The Control-Arousal Signal (CAS) Model – A Theory of Human Emotional Crying

Supplementary Material

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Supplementary Note 1. Theories of Emotional Crying

A considerable amount of research has been devoted to theorizing about when and why individuals cry (see Kottler & Montgomery, 2001; Vingerhoets et al., 2000 for reviews). Vingerhoets and colleagues (2000) differentiate theories based on their focus by classifying *reductionist* and *ecological* views. Reductionist views focus primarily on physiological reasons or functions for crying, while ecological perspectives also consider socio-cognitive and psychological triggers. Further, Kottler and Montgomery (2001) differentiate between *physiological* and *interpersonal* theories, with physiological theories focusing on intrapersonal functions and interpersonal on interpersonal functions of crying. Here, we qualify theories based on those two main dimensions: the proposed *trigger* and the proposed *function* of emotional crying. For triggers, theories mainly highlight biological/physiological (e.g., high bodily arousal) or cognitive/psychological triggers (e.g., appraisal of helplessness). For functions, theories mainly differentiate between intrapersonal functions (e.g., focusing on the crier) and interpersonal functions (e.g., focusing on the environment). When crossing these two dimensions we obtain a theory space of combinations of triggers and functions resulting in four overarching themes that we label *physiological-regulation, physiological-*

signaling, cognitive-regulation, and *cognitive-signaling* as depicted in Table 1. Importantly, many theories highlight several triggers or dimensions, and we tried to identify if a specific theory puts an emphasis on one of those. For each theory we also identified the type of theory (e.g., evolutionary/biological, psychodynamic, cognitive, social/attachment) and what type of valence and emotions researchers identified in conjunction with emotional crying. An overview of each theory is presented in Table 1.

Supplementary Table S1. Overview of different theories of emotional crying and their predictions about causes, functions, experienced feelings, and associated emotions.

Class of Theories	Theory	Cause	Function	Experienced Feeling	Associated Emotion(s)	Source
Physiological-Regulation						
Evolutionary	Protection of Eye (Tears)	Suffering	Signaling Need; Protecting the eye (tears)	Negative	Distress	Darwin (1872)
Evolutionary	Lubrication of Mucous Membrane	Sorrow, Distress	Prevent dehydration of nasal mucous membranes	Negative	Distress	Montagu (1959)
Evolutionary	Toxic Removal Theory	Stress	Removal of toxins following distress	Negative	Distress	Frey & Langseth (1985)
Physiological-Signaling						
Social	Grief as a stressful event	Stress, Physiological Activation, Separation	Group Cohesiveness	Negative	Grief	Averill (1968)
Biological	Distress-Anguish	Excessive level of stimulation	Communicate to Organism and Others that Something is Not Well; Motivate Regulation	Negative, (Positive)	Distress-Anguish	Tomkins (1963)
Biological	Arousal View	High levels of autonomic, somatic, behavioral activation	Signal value to others, group cohesion	Negative	Sadness	Gross et al. (1993)
Evolutionary	Mammalian cry circuit	(Infant) separation, distress, isolation, cooling, pain	Survival function, signaling need to caregiver	Negative	Distress	Newman (2007)
Cognitive-Regulation						
Psychodynamic	Safety Valve	Emotions exceeding tolerance level	Homeostasis, releasing energy, self-soothing	Negative, Positive	Grief, Disappointment, Anger, Joy	Heilbrunn (1955); Sadoff (1966)
Biological	Self-soothing hypothesis	Separation, loss, helplessness, overwhelmedness	Self-soothing (parasympathetic rebound, oxytocin, sobbing as rhythmic regulation), Social-soothing	Negative, Positive	Sadness, Grief, Joy, Relief	Gracanin et al. (2014)
Biological	Mirror Neuron Hypothesis	Pain, Sorrow, Stress, Positive Emotions	Inducing Empathy (Mirror Neurons), Regulating mood	Negative (Positive)	-	Bellieni (2017)

			(massaging effect of tears, sobbing as rhythmic regulation)			
Cognitive-Signaling						
Evolutionary	Signaling Hypothesis	Negative/positive values, incurring costs, enjoying benefits	Plea to minimize costs imposed by nature, Show importance to values	Negative, Positive	Sadness, Anger, Guilt, Shame, Gratitude, Pride …	Sznycer et al. (2025)
Social/Attachment	Signaling Theory	Diverse from grief, pain, joy, humor …	Appeal for assistance, terminate aggression, act of surrender, capitulation, or submission	Negative, Positive	Grief, Pain, Joy, Humor, Adoration …	Huron (2024)
Social/Attachment	Attachment theory	Separation (infant), loss (adult)	Attachment bond, Signal attachment	Negative	Sadness, Grief, Protest	Nelson (1998)
Social/Attachment	Attachment-theory	Separation, loss, grief, reunions, victories	Mood regulation (parasympathetic rebound), Attachment-signal eliciting support	Negative, Positive	Sadness, Grief, Joy	Hendriks et al. (2008);
Social/Attachment	Suffering Symbol Theory	Pain, fear, loneliness, loss; Empathy, solidarity, admiration, heroism	Requesting help/offering help	Negative (requesting, offering), Positive (offering)	Sadness, Grief, Helplessness, Sympathy, Admiration, Joy, Empathy	Murube et al. (1999)
Cognitive/Social	Five Reasons to Cry (FRC)	Need frustration/satisfaction, loneliness, impotence, overload, harmony, media	Regulation of needs; Signal to evoke support	Negative (loneliness, impotence, overload), Positive (harmony, media)	Sadness, frustration, Joy, Awe …	Barthelmäs et al. (2022)
Cognitive	Perceived Helplessness Theory	Frustration, perceived helplessness	Relief, Understanding, Communication	Negative, Positive	Pain, Sadness, Anger, Guilt, Empathy, Joy	Miceli & Castelfranchi (2003)
Cognitive	Two-Factor Theory	Arousal followed by recovery (tension reduction)	Relief, Signaling recovery	Negative, Positive	Sadness, Joy	Efran & Spangler (1979)

Note. The table attempts to provide a broad overview of theories and group them into different classes. Some theories might be more complex than can be captured in the current overview and therefore we only focus on the main propositions of each theory. Triggers: physiological, cognitive; Functions: regulation, signalin

Physiological-Regulation. Some researchers have argued that emotional crying is triggered by changes in neurophysiological processes and its main function is intrapersonal in nature by focusing on biological mechanisms (Darwin, 1872; Frey & Langseth, 1985; Montagu, 1959). Based on this view crying is caused by high physiological arousal in the form of stress, distress or suffering and its main function is an evolutionary mechanism to increase the fitness of the organism. While Darwin (1872) attaches a signaling function to crying, he considers weeping a byproduct of protecting the eye from pressure exerted due to the crying response. Montagu (1959) considers weeping as an evolved mechanism to lubricate the nasal mucous membrane as crying could cause dehydration but this has been questioned as other forms of behavioral expressions not featuring weeping can cause dehydration of such membranes. Frey et al. (1983) argues that the main function of weeping is to remove chemical toxins like other bodily fluids such a sweat or urination. Some first evidence suggests that emotional tears feature a different chemical profile compared to reflex tears (Frey et al., 1981). However, the adaptiveness of such a mechanism has been questioned due to the limited amounts of tears shed compared to other bodily fluids (Bellieni, 2017).

Physiological-Signaling. Another line of theories agree that emotional crying is triggered by changes in physiological arousal, but that its main function is interpersonal in nature by signaling to other conspecifics a high level of stress (Averill, 1979; Darwin, 1872; Gross et al., 1994; Newman, 2007; Tomkins, 1963). For instance, theories highlight that the main function of crying is to communicate to others that something is not well (Gross et al., 1994; Tomkins, 1963), increase group cohesiveness (Averill, 1979; Gross et al., 1994), or in infants signal need to a caregiver (Newman, 2007).

Some theories also ascribe both functions – intrapersonal regulation and interpersonal signaling to emotional crying. For example, Darwin (1872) argues that crying represents a signal of the organism in need, while weeping fulfills a more biological function according.

Tomkins (1963) argues that crying signals need to others but also to the crier and motivates self-regulation.

Cognitive-Regulation. Another class of theories, mainly from the psychoanalytical tradition, argue that crying is not mainly triggered by physiological arousal but the psychological (unconscious) interpretation of such or the situation and that the main function is to provide catharsis or release of energy (Heilbrunn, 1955; Koestler, 1964; Sadoff, 1966). For instance, Heilbrunn (1955) argues that crying is caused by emotions exceeding a tolerance level in intensity and function to release energy, restore homeostasis and provide self-soothing. Similarly, more biologically focused theories have considered crying as regulating mood by parasympathetic rebound (Gračanin et al., 2014; Hendriks et al., 2008), sobbing providing rhythmic breathing (Bellieni, 2017; Gračanin et al., 2014) or tears providing a massaging and relaxing effect (Bellieni, 2017), while also focusing on interpersonal functions.

Cognitive-Signaling. Finally, theories have considered emotional crying being triggered by cognitive appraisals or evaluations and function mainly as signals to communicate the need for support (Barthelmäs et al., 2022; Efran & Spangler, 1979; Huron, 2024; Miceli & Castelfranchi, 2003; Murube et al., 1999; Sznycer et al., 2025). However, the specific triggers differ across the individual theories with theories focusing on perceived helplessness (Frijda, 1986; Miceli & Castelfranchi, 2003), psychological recovery after high arousal (Efran & Spangler, 1979), negative or positive values incurring costs or providing benefits (Sznycer et al., 2025), separation from an attachment figure or loss (Hendriks et al., 2008; Nelson, 2005), need frustration or satisfaction including loneliness, impotence, overload, harmony or media-related triggers (Barthelmäs et al., 2022), or diverse emotions such as grief, pain, joy, or humor (Huron, 2024; Murube et al., 1999). The specific signals also differ slightly among theories including signaling need to others to evoke support

(Barthelmäs et al., 2022; Miceli & Castelfranchi, 2003; Murube et al., 1999), communicating the importance of values (Paoli et al., 2022; Sznycer et al., 2025), forming attachment-bonds (Hendriks et al., 2008; Nelson, 2005), communicating offer for help (Murube et al., 1999), or signaling recovery (Efran & Spangler, 1979).

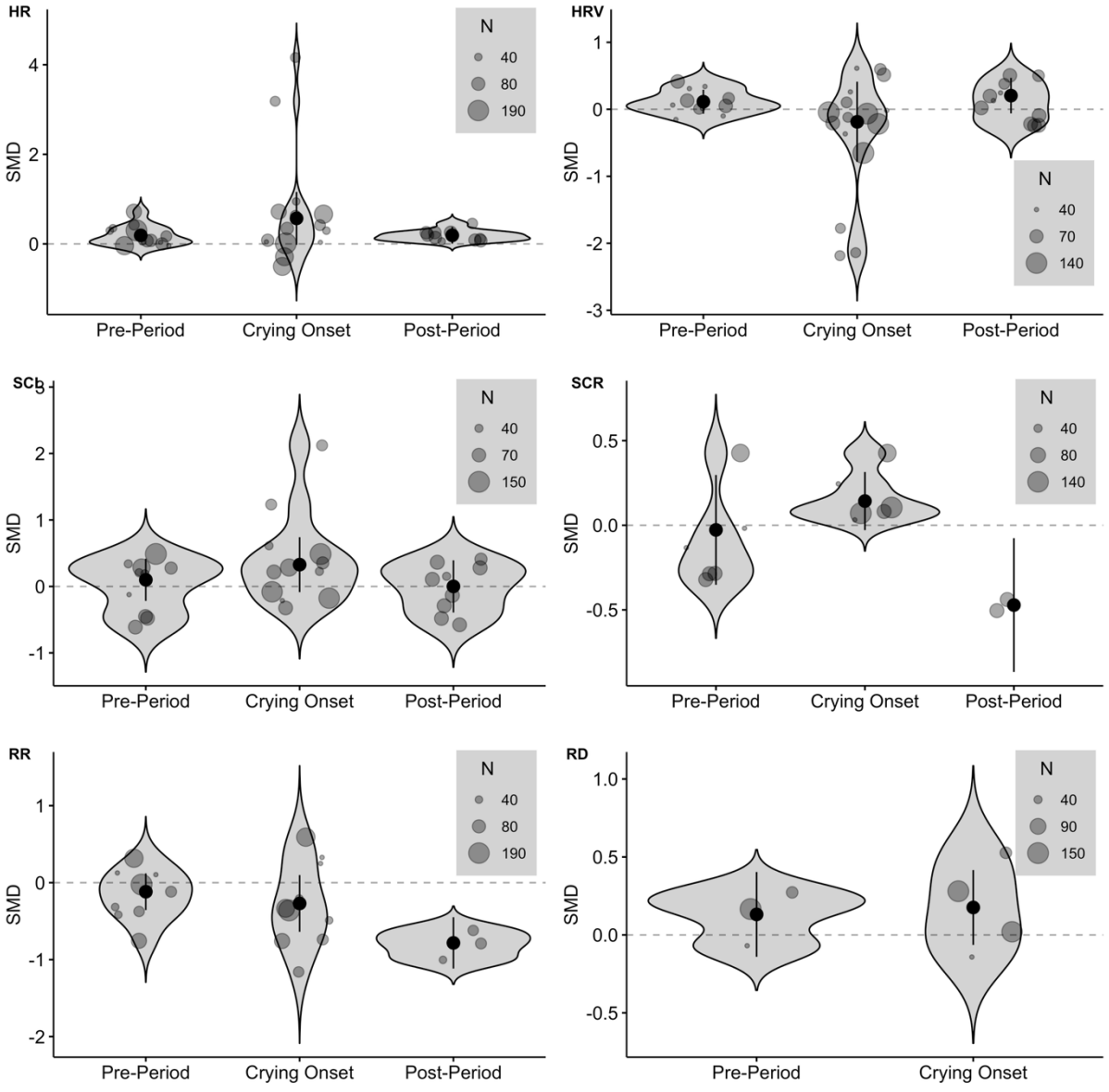
Integration of Theoretical Approaches. Altogether, theories repeatedly highlight two different triggers: high levels of physiological or psychological arousal and the perception or appraisals of helplessness, powerlessness, or loneliness. Considering the function, most commonly theories highlight an intrapersonal function of mood regulation or catharsis and an interpersonal function of communicating the need for support. Importantly theories differ in specific nuances or how they refer to such triggers or functions (e.g., value costs or need frustration) or might combine specific functions. For instance, the psychodynamic theory by Heilbrunn (1955) considers an excessive intensity of emotions as a trigger that could refer to both high physiological arousal but also cognitive evaluations of helplessness. Similarly, the majority of theories presented in Table 1 highlight both intra- and interpersonal functions and some also consider their interaction as important (Gračanin et al., 2014; Rottenberg et al., 2008).

Empirical Evidence of Emotional Crying

Triggers of Emotional Crying.

Physiological Triggers – High Arousal. From a physiological view there exists some evidence of increased sympathetic nervous system activity when individuals cry (Gross et al., 1994; Kraemer & Hastrup, 1988; Labott et al., 1990; Rottenberg et al., 2002). In a meta-analysis focusing on autonomic nervous system measures in response to emotional crying across 12 articles and $N = 1{,}017$ participants it was found that indices assessing sympathetic nervous system activity increased at around crying onset and again decreased post-crying compared to a baseline (see Figure 1; Zickfeld & Grüning, 2021). Considering psychological

evidence, some studies find that individuals report higher feelings of distress or psychological stress when reporting their crying episodes (Bylsma, Vingerhoets, et al., 2008; Bylsma et al., 2011) and a recent large-scale four week diary study across n = 1411 crying episodes observed increases in self-reported arousal increasing before crying onset and reaching a peak during the crying episode (Barthelmäs, 2025). Therefore, there exist some evidence, both physiological and psychological, that arousal is increased at around crying onset.



Supplementary Figure S1. Overview of meta-analytic evidence by Zickfeld and Grüning (2021) for different measures of heart rate (HR), heart rate variability (HRV), skin conductance level (SCL), skin conductance response (SCR), respiratory rate (RR), and respiratory depth (RD). Error bars represent 95% confidence intervals. Figure taken from *Zickfeld, J. H., & Grüning, D. J. (2021). A meta-analysis on the autonomic nervous system correlates of human emotional crying.* https://doi.org/10.31234/osf.io/axjd5.

Nevertheless, there exist two potential caveats in interpreting this and other data related to emotional crying. First, as a general problem in crying research (see Vingerhoets, 2013; Vingerhoets et al., 2000 for critiques) there is no standardized approach to assess crying or its specific trajectory. Studies might differ in ways that they assess crying via self-report, observational measures such as coding video recordings (Zickfeld, Arriaga, et al., 2020), or physiological measures such as infrared thermography (Ioannou et al., 2016). Such measures likely differ in their validity and further studies might use different indicators to assess crying onset and offset. For instance, does the crying episode start when the first action unit of an associated facial expression changes, when eyes get moist, when the first vocalization is recorded, or when the first tear runs down the cheek? Does it end when tears are absent, when vocalizations stop, or when individuals feel relieved? There is no agreed upon definition for the trajectory of crying episodes and most theorizations ignore this aspect completely or provide insufficient predictions. Therefore, studies differ vastly in the way they operationalize crying onset and offset (sometimes just speaking about pre- and post-crying episodes; Zickfeld & Grüning, 2021), while research has shown that the specific timing of measurement does indeed matter (Gračanin et al., 2015). Such bias in measurement and the fact that crying research must commonly rely on quasi-experimental approaches (i.e., it is an impossible task to make everyone in a randomized group cry) precludes any conclusion of

whether high arousal causes crying or crying causes high arousal. Second, even if we would have systematic evidence that high arousal *causes* emotional crying, is it sufficient to evoke this response? There is extensive evidence of high arousal emotional responses that do not elicit crying (Siegel et al., 2018) and most common emotion theories highlight the importance of cognitive interpretations on the final outcome (Moors, 2010).

Cognitive Triggers – Reduced Control. While theories suggest a wide range of possible psychological and cognitive triggers for emotional crying, we argue that the majority focus on some aspect of helplessness, overwhelmingness, reduced control, or frustration (Barthelmäs et al., 2022; Frijda, 1986; Miceli & Castelfranchi, 2003; Murube et al., 1999; Sznycer et al., 2025; Vingerhoets & Bylsma, 2016). For instance, attachment theory argues that crying is triggered by separation or loss (Hendriks et al., 2008; Nelson, 2005), situations that typically feature high levels of helplessness. Other theories have argued that crying is evoked by incurring costs to important values (Sznycer et al., 2025) and such costs can be perceived as overwhelming. Even crying in response to positive situations has been explained by increased overwhelmingness in response to achievement, beauty, or love (Vingerhoets & Bylsma, 2016; Zickfeld, Seibt, et al., 2020).

Reviewing the empirical literature, studies have found that typical situations in which people cry feature rejection, conflict, loss, inadequacy, overload, and suffering (Barthelmäs et al., 2022; Bylsma et al., 2008, 2011; Denckla et al., 2014; Vingerhoets et al., 1997), which were found to feature reduced control (Vingerhoets et al., 1997). Similarly, more intense crying is associated with increased feelings of helplessness or powerlessness in laboratory and retrospective studies (Gračanin & Vingerhoets, 2024; Vingerhoets et al., 1997). While some situations focusing on inadequacy or overload might also highlight low competence or skill (Barthelmäs et al., 2022), they also include reduced control. For instance, hearing about the loss of a loved one does typically not focus on the inadequacy of a specific skill or

competence (except if your skill could have saved the person) but highlights your inability to do anything about that situation (reduced power or control over their fate). When asking about the reasons for not downregulating their crying, people also mainly indicate that they were unable to avoid crying due to its strong intensity (Simons et al., 2013).

Functions of Emotional Crying

Intrapersonal Regulation. Looking at laypeople's beliefs and popular science articles there seems to be an agreement that one main function of emotional crying is to regulate the crier's mood and provide stress reduction or catharsis (Stougie et al., 2004; Vingerhoets & Bylsma, 2007). However, the scientific evidence regarding this idea has been rather mixed. Considering regulation from a physiological level there is some meta-analytic evidence of reduced sympathetic nervous system activity after crying (Zickfeld & Grüning, 2021), but this might be stronger for positive crying (Ishii & Shinya, 2021). Similarly, an increase of parasympathetic activity seems less obvious (Zickfeld & Grüning, 2021), although the lacrimal gland is mainly innervated by parasympathetic activity (Bylsma et al., 2019). However, respiratory rate was found to be reduced during crying, which might be one potential mechanism in regulating mood (Zickfeld & Grüning, 2021). Some theories suggest that rhythmic sobbing and controlled breathing induced by crying might indeed function to decrease sympathetic activity and provide successful regulation (Bellieni, 2017; Gračanin et al., 2014). Physiological studies on stress responses however find no improvement on pain sensitivity or reduction of stress after crying (Gračanin et al., 2022; Sharman et al., 2020).

Focusing on self-report evidence, a majority of individuals typically report positive regulatory effects of crying in retrospective studies but no or negative effects in laboratory studies right after they cry (Bylsma et al., 2008, 2011; see Gračanin et al., 2014; Rottenberg et al., 2008 for reviews). There are several possibilities to explain such conflicting findings. First, it is possible that individuals think of the stereotypical benefit associated with crying

that is consistently highlighted across the media when providing retrospective reports. Second, some evidence suggests that the timing of asking about mood improvement seems important with participants providing improved reports first several minutes after crying (Gračanin et al., 2015). Third, laboratory studies provide environments with low ecological validity and crying in everyday life might be more effective in regulating mood due to other possible influences such as increased support by bystanders (Rottenberg et al., 2008). Overall, it has been suggested that several moderators including individual, social, environmental, and cultural aspects might influence whether crying can be effective in mood regulation and catharsis (Gračanin et al., 2014; Rottenberg et al., 2008), with Rottenberg and colleagues (2008) suggesting that it might be most effective when control is high. Self-report evidence suggest that mood regulatory effects are most pronounced for positive crying and situations in which another individual is able to provide support or succor (Bylsma, Vingerhoets, et al., 2008; Rottenberg et al., 2008), which brings us to the other postulated function of emotional crying.

Interpersonal Signaling. From an evolutionary viewpoint crying has been considered an ethological signal that communicates helplessness and need of the organism to the environment (Bowlby, 1982; Huron, 2024; Nelson, 2005; Provine et al., 2009; Sznycer et al., 2025; Zeifman, 2012). Human infants are known for their extended dependency period compared to other animals and crying provides the pre-verbal infant with the ability to alert their environment about their needs, specifically their caregivers. It has been argued that while crying provides a potent signal across long distances it might also alert potential predators and for this reason weeping or tears might have been co-opted for the same signalling function (Provine et al., 2009). Tears represent a potent signal as they are displayed on the face, the bodily part most salient during social interactions and their reflection can also be spotted across some distance (Sznycer et al., 2025; Vingerhoets, 2013). At the same time,

tears impose costs on the crier as they result in blurred vision and make the crier more vulnerable in case of attacks. This might be one reason why tears are considered especially difficult to fake and considered as more honest signals compared to vocalized expressions (Wróbel et al., 2025).

The empirical literature provides extended support for emotional crying as a signalling function (Gračanin et al., 2017; MacArthur & Shields, 2019; Zickfeld & Wróbel, 2024). Crying individuals consistently evoke higher support intentions and behavior compared to neutral expressions (Zickfeld & Wróbel, 2024) and this effect seems stable across 41 different countries (Zickfeld et al., 2021) or the lifespan (Zeifman & Brown, 2011). This tendency seems to be mostly driven by criers perceived as helpless, warm, honest, and low in aggression (i.e., they are considered to possess low control) and observers tendency to feel compassionate about them (Zickfeld & Wróbel, 2024). Different individual and situational factors have been identified suggesting the signal function of crying is most effective when the reason for crying is salient (Zickfeld et al., 2021), observers are close others in contrast to strangers (Barthelmäs et al., 2024), or crying is perceived as appropriate and authentic (Wróbel et al., 2025). Criers also consistently suggest that a reason for crying (and not downregulating it) was to evoke support from others (Simons et al., 2013). The signaling function also seems to extend to positive crying (Zickfeld et al., 2021), although it has been argued that crying for positive reasons can also signal the offer to help (Murube et al., 1999) or the importance of values or meaning (Paoli et al., 2022; Sznycer et al., 2025).

If one main function of emotional crying is to signal the need for help to (close) others how does this explain the finding that a large percentage of adults report crying alone (Bylsma, Vingerhoets, et al., 2008; Bylsma et al., 2011)? As we will discuss later different variables moderate whether individuals will cry and its effectiveness. Among these, concerns about appearing as weak or emotional (Simons et al., 2013), likely driven by feelings of guilt

or shame (Vingerhoets, 2013). As infants or children are generally considered low in agency or power the possible benefits of crying (e.g., support) can outweigh its costs (low agency). This might be considered different for adults, especially those high on agency that might incur higher costs for showing weakness (Sznycer et al., 2025), which makes downregulation of crying or delaying it until alone a viable strategy for reducing reputation costs (Simons et al., 2013).

Altogether, currently there is mixed evidence for an intrapersonal regulation function of emotional crying with results depending on methods or differences in measurement. At the same time, there is consistent evidence for an interpersonal signaling function of emotional crying across the lifespan.

Supplementary Note 2. Moderators of Occurrence of Crying

Crier Characteristics

Gender. A large body of empirical work has provided evidence that women report on average higher crying frequencies[1] (Barthelmäs et al., 2025; Barthelmäs & Keller, 2021; Peter et al., 2001; Vingerhoets et al., 2000) and this general effect seems to be similar across cultures (A. Fischer et al., 2004; van Hemert et al., 2011). There is no conclusive evidence on whether this difference is based on biological differences (Bylsma et al., 2019) or social-developmental effects related to gender-norms or social roles (A. Fischer & LaFrance, 2015), with current findings suggesting a larger impact of the latter (Bylsma et al., 2019; Van Tilburg et al., 2002). Such differences also seem to interact with age, with gender differences first visible at around 9-11 year olds (Hastrup et al., 2002; Santiago-Menendez & Campbell, 2013; Van Tilburg et al., 2002), which has been attributed to higher empathy for girls at that age (Van Tilburg et al., 2002), but an inhibitory effect of testosterone has also been discussed (Bylsma et al., 2019). Gender also interacts with the valence of the situation with smaller gender differences found for positive crying (MacArthur & Shields, 2015; Zickfeld, Seibt, et al., 2020). Gender differences have been observed in general levels of assertiveness (Feingold, 1994; Leaper & Ayres, 2007) or the experience of powerless emotions (A. Fischer et al., 2004) with women on average reporting lower levels of assertiveness and higher experience of powerless emotions (but see Twenge, 2001 for historical changes). In addition, there is consistent evidence of higher reported levels of affective empathy for girls and women (Rochat, 2023) with empathy argued to affect the crying threshold (Zickfeld et al., 2022). Therefore, we think that gender differences in the occurrence of emotional crying can

[1]Importantly, studies differ in whether they focus on self-reported crying frequency (i.e., how often someone cries), crying latency (i.e., how long ago did someone cry) or crying proneness (i.e., how likely someone cries). Since these are positively correlated (Denckla et al., 2014) we will consider them as evidence for crying occurrence, but emphasize that they could in some circumstances predict different outcomes.

be explained by on average lower baseline levels of control (and thereby smaller PLC for the same level of SIA) and a lower crying threshold as influenced by general assertiveness and empathy.

Age. There is further evidence for variations of crying across the lifespan with research identifying that infant crying peaks at around four weeks, increases until around eight weeks and then decreases (Vermillet et al., 2022). Crying then decreases again in adolescence (Hastrup et al., 2002; Van Tilburg et al., 2002), while weeping due to positive triggers increases across adulthood reaching a peak at around 60-75 (Zickfeld, Seibt, et al., 2020) and weeping due to negative triggers decreases across adulthood until at around 50 years of age when it remains stable (Barthelmäs et al., 2025; Zickfeld, Seibt, et al., 2020). In addition, while crying using vocalizations is the common response in infancy and childhood, weeping or just shedding tears becomes more common in adults (Vingerhoets, 2013).
Our model predicts these developmental changes by highlighting lower levels of control that increases across childhood and adolescence (Zeman et al., 2006). Newborn infants have limited abilities of regulating their emotions beyond alerting their caregivers via crying and would therefore exhibit high reductions in perceived control for any type of aversive arousal. In addition, based on limited emotion regulation capacities they are also expected to have a lower crying threshold. During childhood the child develops first more basic and later more sophisticated emotion regulation strategies (Eisenberg, 2000; Zeman et al., 2006), suggesting that (aversive) arousal can be regulated via different mechanisms than emotional crying. Once the child also gains more autonomy this should generally reduce levels of PLC, reaching higher levels in adolescence. Research on older adults suggest that in general they develop more adaptive emotion regulation strategies, increase in emotional stability, and more frequently seek positive emotions (Carstensen et al., 2000, 2020; Charles & Carstensen, 2010; Sun & Sauter, 2021), as well as show higher self-control (Young & Mikels, 2020). This

can explain findings of frequency of negative crying decreasing over the lifespan with older adults becoming more skilled in emotion regulation strategies and experience less PLC, while at the same time they lower their crying threshold for positive emotions due to an increased focus on seeking those.

Affective Empathy. There are several personality traits that have been consistently associated with emotional crying, with trait affective empathy, the ability to experience the feelings of others, consistently predicting higher frequencies of emotional crying (Barthelmäs et al., 2025; Choti et al., 1987; Denckla et al., 2014; Zickfeld et al., 2017, 2019, 2022), also at an early age (Van Tilburg et al., 2002). The relationship also seems to hold beyond other possible predictors such as gender, social desirability, or well-being (Zickfeld et al., 2022). Similarly, individuals who report that they never cry also show lower empathy (Hesdorffer et al., 2018). The importance of affective empathy in emotional crying has been discussed as reflecting an increased ability to understand one's own emotions and empathize with other's suffering, which is already evident for one-year olds (Roth-Hanania et al., 2011; Zahn-Waxler et al., 1992). In addition, the ability to empathize with others aligns with the interpersonal function of crying. Empathy has been found to be only weakly related to assertiveness (Koch et al., 2024; Vachon et al., 2014), which might also fit the idea that it is related to a lower baseline of control. In addition, affective empathy is considered to lower the crying threshold (Zickfeld et al., 2022).

Neuroticism. Across the Big Five personality traits, neuroticism or low emotional stability has been most consistently linked to the occurrence of emotional crying (Barthelmäs & Keller, 2021; Cotter et al., 2018; De Fruyt, 1997; Peter et al., 2001; van der Veen et al., 2012; Williams, 1982). Again, neuroticism has been associated with low assertiveness or control (Judge et al., 2002; Vestewig & Moss, 1976) and therefore might predispose individuals to lower baselines of control and have a lower crying threshold. This is also

supported by the finding that the relationship with neuroticism is weaker for positive emotional crying (Zickfeld, Seibt, et al., 2020).

Attachment Style. Emotional crying has been discussed as an attachment signal (Nelson, 2005) and studies suggest a positive relationship with anxious attachment (Denckla et al., 2014; Fiori et al., 2013, 2017; Laan et al., 2012; Millings et al., 2016) and a negative relationship with avoidant attachment (Fiori et al., 2017; Laan et al., 2012; Millings et al., 2016). Anxious attachment is characterized by an increased focus on possible abandonment and high interpersonal sensitivity. Since most (if not all) situations triggering emotional crying are interpersonal in nature (e.g., major triggers include disruption or termination of relationships, Vingerhoets, 2013) a heightened sensitivity could increase PLC and thereby influence the crying threshold.

Attitudes towards Crying. Not surprisingly, research finds that individuals who have positive attitudes towards crying also report crying more frequently, intensely, and consider it as more helpful (Millings et al., 2016; Sharman, G. A. Dingle, et al., 2019; Sharman, G. Dingle, et al., 2019). We argue that positive attitudes towards crying lower the crying threshold as those individuals think positively about crying, they will also engage in more upregulation of emotional crying (Simons et al., 2013).

Mental Health Problems. Some studies have provided evidence that emotional crying is related to mental health problems such as reduced psychological well-being (Barthelmäs et al., 2025; Barthelmäs & Keller, 2021; cf. Zickfeld et al., 2022) or increased mental stress (Fiori et al., 2013). Again, low psychological well-being or mental health problems have been linked to low control (Cheng et al., 2013), and could therefore result in lower baseline levels of control. Notably, relationships between mental health problems and emotional crying were weaker for positive situations (Zickfeld, Seibt, et al., 2020). While emotional crying has been linked to mental health problems there is limited systematic evidence that crying or excessive

crying is a symptom of clinical depression (Hastrup et al., 1986; Rottenberg et al., 2002; Vingerhoets et al., 2007). The current and previous versions of the Diagnostic Statistical Manual of Mental Disorders (DSM-5) do not list emotional crying or tearfulness as a symptom or criteria for the class of depressive disorders. Rottenberg and colleagues (2002) observed lower increase of sympathetic activation for depressed criers suggesting that such reductions in autonomic nervous system in response to stimuli might also influence the capacity to cry (Bylsma, 2021). Vingerhoets and colleagues (2007) speculated that crying frequency will increase with non-clinical mental health problems but decrease again for clinical conditions.

Serotonin Levels. There is some evidence that emotional crying is influenced by 5-hydroxytriptamine (HT, serotonin) levels. Selective serotonin reuptake inhibitors (SSRIs) that increase 5-HT levels are used to treat pathological crying after brain injury (Muller et al., 1999). Further, a randomized control trial with a non-clinical sample found that crying in response to a movie was reduced for participants receiving a SSRI (paroxetine) compared to a placebo control (van der Veen et al., 2012). The study further observed reduced reports of arousal and valence in the treatment group fitting our model that elevated 5-HT levels influence the occurrence of SIA. There is a general finding of reduced emotional reactivity in depressive disorders that also fits this finding (Bylsma, Morris, et al., 2008). Further, SSRIs are often used in the treatment of clinical depression, which could explain reduced levels of emotional crying for such conditions (Rottenberg et al., 2002; Vingerhoets et al., 2007).

Alexithymia. Similar to findings of low emotional reactivity, emotional crying has been negatively linked to alexithymia, a reduced capacity with feeling, expressing, or correctly labelling emotions (Vingerhoets et al., 1993; Zickfeld et al., 2022). We argue that this would also reduce susceptibility to arousal (Peasley-Miklus et al., 2016) and decrease PLC, as well as increasing the crying threshold.

Situation Characteristics

Valence of Situation. One major differentiation has focused on the eliciting events or situations of emotional crying, differentiating between crying triggered by negative or positive stimuli (Scheirs & Sijtsma, 2001; Vingerhoets & Bylsma, 2016). Some theories have considered positive crying distinct from negative crying as it might provide a different function or their triggers were considered incompatible (Kottler & Montgomery, 2001; Paoli et al., 2022). We argue that positive and negative crying alike are evoked by the same mechanism – a PLC and SIA. Compared to negative crying, SIA are considered rather similar. Positive situations can evoke equally strong SIA as negative situations (Behnke et al., 2022). However, we argue that valence moderates PLC, expecting a smaller reduction of control for positive situations. Excessive arousal in positive situations will likely also affect PLC, but due to the fact that coping in general might be higher in positive situations (Cong et al., 2022; Tong, 2015; Tong & Jia, 2017) and because the situation is experienced as positive overall, this results in a smaller PLC. The proposition is similar to previous theories arguing that individual cry in positive situations because of being overwhelmed (i.e., perceived loss in control) by positive feelings suggesting it mainly occurs for high intensity emotions (Vingerhoets & Bylsma, 2016). This suggests that positive crying is also easier to regulate, which is indeed supported by empirical findings (Bylsma et al., 2011; Bylsma, Vingerhoets, et al., 2008; Gračanin et al., 2014; Ishii & Shinya, 2021; Rottenberg et al., 2008) and that it should be less intense (e.g., by featuring more subtle displays) than negative crying. Similarly, while SIA and PLC increase negative valence for negative crying, it will do so for positive crying as well but to a much smaller degree due to a reduced loss in control. This is supported by research showing that positive crying also includes a small degree of negative valence or negative emotions (Zickfeld, Seibt, et al., 2020). An example and comparison of

both predicted trajectories for negative and positive crying with a similar SIA is provided in Figure 3 (a & c).

We have already mentioned that valence of the situation interacts with age, with the capacity to cry for positive reasons most likely first emerging in childhood, although there is no scientific evidence on this question (see Cova & Deonna, 2014). Why would younger children not cry for positive reasons although they most likely also experience increases of arousal and a reduction of control in positive situations? There are three main reasons why we think that young children do not cry for positive situations. First, crying in infancy is mainly used for negative situations to communicate loss of control and might be conditioned as such (Newman, 2007). Second, crying is associated with negative situations based on social and cultural norms and children first need to learn the ability to experience and understand more complex emotions. Understanding of complex or mixed emotions seems to develop earlier at around the age of 3 (Smith et al., 2015), while experiencing such emotions first develops later between ages 5 and 12 (Kestenbaum & Gelman, 1995; Larsen et al., 2007; Zajdel et al., 2013). Third, due to low control across situations toddlers will have a lower baseline also for positive situations, which might decrease the impact of PLC compared to adults who have a higher baseline.

Presence of Observer & Relationship with Observer. Another situational moderator is the specific social situation including the presence of observers and whether this includes close others or strangers (Barthelmäs et al., 2024; Sharman, G. Dingle, et al., 2019). As we will argue in the next section, the main function of emotional crying is to communicate PLC and attract social support. This function is more likely fulfilled by caregivers or close others which would suggest that the presence of such individuals should increase the probability of emotional crying. Indeed, research shows that at a certain developmental stage children can use crying strategically by delaying crying until a caregiver is present (Bruzek et al., 2024).

Adults are also more likely to cry in the presence of few close others (Barthelmäs et al., 2024; Bylsma, Vingerhoets, et al., 2008) or might delay crying until they are alone to avoid crying in front of strangers or others that might not respond positively (Bylsma, Vingerhoets, et al., 2008; Rottenberg et al., 2008). The social context and social norms will therefore influence costs and benefits related to crying. While crying in the presence of close others can improve benefits for adults by increasing the probability of receiving social support, crying in the presence of strangers or less close others might impose several costs (Huron, 2024; Sznycer et al., 2025). First, non-close observers might feel distressed or unsure how to react ultimately failing to provide support or even avoidant or threatening behavior (Zickfeld & Wróbel, 2024). Second, in the case of weeping, tearing up further exposes criers by blurring their visual field and making them less able to quickly respond to changes in their environment (Provine et al., 2009). Third, signaling PLC will come at the cost of reduced power and maybe social status that will be especially costly for individuals high in baseline dominance or power. While such costs are negligible for infants or children (since their general baseline of control is low) they might be especially high for high-status individuals as crying could also affect reputation costs. Research supports this idea finding that crying is perceived as most detrimental for individuals perceived as higher in dominance (e.g., males) in settings highlighting assertiveness or ability (e.g., work settings; A. Fischer et al., 2013) and men also report feeling more shameful about crying (Becht & Vingerhoets, 2002). Finally, the number of observers should also influence the occurrence of crying, which has been supported in self-report studies (Byslma et al., 2008, 2010). Based on general findings of reduced probability of support for increasing number of observers (Fischer et al., 2011), people should be less likely to cry the more observers are present (especially when these are also strangers). The finding that individuals often report crying when they are alone (Bylsma et al., 2011; Bylsma, Vingerhoets, et al., 2008) might suggest that crying's potential costs driven by social norms

(e.g., loss of status, shame) might outweigh its potential gains (e.g., receiving social support, regulating excessive arousal) in certain situations.

Time of the Day. Some evidence suggests that children and adults are most prone to crying in the evening (Vingerhoets, 2013). One explanation based on the current model might be reduced levels of self-control (Baumeister et al., 2019) and increased sleepiness (Dolan et al., 2009) during the end of the day, that could lower the crying threshold. Alternatively, it is possible that especially adults delay crying until the evening when they reflect on the day and feel they are in a safe environment (Vingerhoets, 2013). Another explanation considers that common triggers of crying (e.g., watching movies, having an argument) occur more frequently at the end of the day (Barthelmäs et al., 2022).

Cultural Characteristics

Anthropological findings emphasize the importance of emotional crying, especially tears, in rituals and traditions across cultures (Fiske, 2019). As such weeping plays an important role in greeting or farewell rituals (e.g., funerals) in different cultures (Ebersole, 2000). Still, there is limited research on crying across cultures (Becht & Vingerhoets, 2002; van Hemert et al., 2011; Zickfeld, Seibt, et al., 2020)[2], but findings suggest that cultural norms or rules can impact the shedding or suppression of emotional crying (Sharman, G. Dingle, et al., 2019). For example, one study found that positive mood changes after crying were negatively associated with country levels of masculinity or shame (Becht & Vingerhoets, 2002), suggesting that emotional crying might be more effective in cultures that support its expression (Van Hemert et al., 2011).

[2]All systematic studies of adult crying across cultures focus on the same dataset, the International Study on Adult Crying (ISAC) collected in the late 90's across 35 countries and using convenience samples of young adults. While this project provides a first overview of cross-cultural effects it also suffers from an increased focus on young adults and specific regions (about 50% of the included countries are in Europe).

Supplementary Table S2. Moderators of crying occurrence, their empirical evidence, and relation to the CAS model.

Focus	Type	Variable	Empirical Evidence	Importance to CAS Model
Crier	Demographics	Gender	• Women report on average higher crying frequencies[1] (Barthelmäs et al., 2025; Barthelmäs & Keller, 2021; Peter et al., 2001; Vingerhoets et al., 2000) ○ Inconclusive whether based on biology (Bylsma et al., 2019) or socio-developmental effects (A. Fischer & LaFrance, 2015), with evidence favoring the latter (Bylsma et al., 2019; Van Tilburg et al., 2002) • Interaction with age, gender differences first visible around 9-11 years (Hastrup et al., 2002; Santiago-Menendez & Campbell, 2013; Van Tilburg et al., 2002) attributed to higher empathy in girls (Van Tilburg et al., 2002) • Interaction with valence, smaller differences for positive crying (MacArthur & Shields, 2015; Zickfeld et al., 2020)	• Women report on average lower levels of assertiveness (Feingold, 1994; Leaper & Ayres, 2007); more powerless emotions (A. Fischer et al., 2004; cf. Twenge, 2001) • Higher levels of affective empathy for girls and women (Rochat, 2023) • Gender differences predicted based on lower baseline levels of control for women (smaller PLC) • High empathy and lower assertiveness lower the crying threshold

		Age	• Variations in crying across the lifespan
			  ○ Infant crying peaks at four weeks, increases until eight weeks and then decreases (Vermillet et al., 2022)
			  ○ Crying decreases in adolescence (Hastrup et al., 2002; Van Tilburg et al., 2002)
			  ○ Positive crying increases in adulthood, peak ~60-75 years (Zickfeld et al., 2020)
			  ○ Negative crying decreases in adulthood until ~50 years and remains stable (Barthelmäs et al., 2025)
			  ○ Crying with vocalizations more common in infancy and childhood, weeping or tears more common in adulthood (Vingerhoets, 2013)
				• Lower levels of control in childhood and adolescence (Zeman et al., 2006)
				• Infants should perceive PLC for any type of aversive arousal, and limited regulation capacities should influence their crying threshold
				• Childhood, development of basic and later sophisticated regulation strategies (Eisenberg, 2000; Zeman et al., 2006), suggesting regulation via other means than crying
				• Higher levels of control once child gains more autonomy
				• Older adults show more adaptive regulation strategies, stability, and positive emotions (Carstensen et al., 2000, 2020; Charles & Carstensen, 2010; Sun & Sauter, 2021) and higher self-control (Young & Mikels, 2020)

			○ Lower levels of PLC, lower crying threshold for positive situations
Personality	Affective Empathy	• Trait affective empathy positively associated with crying frequency (Barthelmäs et al., 2025; Choti et al., 1987; Denckla et al., 2014; Zickfeld et al., 2017, 2019, 2022) • People reporting never crying show lower empathy (Hesdorffer et al, 2018)	• Increase ability to understand own and other's emotions, already at an early age (Roth-Hania et al., 2011; Zahn-Waxler et al., 1992) • Empathy only weakly related to assertiveness (Koch et al., 2024; Vachon et al., 2014) and probably related to lower baseline levels of control • Considered to lower crying threshold (Zickfeld et al., 2022)
	Neuroticism	• Neuroticism positively associated with emotional crying (Barthelmäs & Keller, 2021; De Fruyt, 1997; Peter et al., 2001; van der Veen et al., 2012; Williams, 1982) • Weaker relationship for positive crying (Zickfeld et al., 2020)	• Neuroticism negatively associated with assertiveness and control (Judge et al., 2002; Vestewig & Moss, 1976) and probably relate to lower baseline levels of control and lower the crying threshold
	Attachment Style	• Positive association between anxious attachment and emotional crying (Denckla et al., 2014; Fiori et al., 2013, 2017; Laan et al., 2012; Millings et al., 2016) • Negative association between avoidant attachment and emotional crying (Fiori et al., 2017; Laan et al., 2012; Millings et al., 2016)	• Anxious attachment related to increased focus on abandonment and high interpersonal sensitivity • Most situations triggering crying are interpersonal (e.g., disruption or termination of relationship) • Heightened sensitivity could influence PLC and crying threshold
	Alexithymia	• Negative association between alexithymia (reduced capacity of feeling, expressing, labelling emotions) and emotional crying (Vingerhoets et al., 1993, Zickfeld et al., 2022)	• Alexithymia linked to lower emotional reactivity and susceptibility to arousal (Peasley-Miklus et al., 2016) • Could decrease PLC and increase crying threshold
Beliefs	Attitudes Towards Crying	• Positive attitudes towards crying positively associated with emotional crying (Millings et al., 2016; Sharman et al., 2019a, 2019b)	• Positive attitudes should lower the crying threshold since people think positively about the functions of crying and use more upregulation (Simons et al., 2013)
Mental Health	Mental Health Problems	• Some studies show positive association between emotional crying and psychological well-being (Barthelmäs et al., 2025; Barthelmäs & Keller, 2021; cf. Zickfeld et al., 2022) or stress (Fiori et al., 2013) • Weaker relationship for positive crying (Zickfeld et al., 2020)	• Mental health problems negatively linked to control (Cheng et al., 2013) and could result in lower control baselines • Lower sympathetic activation for depressed criers (Rottenberg et al., 2002) might suggest that in clinical depression less SIA can influence crying (Bylsma, 2021)

			• Limited evidence for relation to clinical depression (Hastrup et al., 1986; Rottenberg et al., 2002; Vingerhoets et al., 2007) • Proposition that crying frequency increases with non-clinical mental health problems but decreases for clinical conditions (Vingerhoets et al., 2007)	
		Serotonin Levels	• Negative association between 5-hydroxytryptamine (5-HT, serotonin) levels and emotional crying (Muller et al., 1999; van der Veen et al., 2012)	• Lower emotional reactivity for higher 5-HT levels (van der Veen et al., 2012) and in depressive disorders (Bylsma, Morris et al., 2008) • Treatment of clinical depression often involves medication increasing 5-HT levels, which could explain reduced crying for such conditions (Rottenberg et al., 2002; Vingerhoets et al., 2007) • Lower emotional reactivity could influence appraisal of stimuli and PLC
Situation		Valence of Situation	• Similarly strong SIA for positive and negative emotions (Behnke et al., 2022) • Higher control for positive situations and emotions (Cong et al., 2022; Tong, 2015; Tong & Jia, 2017) • Positive crying easier and more successful to regulate (Bylsma et al., 2011; Bylsma, Vingerhoets, et al., 2008; Gračanin et al., 2014; Ishii & Shinya, 2021; Rottenberg et al., 2008) • Small increase in negative valence for crying positive situations (Zickfeld et al., 2020) • Interaction with age, positive crying first emerging in childhood but limited empirical evidence (Cova & Deonna, 2014)	• Higher baseline control for positive situations and lower PLC • Positive crying is generally shorter and less intense • Positive crying regulates arousal and mood more successfully • Infants and young children do not show positive crying due to (1) crying used to communicate loss of control in infancy (Newman, 2007), (2) crying associated with negative situations based on social and cultural norms, (3) children need to develop complex emotions with understanding at ~3 years (Smith et al., 2015) and experience later between ~5-12 years (Kestenbaum & Gelman, 1995; Larsen et al., 2007; Zajdel et al., 2013)
		Presence of Observer	• Emotional crying most common with few other people present (Barthelmäs et al., 2024; Bylsma et al., 2008, 2010) • Interaction with relationship: more likely when few close others (Bylsma et al., 2008, 2010)	• Reduced probability of receiving support for increasing number of observers (Fischer et al., 2011) • People often report crying when they are alone (Bylsma et al., 2011) which might suggest that costs driven by social norms (e.g., shame) could outweigh its potential gains (e.g., receiving social support)
	Social Context			

	Relationship with Observer	• Children and adults are more likely to cry in the presence of a close other (Barthelmäs et al., 2024; Bylsma, Vingerhoets et al., 2008; Bruzek et al., 2024; Sharman et al., 2019a)	• Higher probability of receiving support for close observers (Huron, 2024; Sznycer et al., 2025)
			  ○ Non-close others might be distressed and unsure how to react (Zickfeld & Wróbel, 2024)
			  ○ Tearing up exposes crier by blurring visual field making them less able to respond to changes in their environment (Provine et al., 2009)
			  ○ Signaling PLC comes at cost of reduced social status and power, especially costly for individuals high in baseline control or power

	Time of Day	• Some evidence that children and adults cry more frequently in the evening (Vingerhoets, 2013)	• End of the day associated with lower levels of control (Baumeister et al., 2019) and increased sleepiness (Dolan et al., 2009), which could lower the crying threshold • Adults could delay crying until the evening when in a safe environment (Vingerhoets, 2013) • Common triggers such as media or having an argument occur more frequently at the end of the day (Barthelmäs et al., 2022)
Culture	Cultural Norms	• Weeping plays an important role in rituals such as greeting or farewell rituals (Fiske, 2019; Ebersole, 2000) • Culture norms can impact shedding or suppression of emotional crying (Sharman et al., 2019b) • Positive outcomes of crying negatively associated with country-levels of masculinity or shame (Becht & Vingerhoets, 2002)	• Cultural norms or country-levels of masculinity or shame expected to influence the crying threshold

Note. [1] Importantly, studies differ in whether they focus on self-reported crying frequency (i.e., how often someone cries), crying latency (i.e., how long ago did someone cry) or crying proneness (i.e., how likely someone cries). Since these are positively correlated (Denckla et al., 2014) we will consider them as evidence for crying occurrence but emphasize that they could in some circumstances predict different outcomes.

Supplementary Note 3. Moderators of Functions of Emotional Crying

We consider potential moderators separately for the interpersonal signaling function and the intrapersonal regulation function (Figure 1). However, in some cases (e.g., crying intensity) they might overlap which is why we discuss them in the same section. Again, we consider characteristics of the crying response, the crier, the (potential) observer, the situation, and the culture. Detailed discussions of moderators related to the signaling function (MacArthur & Shields, 2019; Zickfeld & Wróbel, 2024) and the regulation function (Gračanin et al., 2014; Rottenberg et al., 2008) have been provided elsewhere, which is why we only focus on the most important aspects and direct readers for in-depth considerations to these sources.

Crying Characteristics

Crying Intensity. Crying intensity is one variable that should influence both the signaling function and the regulation function. While high crying intensity might communicate seriousness and intensity of crying it has been found to reduce ratings of genuineness, appropriateness, and honesty in adults (Golding et al., 2003; Wong et al., 2011; Wróbel, Zickfeld, & Paweł Ciesielski, 2025). On the one hand, tears are considered as more honest signals, with a recent study finding relatively negligible differences for low or high intensity of tears, also because they are considered difficult to produce on demand (Wróbel, Zickfeld, & Paweł Ciesielski, 2025). On the other hand, exaggerated facial expressions or vocalizations are typically considered less appropriate and more commonly evaluated as fake (Wróbel et al., 2025b). Excessive vocalizations might also be considered as distressing and might trigger negative response such as physical abuse (e.g., Levitzky & Cooper, 2000; Reijneveld et al., 2004; Zoucha-Jensen & Coyne, 1993). Crying intensity can also influence the specific support behavior of observers (Pauw et al., 2019).

Regarding the regulation function, according to the model higher crying intensity is caused by a combination of high PLC and SIA. The higher the arousal and the lower the perceived control the more difficult it will be to regulate this state via intraindividual processes (Bylsma et al., 2011; Bylsma, Vingerhoets, et al., 2008; Rottenberg et al., 2008; see Figure 3).

Perceived Appropriateness. An important factor for whether criers can evoke social support in others is the perceived appropriateness of the crying response by the observer (Zickfeld & Wróbel, 2024). This perception further interacts with other crying characteristics (crying intensity), the relationship between crier and observer, and situational and cultural factors. For example, crying at work might be perceived as less appropriate than crying at home across many cultures which will influence reactions to the crier (A. Fischer et al., 2013).

Crier Characteristics

Age. As discussed earlier, the crier's age is expected to moderate the effectiveness of emotional crying as an intraindividual regulation strategy since other regulation strategies might not be available based on the developmental stage. Considering the signaling function, some evidence suggests that the signal function of tears is most potent for adults (and less pronounced for children and infants in that order; Zeifman & Brown, 2011). However, these findings do not necessarily mean that emotional crying is less effective as a signal function in infants as they only focus on tears, but we would rather predict that vocalizations are more effective in infants than in adults. Similarly, tears might be more adaptive in adults as crying could be seen as more irritating and highlight PLC beyond a typical level in adults. The perceptions of PLC seem rather stable for younger and older adults' tears (Grainger et al., 2019).

Perceived Assertiveness. The effect of emotional crying on social support is moderated by the perceived assertiveness of the crier. Specifically, the more in need and

helpless the crier is perceived the more likely others are willing to support them (Zickfeld & Wróbel, 2024). This effect also interacts with crying intensity, whether the crying response is perceived as appropriate, or valence of the situation (with positive crying featuring higher levels of assertiveness). In general, higher reductions in PLC should make the crier appear as less assertive and highlight a loss in control.

Perceived Communion. Further, the effect of emotional crying on evoking social support is influenced by perceived communion, both perceived friendliness and morality (Zickfeld & Wróbel, 2024). Criers are typically perceived as warmer and honest, and this effect again interacts with perceptions of appropriateness or crying intensity.

Felt Shame or Embarrassment. The experience of shame or embarrassment during the crying episode can affect both the successful signaling and regulation function (Rottenberg et al., 2008). Shame is often triggered by uncontrollable events (as is the case for PLC) and its main motivation is to withdraw or escape from a situation (Miceli & Castelfranchi, 2018), which would fail to attract potential support from others (Becht & Vingerhoets, 2002; Bylsma, Vingerhoets, et al., 2008). Shame about crying might also reduce successful intraindividual regulation of arousal and further increase negative affect during crying (Becht & Vingerhoets, 2002). Shame or embarrassment are expected to interact with the crier's age, as the capacity for such moral emotions develops first during childhood (Lewis, 1993), and adult crying might be perceived as more costly due to PLC (Huron, 2024), as well as situational (e.g., who is present) and cultural variables.

Attitudes towards Crying. In contrast, positive attitudes about crying and its social acceptability or success moderates the effectiveness of both the signaling and regulating function (Millings et al., 2016; Sharman, G. A. Dingle, et al., 2019; Sharman, G. Dingle, et al., 2019; Simons et al., 2013). Positive attitudes towards crying will reduce the crying threshold meaning crying can be triggered at higher levels of control (compared to higher

crying thresholds), which will also make it easier to regulate the excessive arousal and feeling due to a smaller PLC (Figure 3c).

Observer Characteristics

Felt Compassion. One major factor for observers providing social support to criers is their felt compassion (sometimes also referred to as *empathy*, *sympathy,* or *empathic concern*; Batson et al., 1987) - sympathetic feelings for others in need (Zickfeld & Wróbel, 2024). This is expected to interact with perceived assertiveness or the reduction in control, such that criers who are perceived as having lower control evoking more compassion in observers. Notably, the effect of felt compassion on supporting the crier is found to be larger than a possible effect of felt distress (i.e., being motivated to help the crier for selfish reasons; Zickfeld et al., 2021).

Trait Affective Empathy. Similarly, dispositional levels of affective empathy should influence observers' responses to emotional crying (Zickfeld et al., 2021). This is most likely because they influence state levels of felt compassion, but also because they are positively associated with crying proneness (Zickfeld et al., 2022).

Relationship with Crier. Another factor determining whether observers would provide social support is the relationship with the crier. Studies found that individuals are more likely to help close others crying and also report more frequently being supported by close others when crying (Barthelmäs et al., 2024; Sharman, G. Dingle, et al., 2019). From an evolutionary perspective it makes sense to first provide support to kin or close others to increase their chances for survival (Sznycer et al., 2025). Further, evidence suggests that closer relationships should interact with higher feelings of compassion or empathy (Depow et al., 2021; Scheffer et al., 2022)

Situational Characteristics

Valence of the Situation. Just as for the occurrence of crying the valence of the situation or the crying response is important in determining both the success of the signaling and regulation function. Evidence is robust that individuals are more likely to help criers in negative situations compared to positive situations, which is determined by lower levels of perceived assertiveness in negative crying (Zickfeld & Wróbel, 2024). Based on the model, positive crying assumes a lower PLC, which would translate to decreased social support compared to negative crying. For the regulatory function, crying is found to be more effective in regulating arousal and mood for positive crying (Bylsma, Vingerhoets, et al., 2008; Ishii & Shinya, 2021; Rottenberg et al., 2008). This is not surprising, since the model predicts that positive crying results in less PLC and lower increases in negative affect (also due to a lower crying threshold). Given higher control and reduced negative affect arousal will be easier to regulate even if less regulation is provided by observers.

Cultural Characteristics

Limited research has been provided on the importance of cultural characteristics with the exception of one study investigating reactions to crying across different cultures (Zickfeld et al., 2021). The study found that across all countries participants reacted on average positively towards crying with increased helping intentions, while showing heterogeneity across the effect. A country's GDP and country-level well-being partly explained those differences and the authors discussed the possibility of higher psychological well-being and more resources being linked to more opportunities to provide support in general but also cautioned against overinterpretation due to low variation in country-level indices (Zickfeld et al., 2021).

Supplementary Table S3. Moderators of functions of emotional crying, their empirical evidence and relation to the CAS model.

Focus	Variable	Empirical Evidence	Importance to CAS Model	
			Interpersonal Signaling Function	**Intraindividual Regulating Function**
Crying	Crying Intensity	• Crying intensity reduces ratings of genuineness, appropriateness, and honesty in adults (Golding et al., 2003; Wong et al., 2011; Wróbel et al., 2025c) • Tears are considered a more honest signal regardless of their intensity (Wróbel et al., 2025c); high-intensity facial expressions or vocalizations are considered less appropriate and fake (Wróbel et al., 2025b, 2025c) • Excessive vocalizations might cause negative responses such as physical abuse (e.g., Levitzky & Cooper, 2000; Reijneveld et al., 2004; Zoucha-Jensen & Coyne, 1993)	• Lower intensity vocalizations and facial expressions and tears are more likely to attract support since they communicate a genuine loss of control (Wróbel et al., 2025c)	• High PLC and SIA cause high crying intensity, which is more difficult to regulate
	Perceived Appropriateness	• Studies show that perceived appropriateness influences social support (Zickfeld & Wróbel, 2024) • Most likely interacts with crying intensity, the relationship between the crier and observer, situational, and cultural factors	• Higher perceived appropriateness should attract more support (Zickfeld & Wróbel, 2024)	
Crier	Age	• Some evidence that the signaling function of tears is more effective for adults (Zeifman & Brown, 2011) • Similar perceptions for younger and older adults' tears (Grainger et al., 2019)	• Tears are expected to be more effective for adults, while vocalizations should be more effective for infants and children and less so for adults	• More effective across development when control increases, and other regulation strategies are available (Zeman et al., 2006)
	Perceived Assertiveness	• Emotional crying reduces perceived assertiveness, which mediates support (Zickfeld & Wróbel, 2024) • Interaction with crying intensity, perceived appropriateness, and valence of situation	• Signaling higher PLC should make the crier appear as less assertive and increase support	
	Perceived Communion	• Emotional crying increases perceptions of friendliness and morality, which mediates support (Zickfeld & Wróbel, 2024) • Interaction with crying intensity and perceived appropriateness	• Genuine signals of reduction in PLC increase perceptions of morality	

	Felt Shame/ Embarrasment	• Emotional crying is sometimes associated with shame (Sharman et al., 2019a), and such feelings can reduce the success of the signaling and regulating function (Rottenberg et al., 2008) • Shame is often triggered by uncontrollability (related to PLC; Miceli & Castelfranchi, 2018), • Interaction with age, since moral emotions first develop during childhood (Lewis, 1992), situational (who is present?), and cultural variables	• Felt shame can lead to a motivation to withdraw or escape a situation (Miceli & Castelfranchi, 2018), thereby failing to attract support (Becht & Vingerhoets, 2002)	• Felt shame can increase PLC and negative affect during crying, thereby reducing successful regulation (Becht & Vingerhoets, 2002)
	Attitudes Towards Crying	• Evidence that positive attitudes influence the effectiveness of both signaling and regulation (Millings et al., 2016; Sharman et al., 2019a, 2019b; Simons et al., 2013)	• Positive attitudes should promote crying in situations with observers, increasing the probability of support	• Positive attitudes should reduce the crying threshold, meaning crying can be expressed at higher levels of control, making regulation easier due to a lower PLC
Observer	Felt Compassion	• Emotional crying increases felt compassion in observers, which mediates support (Zickfeld & Wróbel, 2024)	• Signaling higher PLC should increase felt compassion (due to lower perceived assertiveness) and thereby support	
	Trait Affective Empathy	• Trait affective empathy influences observers' responses to emotional crying (Zickfeld et al., 2021)	• Trait affective empathy should correlate positively with felt compassion and crying proneness (Zickfeld et al., 2022), thereby sensitizing for signaled PLC	
	Relationship with Crier	• Individuals more likely to help and helped by close others (Barthelmäs et al., 2024; Sharman et al., 2019a) • Interacts with higher feelings of compassion and empathy (Depow et al., 2021; Scheffer et al., 2022)	• Evolutionary perspectives arguing for stronger support for kin or close others to increase their chances of survival (Sznycer et al., 2025)	
Situation	Valence of Situation	• Individuals are more likely to help criers in negative compared to positive situations based on lower levels of assertiveness (Zickfeld & Wróbel, 2024)	• Positive crying includes lower PLC, and lower signaled PLC should result in less support	• Positive crying includes lower PLC, which should be easier to regulate (Bylsma, Vingerhoets, et

				al., 2008; Ishii & Shinya, 2021; Rottenberg et al., 2008)
Culture	Economic Resources & Well-Being	• Limited cultural research, but one study found that high country-levels of well-being and economic resources were associated with increased support intentions (Zickfeld et al., 2021)	• Higher opportunities for engaging in support (e.g., economic resources) and lower costs (e.g., high country-level trust) on the cultural level could increase support	

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