Metacognition and Headache: Which Is the Role in Childhood and Adolescence?

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Headache, in particular migraine, is one of the most frequent neurological symptoms in children and adolescents and it affects about 60% of children and adolescents all over the world. Headache can affect several areas of child's functioning, such as school, physical activities, peer, and family relationship. The global and severe burden of this disease requires a multidisciplinary strategy and an effective treatment addressed all of the patient's needs and based on cutting-edge scientific research. In recent years, research has focused on cognitive factors specifically in functions called metacognitive processes. Metacognition can be defined as the knowledge, beliefs, and cognitive processes involved in monitoring, control, and assessment of cognition. Metacognition seems to be closely related to the ability of theory of mind, the ability to infer, and reason about the mental states of other people in order to predict and explain own behavior. Recent studies found a relationship between metacognitive skills and anxiety, depression, motivation, academic performance, human social interactions, and stress symptoms. This relationship is very interesting for headache treatment, because these factors are the most commonly reported triggers in this disorder and there is a high comorbidity with anxiety and depression in children and adolescents with headache. So, headache and these comorbidities, in particular anxiety and depression, may have in common persistent and maladaptive patterns of thinking which are related to maladaptive metacognitive beliefs. Further research should assess metacognitive processes of children and adolescents with headache in order to increase their ability to control their own cognitive processes and consequently monitor factors which may trigger the attacks.

Keywords: metacognition, children, adolescents, headache, comorbidity, theory of mind

INTRODUCTION

Recurrent headache and migraine are the most common neurological complaints in children and adolescents and they are recognized as a significant health problem. The prevalence of this neurological disorder in children and adolescents is about 55 and 91% of migraine (1). The global and severe burden of this disease requires a multidisciplinary strategy and an effective treatment addressed all of the patient's needs and based on cutting-edge scientific research (2, 3). Indeed, primary headache in childhood is often associated with a number of comorbidities, such as asthma, allergies, sleep disorders, emotional and behavioral problems, internalizing disorders, such as depression and anxiety, obesity, etc. (4), and it can negatively affect child and family lives and interfere in daily activities, social interaction, and school performance in combination with psychopathological symptoms (5, 6).

Some studies have focused on possible cognitive deficit in children with headache or migraine. For example, an interesting study realized by Parisi and colleagues (7), investigated differences in intellectual functioning and cognitive profile in 82 children with tension-type headache (TTH) and migraine without aura (MOA), compared with a control group without any disorders. The two groups shown significant differences in the mean total intelligence quotient and verbal intelligence quotient scores (7). Moreover, the authors hypothesized that high frequency of headache attack and its early age at onset are associated with cognitive impairment probably, because in the developmental age the central nervous system is not yet completely mature (7).

Some findings show that the most impaired neuropsychological functions concern selective and divided attention, speed of processing information, and short- and long-term verbal memory (8, 9). Melissa Andréia et al. (10) compared 28 adolescents diagnosed with migraine and 26 subjects without a history of headache after a neuropsychological assessment. They noticed that adolescents with migraine were more affected by distractors during the learning process, had verbal memory and more learning difficulties and shown impairment in recognition and recall (10). These problems may have a connection with learning difficulties sometimes referred by children with migraine or recurrent headache. In contrast with these findings, Riva (11) highlights the greater presence of internalizing problems instead of neuropsychological dysfunctions. According to this hypothesis, Haverkamp et al. (12) conclude that children with migraine were not at risk for impaired cognitive development. So, the authors believe that it should be clarified if specific neuropsychological deficits in patients with migraine are caused by other factors independent from migraine (12).

In recent years, a much studied cognitive function, especially in childhood, is mentalization [including theory of mind (ToM)] or metacognition. These abilities explain or predict behavior based on beliefs, intentions, or feelings attributed to the self or others, mental states, and including thoughts (13). For example, in the last 30 years the role of ToM in autism spectrum disorders (ASD) and other communication impairments has been a prosperous research area (14, 15) and neurobiological studies have discovered interesting brain networks underlying both ASD and ToM (16, 17).

Other psychological and psychiatric disorder in which there could be an impairment or dysfunctions in mentalization ability or ToM are for example ADHD (18, 19), intellectual disability (20), externalizing disorders, also connected with high levels of callous-unemotional (CU) traits (21) and, especially regarding metacognition and metacognitive strategies, learning disabilities (22).

In the following paragraphs will be deepened the role that those psychological constructs have in pediatric headaches and how their role in treatment.

WHAT IS METACOGNITION?

The concept of metacognition is a relatively recent psychological construct, first introduced by Flavell in 1979. Metacognition can be defined as the knowledge, beliefs, and cognitive processes

involved in the monitoring, control, and assessment of cognition (23). These processes involve:

- (1) “introspective knowledge about one’s cognitive states and abilities and their operation”;
- (2) “the ability to use metacognitive knowledge strategically to achieve goals (strategy regulation)”;
- (3) “cognitive monitoring of thoughts (the ability to read one’s own mental state)” (24–27).

It refers to any cognitive or knowledge process that is involved in assessment, monitoring, or controlling cognition and it can be synthesized as “thinking about thinking” (24).

This ability first allows people to identify and recognize mental states in both the self and others. It consents also to think about mental processes, such as cause and effect relationships, emotions, feelings, thoughts, and behaviors and, finally, it helps to understand that ideas are subjective and that people have different point of view and different perspectives on things (28).

Metacognition is linked to other psychological construct such as mentalization and it refers to “the ability to understand ourselves and others in terms of intentional mental states, such as feelings, desires, wishes, attitudes, and goals.”

It is fundamental in our social environment and its acquisition depends on the context of attachment relationships (29). The concept of mentalization contains related constructs, such as empathy, mindfulness, and ToM (30). Indeed, metacognition seems to be closely related to the ability of ToM, the “ability to infer and reason about the mental states of other people in order to predict and explain own behaviour” (31).

Both mentalization and metacognition are included in executive functions, the higher cortical functions. Because of their nature, the more involved cortical areas are the dorsolateral prefrontal cortex, ventromedial prefrontal cortex, medial frontoparietal network, and more in general the prefrontal areas and the frontal lobe (29, 32).

It is commonly assumed that the acquisition of fully developed explicit concept of mental states starts around age 4, period in which children start to control standard verbal tasks necessary for the identification of “false beliefs to other agents” (33, 34). The evaluation of mentalization or ToM usually consists of tasks that exhort participants to infer others’ mental states, for example, completing stories embody the protagonist’s point of view (35). These tests are also called “false believes task” and they involve first- or second-order false beliefs according to the task difficulty. While the first-order beliefs refer to assumptions made about another person’s beliefs, the second-order beliefs deal with another person’s assumptions about a third individual’s belief (36). One most famous and commonly used false belief task, developed by Wimmer and Perner first (37) and implemented later by Baron-Cohen et al. (38), is the Sally–Anne test, in which there are two story characters with two different belief states with respect to a hidden object.

WHAT IS THE ROLE OF METACOGNITION IN HEADACHE?

As widely described above, psychological constructs as metacognition and ToM are broadly studied and evaluated in many

psychiatric diseases. However, there are not numerous studies that explore the relationship between headache, in particular migraine and metacognition especially in children and adolescents. There are some studies (conducted with adult patients) that find a connection between somatoform pain disease and deficit in ToM. For example, Zunhammer and colleagues (39) found that chronic somatoform pain patients (included headache/migraine suffering) had more difficulties in their mentalizing abilities compared to healthy controls. Moreover, they evidenced in their patient significant impairment in emotional awareness.

According to this study, Preis et al. (40) reported impairment in affective ToM in patients with somatoform disease related to people without any disease, but they do not identify significant differences in cognitive ToM between the two groups. A study conducted by Petolicchio and colleagues (41) involved 57 patients with chronic migraine, with or without medication-overuse headache (MOH). They suggest that there could be a possible connection between the chronicization of migraine and a low mentalizing level.

While some studies have demonstrated deficit in ToM in children with neurological disorders such as epilepsy (42), no one has yet demonstrated the same thing in children with headache or migraine. Only one study has considered the possible impairment in mentalization ability in children with headache and epilepsy. La Grutta and colleagues (43) enrolled 65 children from 7 to 11 (48 males and 27 females) suffering from epilepsy and primary headache. For the evaluation of mentalization quality, they use semi-structured interview on dreams and to assess the quality of the psychological suffering they used the drawing stories technique. Their results suggest that psychological suffering due to body sickness can affect some mental representation and way to think.

Since headache in pediatric age is widespread, complex, and often in comorbidities with other disease (psychiatric, neurological, etc.), deepening possible relationship with mentalization could be helpful to children to improve social skills and their quality of life.

HEADACHE, COMORBIDITIES, AND BAD LIFE EVENTS

Although some studies found inconsistent results showing that the majority of children and adolescents with chronic daily headache do not have a psychiatric comorbidity (44) and suggesting that it is difficult to clearly differentiate some migraine features from psychiatric diagnoses with the current screening tools available (45), the majority of studies in this field identified a high presence of psychological comorbidities in children and adolescents with headache (4).

A cross-sectional, population-based study, called Young-HUNT1 was conducted in Norway from 1995 to 1997. In this study, 4,872 adolescents (12–17 years) were interviewed about their headache complaints and completed a comprehensive questionnaire that included assessment of symptoms of anxiety and depression and behavioral problems. The authors found higher levels of symptoms of anxiety and depression in adolescents aged

12–14 years with recurrent headache, while in adolescents aged 15–17 years with higher levels of anxiety and depression were associated with all diagnosis of headache (46).

A recent study confirmed not only that children and adolescents with MoA have higher anxiety levels than a control healthy group but also it shows differences with respect to security of attachment to both mother and father between two groups. Thus, the authors suggested that “the migraine-anxiety association would be at least partially mediated by attachment security” (47).

Headache would seem to be associated with bad life events, in particular with childhood abuse and neglect (48). Tietjen et al. (49) assessed the prevalence of childhood maltreatment and adult revictimization in patient with migraine taking in account several factors such as the presence of anxiety or depression and sociodemographic factors. They found that: “reports of childhood maltreatment, especially emotional abuse and neglect, were prevalent in outpatients with migraine and all types of childhood abuse and neglect were strongly associated with remote and current depression and anxiety, and the relationship strengthens with an increasing number of maltreatment types” (49).

Some studies found that younger with chronic pain and comorbid depression are at increased risk of thinking about and attempting suicide (50), in particular it was shown a high comorbidity suicidal risk in adolescents with chronic daily headache (51).

Moreover, several researches have found that children and adolescents with migraine compared with a healthy sample show difficulty in expressing emotional states (52), displaying a higher level of alexithymic characteristics (53, 54).

Alexithymia refers to a “personality construct that implies a poor ability to identify and describe feelings, a reduced imagination, and a concrete, externally-oriented way of thinking” (53), and it would seem to be associated with metacognition skills, understood as the beliefs and attitudes of an individual about cognitive events like thoughts, emotions, memories, feelings, and other perceptual forces (55, 56).

So, headache and these comorbidities, in particular anxiety and depression, may have in common several persistent and maladaptive patterns of thinking which are related to maladaptive metacognitive beliefs (57).

According to this metacognition theory and in the light of this scientific evidences that report a greater presence of stressful life situations in patients with headache, the use of metacognition therapy, and mindfulness practices could be effective means of swiftly modifying cognitive events, such as emotions, thoughts, and bad memories.

THE ROLE OF METACOGNITION, COGNITIVE BEHAVIORAL THERAPY (CBT), AND MINDFULNESS IN THE TREATMENT OF PSYCHOPATHOLOGICAL COMORBIDITIES IN HEADACHE

Non-pharmacological therapy, in particular behavioral strategies seem to be as effective as pharmacological treatment for headache management (3, 58, 59).

Ideal candidates for behavioral intervention seem to be patients with chronic pain and clinical depression or anxiety or individuals with reduced ability to manage triggers (e.g., stress) or with other significant psychological problems (e.g., history of abuse/maltreatment) (60–62).

Behavioral therapy consists of three main components (63):

1. Treatment adherence;
2. Adjustment of lifestyle management;
3. Psychological intervention.

In particular, psychological interventions include (64):

- Relaxation skills;
- Biofeedback;
- Cognitive behavioral therapy.

Relaxation skills, such as autogenic phrases, guided imagery (GI), self-hypnosis, diaphragmatic breathing, and progressive muscle relaxation (PMR), seem to be as effective as pharmacological treatment in children, adolescents, and adult, improving the clinical features, such as frequency, intensity, and duration of headache (65, 66).

Cognitive behavioral therapy consists mainly of cognitive and behavioral strategies with the aim to change patient exaggerated or irrational thought patterns, dysfunctional negative emotions, interpretations of events, and maladaptive behavioral patterns of responding to stressors or events, enhancing patient's ability to cope with the pain, and to reduce headache-related distress (3, 67).

Among CBTs, the most effective treatment for the management of childhood abuse or maltreatment seems to be the trauma-focused CBT (TF-CBT) (68, 69).

Trauma-focused cognitive behavioral therapy includes cognitive behavioral, family, humanistic, and trauma-sensitive interventions and techniques. In this therapy, “children and their parents are taught skills to help them elaborate thoughts and feelings related to traumatic life events and manage and resolve distressing thoughts, feelings, and behaviors related to traumatic life events” (70).

Cognitive behavioral therapy is strictly related to metacognition and mindfulness practices: “metacognitive therapy is based on the principle that worry and rumination are universal processes leading to emotional disorder” (71).

These processes are associated with inefficient self-regulation, coping strategies, and erroneous thinking and so mindfulness tries to change the individual's perspective toward own relationship, thoughts and feelings, observing what occurs, with a special focus on the contents of inner experience, without evaluating or judging (71).

Several researches found that mindfulness can benefit adults with headache (72), but very few studies have been conducted with children and adolescents.

Hesse et al. (73) conducted a pilot clinical trial with 20 adolescent females with recurrent headaches, showing that although mindfulness-based intervention did not report decreased frequency or severity of headache, it had a beneficial effect for depression, quality of life, and acceptance of pain.

Mindfulness seems to play an important role in cognitive and behavioral reactions to daily pain. Petter et al. (74) found that “mindfulness is negatively associated with typical pain intensity and pain catastrophizing, and it is a unique and non-redundant predictor of how much pain interferes in the lives of adolescents.”

Przekop et al. compared a multimodal (“osteopathic manipulative treatments, mindfulness, and qi gong”) and pharmacologic (amitriptyline or gabapentin) treatment in children and adolescents with chronic TTH, showing that the multimodal treatment was significant in reducing headache frequency and pain in increasing participants' quality of life, reducing the physical and emotional problems reported by patients (75).

Kemper et al. (76) conducted a study on adolescents who had multi-year histories of recurrent headaches, showing that the depression was positively associated with stress, anxiety, and sleep disturbances and negatively associated with mindfulness, self-compassion, and resilience.

Resilience also, seems to play a role in pain self-efficacy and acceptance in patients with chronic pain. Resilience refers to “a class of phenomena characterized by good outcomes despite serious threats to adaptation or development” (77). In the context of pediatric chronic pain, a child's resilience might be conceptualized as “the personal resources and effective responding that protect from dysfunction, lead to adaptation, or result in well-being and growth” (78).

Sturgeon and Zautra (79) proposed the process of resilience to pain like a multimodal paradigm for understanding pain and pain coping, that can “identify the traits and mechanisms underlying the sustainability of a good life and recovery from distress.”

In particular, two processes of resilience have been considered in children with chronic pain: *pain acceptance* and *pain self-efficacy*. Kalapurakel et al. (80) showed that these two processes were negatively related with the disability and the depressive symptoms and positively related with a school functioning. In particular, pain acceptance seems to have a greater association with less depressive symptoms and better school functioning, while pain self-efficacy seems to have a greater association with less functional disability (80).

CONCLUSION

Further studies and evidences are needed, but the use of metacognitive strategies and mindfulness practice in children and adolescents with headaches could be a preventative factor for the development or strengthening of psychiatric comorbidities, especially in children with chronic and recurrent headache who are at increased risk for psychiatric and behavioral comorbidities.

AUTHOR CONTRIBUTIONS

VG, NF, and GN conceived and designed the study and they are responsible for data acquisition. DC, RC, and PV were responsible for critical revision of this manuscript. All authors approved the final version of this manuscript.

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