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Perceived Triggers of Asthma: Key to Symptom Perception and Management

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Abstract

Adequate asthma management depends on an accurate identification of asthma triggers. A review of the literature on trigger perception in asthma shows that individuals vary in their perception of asthma triggers and that the correlation between self-reported asthma triggers and allergy tests is only modest. In this paper, we provide an overview of psychological mechanisms involved in the process of asthma triggers identification. We identify sources of errors in trigger identification and targets for behavioral interventions that aim to improve the accuracy of asthma trigger identification and thereby enhance asthma control.

Introduction

Asthma and allergies are a major source of health problems. In Western and Westernized countries, prevalence of physician diagnosed asthma is about 9–12% [1–3], while 28% report at least 1 type of diagnosed allergic disorder (e.g, asthma, food allergy, rhinitis, dermatitis [2]. Allergic asthma and allergies have in common that symptoms occur in response to an allergic trigger (e.g. house dust mite, pollen). In asthma, non-allergic triggers such as air pollution, cigarette smoke, perfume, stress, negative emotions or physical activity may also trigger asthma symptoms [4]. Management of asthma and allergies consists of pharmacological management, combined with avoidance of triggers that cause symptom exacerbations [4, 5]. However, trigger avoidance interventions have shown mixed results, and systematic evaluations of interventions that focus on a specific environmental control measure for a specific trigger have shown only limited overall effects on symptoms and disease severity [6, 7].

Although it may be hard to generalize findings from the wide variety of trigger avoidance interventions that have been evaluated [8], we argue that one reason for the mixed success of trigger avoidance may be that individuals have difficulty identifying their personal triggers. In patients with asthma, agreement between reported asthma triggers and actual tests of physical or psychological trigger impact is only moderate [9]. Although this discrepancy could be due to a lack of accuracy of the allergy test, this finding suggests that patients may be unaware of all or some of their triggers, which may leave them uncertain about what the exacerbating factors of their disease are and about which specific triggers to avoid, and could leave them exposed to critical triggers repeatedly without protection. This way, they are presented with recurrent aversive somatic experiences that appear unpredictable and uncontrollable [10, 11]. Alternatively, patients with asthma may attribute their respiratory

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Conflict of interest

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symptoms to a specific trigger despite the absence of a relationship between the trigger and actual airway obstruction. In other allergic conditions, such as food allergy, the discordance between perceived allergic triggers and triggers identified by atopy tests or provocation tests is even worse [12, 13]. Misidentification of asthma triggers can lead to unnecessary avoidance of perceived triggers and thus restrictions in daily functioning and impairments in quality of life. In asthma, a discrepancy between the perception of symptoms and actual lung function effects of benign daily life physical activity [14] could be associated with the long term risk of forgoing the protective effect of exercise.

In this paper, we will review the empirical evidence on trigger perception in asthma, outline psychological mechanisms that are involved in the identification of allergens or asthma triggers, and identify potential sources of errors in trigger identification. We will conclude the review with potential targets for interventions that aim to improve accurate trigger identification and thus enhance patients' perception of their disease activity.

Perceived Triggers of Asthma: Measurement, Structure, and Association with Asthma Outcomes

Despite the importance of trigger perception in asthma management, only few studies have investigated patients' self-report of asthma triggers. These studies have been carried out in a variety of settings and differ in methodology, making it difficult to compare their results. In absence of a more established research base, we will try to distill some general findings from these studies[1].

The number of asthma triggers that is reported by patients in different studies varies widely, ranging from 4–12 [15–17]. Differences in the number of triggers reported across studies may be a function of the questions that are used to elicit personal trigger reports, with the number of triggers being evaluated ranging from 9–32 [9, 15–17]. In order to assess asthma triggers in a standardized form, studies have attempted to develop measures to probe patients' trigger perceptions. An earlier instrument, the Asthma Trigger Index, [18] was specifically developed to evaluate emotional triggers of asthma. It consisted of a list of potential triggers and a series of situation vignettes linked to emotional experiences.. Although the instrument was reported to have a high test-retest reliability and good content validity, results of a psychometric evaluation have never been published. More recently, the Asthma Trigger Inventory (ATI) [9] has been developed to assess a broad spectrum of asthma triggers in a standardized way. It is a 32-item questionnaire, consisting of 7 subscales measuring trigger domains of pollen allergens, animal allergens, physical activity, air pollution/irritants, infections, and psychological factors. All domain scales have a high internal consistency and test-retest reliability.

Despite the variation in the assessment of self-reported asthma triggers, some general findings can be drawn from this literature. Self-reported asthma triggers are associated with disease severity and impact. Patients with a higher number of asthma triggers report less quality of life [16]. Furthermore, a higher number of self-reported asthma triggers is correlated with physician ratings of more severe asthma [9, 17, 19], more exacerbations, and a higher frequency of oral corticosteroid use [9, 16]. Self-reported asthma triggers, are also associated with more primary care visits and emergency room visits, as well as a higher rate of hospitalization [9, 16]. Moreover, patients with a higher number of asthma triggers had a greater chance of relapse defined as urgent or unscheduled physician visits in the two weeks after an emergency room visit [15].

[1]The search for articles on trigger perception was conducted in Google Scholar, using the search term asthma trigger perception OR identification, and by identifying papers that cited to key articles identified by our search

Demographic variables appear to moderate asthma trigger reports. Consistently, female patients report more asthma triggers than male asthma patients [16, 17, 19]. Higher education levels are associated with the report of fewer asthma triggers [9, 19], although the latter association is not always found [16]. Similarly, evidence for a relationship with race or ethnicity of participants is still equivocal [9, 16].

Studies that have examined the association of different types of triggers with asthma and other health outcomes found that self-report of animals as asthma triggers is related a lower age of asthma onset [9, 16, 19]. Self-report of exercise as an asthma trigger is associated with obesity [16, 20]. Emotional triggers (e.g. stress, intense emotions) are associated with more severe asthma, occurrence of nighttime symptoms, and oral corticosteroid use [9, 17, 19]. Furthermore, emotional triggers are linked to a decrease in quality of life and increased anxiety and depression [16, 19]. In general, trigger domains of allergic versus non-allergic triggers appear to be relatively independent from each other and are associated differentially with demographics, asthma manifestations, and outcomes [9, 19].

When comparing two studies that used the ATI to investigate asthma triggers in different countries, Britain [9] and Germany [19], we noticed some differences in the relationship between ATI subscales and specific demographics or disease-related variables (e.g., gender differences in the report of air pollution and infections as asthma triggers). On the other hand, consistent associations with a standardized asthma symptom exacerbation measure, the Asthma Symptom Checklist [21] were observed, in that psychological asthma triggers were linked to hyperventilation symptoms [22]. In terms of the structure of trigger report, remarkable consistency was uncovered with British [9] and German [19] adult asthma patients as well as children with asthma in the United States [23]. The ATI subdomains of trigger perception were also readily identified in an Indonesian sample of adult asthma patients using the 32-item set of the ATI, but discrepancies appeared when the item pool was expanded and factors associated with regional specifics, such as weather conditions and specific aeroallergens, emerged [24]. These findings suggest both cross-cultural consistencies and variations in the perception of asthma triggers. More inconsistencies exist in form of culturally idiosyncratic trigger beliefs, such as exposure to cold foods in south Asian cultures, or imbalances in hot and cold elements often endorsed in Guatemala and Mexico, which are often tied to specific traditional remedies for asthma that are thought to alleviate these effects [25, 26].

The variation in self-reported asthma triggers and association of different asthma triggers with different demographic variables and disease outcome require further study. Although some of this variation could be explained by the existence of different asthma phenotypes (e.g., an adult-onset non-allergic phenotype vs. early onset atopic asthma, [27], other parts of this variation may be clarified by examining the psychological processes involved in asthma trigger identification.

Mechanisms of asthma trigger identification

Asthma trigger identification is a complex task. It requires perception of asthma symptoms, perception of potential asthma triggers, and perception of a contingency or causal relationship between potential asthma triggers and symptoms (cf. Figure 1). Each of these components of trigger identification is associated with specific challenges. Furthermore, the components are not fully independent, as each of the components exerts an influence on the other. In pediatric asthma, the task of trigger identification may be further complicated by potential parent-child discordances on each of these components [28, 29].

Perception of Triggers and their Identification as Asthma-Relevant

Many potential asthma triggers, such as pollen, house dust mite, mold, small particulate matter, or respiratory viruses, do not have a phenomenal appearance that is easy to perceive. Therefore, presence of these triggers is often inferred from the occurrence of cues that are associated with these triggers, such as trees in summer, dust, damp indoor spaces, diesel smell, or the occurrence physical symptoms that are indicative of upper respiratory infections. This difficulty reflects for example on the association between perceived allergic triggers and allergy skin test results. The association between perceived allergens and skin prick test wheal sizes is sometimes stronger for triggers with a clearer phenomenal presentation, such as cats and dogs, than for less distinct triggers, such as pollen or molds [9, 30]. Similarly, the availability of a potent trigger that is easy to perceive may explain why smokers report fewer asthma triggers, especially allergic asthma triggers, compared to non-smokers [9, 16].

Prior knowledge and beliefs about potential asthma triggers and their occurrence may help identify asthma triggers that are hard to perceive, whereas a lack of knowledge about potential asthma triggers may hinder perception of triggers. Patients with greater knowledge about asthma report a higher number of asthma triggers [16], whereas lack of information about the role of mold or cockroaches as asthma triggers may hinder their perception as personally relevant asthma triggers [30–32]. Furthermore, given the large inter-individual variability of asthma triggers and allergic triggers [9, 33], knowledge and beliefs about common asthma triggers may both help and hinder identification of personal asthma triggers, depending on whether or not general knowledge of asthma triggers matches personal susceptibilities.

Perception of asthma symptoms

The perception of asthma symptoms occurs when changes in somatosensory information are detected and matched to mental models of asthma symptoms [34, 35]. In this process, several factors have been identified that may cause a divergence between the level of bronchoconstriction and the level of perceived asthma symptoms. For example, a person may be unable to detect changes in respiratory resistance, and the resulting absence of asthma symptoms increases the risk of near-fatal asthma [36] and may also hinder a person to perceive a contingency between airway obstruction and environmental factors that triggers the obstruction. Furthermore, concurrent affect or contextual information may also interfere with the accurate perception of asthma symptoms [37–41]. Experimental studies have shown that contextual information that is related to previous experience with asthma triggers can lead to the perception of asthma symptoms in absence of the original asthma trigger [42], whereas being in a situation that is perceived as unrelated to asthma may also reduce the perception of asthma symptoms [43]. Also, other factors such as memory, personality, gender, and cultural norms have been shown to influence perception and report of asthma symptoms [35, 44, 45]. Similar to perception of asthma symptoms, perception of other physical symptom, such as symptoms linked to upper respiratory tract infections, is also correlated with personality characteristics and may also lack accordance with objective disease criteria [46, 47]. However, information about the role of perception of upper respiratory tract infections in asthma management is currently lacking.

These examples show that perception of respiratory symptoms is a complex process that is prone to inaccuracies. It is therefore unsurprising that inaccurate perception of asthma symptoms is a widespread problem, with an estimated prevalence of 15 to 60%, depending on the methodology that is used to assess it [35]. As accurate perception of asthma symptoms is a prerequisite for accurate identification of asthma triggers, this may further complicate the identification of asthma triggers.

Perception of Contingencies Between Triggers and Symptoms

Accurate identification of asthma triggers is dependent upon the accurate perception of a contingency between the trigger and asthma symptoms. Humans and animals can be very adept at identifying contingencies and rely on this ability to reduce uncertainty and unpredictability in their environment [48]. In asthma and allergies, contingency perception is used to predict and avoid onset of asthma symptoms. However, contingency perception is often biased. Several studies have shown that perceived intensity or unpleasantness of an event is associated with an overestimation of the contingency between this event and preceding cues [49–51]. Because perceived unpleasantness and contingency perception are associated, this may also explain the discrepancy between self-reported allergy symptoms versus their diagnosis and treatment [52]. Indeed, in a survey on underdiagnosis and undertreatment of allergic rhinitis, patients reported that they have had symptoms for quite some time, but only started seeking diagnosis and treatment when their symptoms became intolerable [53]. If individuals with rhinitis perceive their symptoms to be present yet of little importance, this may not only lead to underdiagnosis and undertreatment, but may also leave these individuals less inclined to identify and avoid triggers of their symptoms.

Prior expectancies or beliefs can also have an influence on the perceived relationship between a potential trigger and respiratory symptoms. In laboratory experiments, prior expectancies have been shown to guide perceived contingencies and symptom reports, even when an objective contingency between the potential trigger and respiratory symptoms was absent [54]. Related research on anxiety disorders suggests that the effect of prior expectancies may be dependent upon fear levels. Whereas individuals show an increased expectancy of a negative event following fear-relevant (e.g. pictures of spiders) vs. fear-irrelevant (e.g. pictures of mushrooms) pictures, only in high fearful individuals, this expectancy persists after repeated confrontation with situations wherein presentation of these pictures is noncontingent with the aversive outcome [55]. Fear and anxiety also promote other inaccurate perceptions of contingencies that may be especially relevant for asthma trigger identification. For example, individuals with panic disorder show an overgeneralized fear response when confronted with cues that share perceptual similarity with a known fear cue [56]. Furthermore, after confrontation with a contingency between a cue A and an unpleasant outcome, and confrontation with a contingency between a compound cue AB and an unpleasant outcome, anxious individuals show sustained fear to element B, even though confrontation with cue A and compound cue AB resulted in the same aversive outcome. [57]. Thus, anxious individuals do not learn that one of the elements of the compound cue AB, the cue B, is unrelated to the aversive outcome. This observation is particularly relevant to the perception of asthma triggers as many asthma triggers may co-occur in complex stimulus configurations, which may lead individuals to experience asthma symptoms when confronted with individual elements of the compound stimulus. For example, confrontation with asthma symptoms in response to physical exercise may cause high anxious individuals to perceive co-occurring cues, such as particular aspects of the environment in which the exercise takes place, as an asthma trigger, even if physical exercise alone (e.g., on a treadmill) would cause the same amount of asthma symptoms. In low-anxious individuals, the perception of physical exercise as a trigger would ‘block’ the perception of the exercise context as an asthma trigger.

These examples suggest that confrontation with an aversive outcome may lead to the adoption of a “better safe than sorry” approach, especially in persons with asthma that are highly fearful or have comorbid anxiety disorders. The prevalence of anxiety disorders is higher in persons with asthma compared to the general population [58].

Other biases may occur in depressed individuals with asthma. Research on cognitive bias in depression shows that depressed individuals are less prone to inflating contingencies when

there is no objective contingency between a cue and an outcome [59]. However, depressed individuals do exhibit an underestimation of contingency, especially in situations where control is important [60], which could lead to a reduction in the ability to detect asthma-trigger contingencies in individuals with asthma and comorbid depression. Experimental inductions of non-contingency or lack of control (learned helplessness) have similar effects on subsequent contingency ratings and task performance [61], and individuals with asthma are more susceptible to these effects (impaired problem solving after a learned helplessness induction) compared to matched controls [62].

Beyond cognitive biases, actual bronchoconstriction due to emotional states [63] may be present in anxiety disorders and depression, which might enhance the perception of contingencies between psychological triggers and resulting symptoms, or contribute to bronchoconstriction elicited by other triggers and therefore enhance their perception.

Temporal characteristics of the allergic response may further complicate the accurate perception of trigger-symptom contingencies. Allergic reactions consist of both an acute (within minutes after exposure) as well as a late phase response (4–24 hours after initial exposure)[64], which means that by the time the late response occurs it may not be easy to determine what triggered the response originally. Indeed, a decrease in lung function during the late phase response is perceived as less intense compared to a similar decrease in lung function during the acute phase [65]. In contrast, the airway constriction to emotional triggers happens while exposed to the trigger, thus providing a much better condition for perceiving trigger-symptom contingencies [66]. Consequently, reports of psychological asthma triggers in daily life have been linked to stronger bronchoconstriction to emotionally aversive laboratory stimuli [9, 66, 67] Furthermore, allergic reactions to specific triggers have been known to change during the lifetime response in later life [68]. This implies that previous knowledge about individually relevant asthma triggers may become inaccurate when the sensitivity to specific triggers changes.

Activation of the immune system may be involved in the perception of trigger-symptom contingencies. Although no study has directly investigated the effects of inflammation on contingency perception, stronger inflammatory responses to allergen provocation have been found in periods of stress [69], which could make it easier to perceive trigger-symptom contingencies. Furthermore, increased immune activation is also associated with attention for and avoidance of disease-related cues [70]. Asthma patients also show a specific association of airway inflammation and attention for asthma-specific cues, but not for general negative cues [71]. This increased attention to environmental asthma-specific cues may help identification of asthma triggers, but there is also a risk of biased contingency perception if inflammation directs attention to asthma-specific cues that are present but not involved in the airway response. Furthermore, prior beliefs may interact with the effect of inflammation on attention to potential triggers.

Bronchoconstriction due to trigger perception

Perception of an environmental agent as an asthma trigger or suggestion that an pharmacological agent is an asthma trigger not only can elicit the perception of asthma symptoms but also can lead to an increase in bronchoconstriction, as the large literature on suggestion-induced bronchoconstriction shows [72]. Although the effect of suggestion on bronchoconstriction and symptom perception appear to occur independently [73], both effects can be conceptualized as feed-forward mechanisms, motivating a person to get away from this context before more damage occurs. These feed-forward mechanisms may be involved in the maintenance of perceived trigger-symptom contingencies, which in turn may have an impact on asthma-related quality of life and may interfere with adequate self-management of asthma. Furthermore, there are large individual differences in the effect of

suggestions on symptom experience and bronchoconstriction [72]. Further investigation of these individual differences may also aide our understanding of asthma trigger perception.

Potential interventions

The effects of suggestion on bronchoconstriction and symptom perception, as well as the role of contextual information and trigger beliefs on symptom perception, suggest that interventions that try to modify trigger information or trigger beliefs can be used to correct inaccurate perception of asthma symptoms [35]. Education about potential triggers (e.g. allergens, irritants, respiratory infections) is an essential part of asthma management (GINA, 2010). Asthma education programs, which include education about asthma triggers and environmental control measures have been shown to improve clinical outcomes (hospitalizations, emergency room visits, unscheduled doctor visits) and quality of life [74],with newer programs tailoring information to patient needs [75, 76].

However, in day to day allergy care, problems may occur that can interfere with optimal asthma trigger management. Although clinicians often inquire about potential asthma triggers during appointments, education about triggers and environmental control measures is less frequent [77]. In addition,, patients often have difficulty carrying out environmental control measures, or may be hindered by the cost of some of these measures [78]. More problematic is that about half of the environmental control measures that are carried out by patients are unlikely to be beneficial on the basis of current guidelines [79].

A further potential problem with trigger education and inquiry is that alerting participants to potential asthma triggers may promote unwarranted generalization of asthma triggers. Indeed, knowledge about asthma is associated with a larger number of self-reported asthma triggers [16] and experimental research has shown that informing participants about the danger of environmental agents promotes learned symptom responses [80]. A thorough evaluation of potential asthma triggers, including objective allergen tests may therefore help to identify asthma triggers that the patient was previously unaware of and correct erroneous trigger beliefs that erroneous symptom-trigger associations. For non-allergic triggers, monitoring of triggers, peak expiratory flow and asthma symptoms in daily life may help to detect previously unidentified and misidentified asthma triggers [81]. In order to improve participation in physical exercise, it may be important to provide patients with a clear plan that includes type of exercise and measures patients can take to reduce the occurrence of asthma symptoms [82].

The improvement of asthma trigger management in routine clinical care also remains a challenge. One descriptive study of urban pediatric clinic visits suggested that less than half of the parents received advice about environmental triggers and control measures [83]. Based on this and other shortcomings reported by clinicians and patients [77–79], it would be advisable for clinicians to routinely inquire about potential triggers and tailor information about triggers and environmental control methods to patient needs. Non-adherence to environmental control measures may be avoided when they are easy to implement and follow up (e.g. simple steps as part of an asthma action plan). Furthermore, clinicians would need to be mindful about inaccurate trigger beliefs and use of ineffective trigger control methods.

One way to tailor information to patient needs is the combination of allergy skin prick tests with trigger evaluation and education, which has been shown to result in the identification of discrepancies between asthma trigger beliefs and allergic response, an increase in the relationship between specific allergic sensitization and trigger-specific avoidance measures and improvement of lung function, compared to a limited intervention control group [30]. Furthermore, patients receiving a trigger evaluation intervention who did not report animal

triggers among their top triggers at baseline, showed an increase in perceived animal-related triggers at follow-up, suggesting that this type of asthma trigger education may be especially beneficial for persons that were previously unaware of crucial asthma triggers [30]. However, given the limited data that is available, more research on trigger identification interventions and integration of these methods in routine clinical care is definitely needed.

Interventions that are aimed at increasing accuracy of trigger identification may be especially beneficial for certain subgroups of individuals with asthma. For example, individuals that are susceptible to respiratory infections may benefit more due to the synergistic effects of allergen exposure and respiratory infections on asthma exacerbations [84]. Moreover, persons with comorbid asthma and panic disorder may benefit from interventions aimed at correcting inaccurate asthma trigger beliefs, as these persons may fail to differentiate between triggers of asthma symptoms and triggers of panic [85]. Information about differences between asthma and panic symptoms has been included in a pilot trial for treatment of asthma and panic disorder that has shown promising results [86]. Furthermore, misidentification of asthma triggers that is associated with anxiety of fear about asthma triggers may benefit from treatment strategies that are adapted from the treatment of anxiety and fear. In anxiety disorders, the success of exposure therapy has shown that repeated exposure to fear-eliciting cues during treatment is one of the most effective ways to reduce fear [87]. In a similar fashion, we expect that a treatment that exposes patients to misidentified asthma triggers may result in a reduction of potential anxieties that are associated with these triggers and in a reduction of asthma symptoms that are associated with these misidentified triggers. Ideally, such a treatment would be preceded by a thorough identification of perceived asthma triggers using monitoring in daily life, lung function testing and allergy diagnosis, but due to practical limitations (e.g. the availability of trigger challenge chambers) more limited interventions will probably have a better chance at being implemented in routine clinical care.

Conclusion

Accurate identification of asthma triggers often is a prerequisite for adequate asthma management. However, so far, research on the identification of asthma triggers has not received sufficient attention. Problems with the perception of asthma symptoms and asthma triggers as well as difficulties perceiving contingencies between triggers and symptoms may hinder accurate identification of asthma triggers. Beliefs about asthma triggers can both help and hinder the identification of trigger-symptom contingencies. Lack of knowledge about an important asthma trigger may lead to a failure to identify this trigger as a personally relevant asthma trigger. Beliefs about asthma triggers can also lead to misidentification of asthma triggers, although further research into the role of anxiety and fear in this misidentification is needed. Finally, perceived asthma triggers can elicit the perception of asthma symptoms and/or elicit bronchoconstriction, which may further complicate the accurate identification of asthma triggers. The role of beliefs about asthma triggers in asthma trigger identification makes them a key target for interventions that are aimed at improving identification of asthma triggers. We have identified educational interventions, daily life monitoring, and exposure to perceived asthma triggers as interventions that may change trigger beliefs, but further research is needed to evaluate these interventions and study the ways in which they can improve asthma control.

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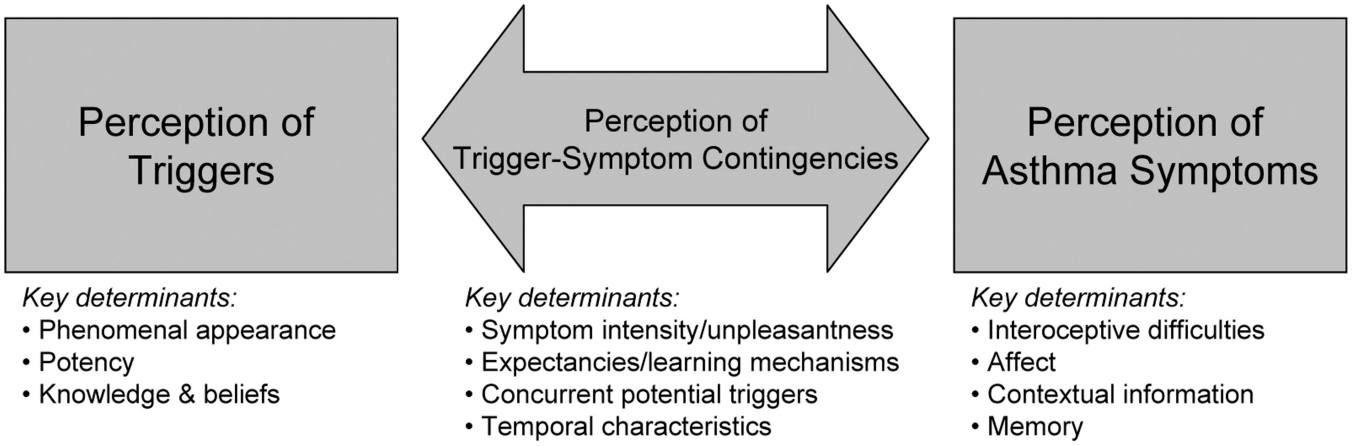

Figure 1.
Key determinants of asthma trigger identification