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How and why could smiling influence physical health? A conceptual review

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ABSTRACT

Smiling has been a topic of interest to psychologists for decades, with a myriad of studies tying this behavior to well-being. Despite this, we know surprisingly little about the nature of the connections between smiling and physical health. We review the literature connecting both naturally occurring smiles and experimentally manipulated smiles to physical health and health-relevant outcomes. This work is discussed in the context of existing affect and health-relevant theoretical models that help explain the connection between smiling and physical health including the facial feedback hypothesis, the undoing hypothesis, the generalized unsafety theory of stress, and polyvagal theory. We also describe a number of plausible pathways, some new and relatively untested, through which smiling may influence physical health such as trait or state positive affect, social relationships, stress buffering, and the oculocardiac reflex. Finally, we provide a discussion of possible future directions, including the importance of cultural variation and replication. Although this field is still in its infancy, the findings from both naturally occurring smile studies and experimentally manipulated smile studies consistently suggest that smiling may have a number of health-relevant benefits including beneficially impacting our physiology during acute stress, improved stress recovery, and reduced illness over time.

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A smile a day keeps the doctor away. While this saying may not yet be common wisdom, in recent years, research has begun to illuminate the association between positive facial expressions and health-relevant pathways. In 1872, Charles Darwin first proposed that emotional expressions including smiling serve important functions such as the communication of positive emotions. Since then, smiling has been linked with the experience of positive affect (PA) and has been shown to activate areas in the brain that are associated with PA (Davidson, 1992). Indeed, research has demonstrated time and time again that the simple act of smiling can actually make you feel happier (e.g., Coles, Larsen, et al., 2019; Davies et al., 2011; Davis et al., 2010; Soussignan, 2002). But can smiling also make you healthier? A large literature has documented the relationship between PA and health (for reviews, see Chida & Steptoe, 2008; Ong, 2010; Pressman et al., 2019). We often associate smiling with PA, yet it is a distinct behavior in many ways (Ekman et al., 1990). Relatively few studies have examined the phenomenon of smiling itself and its relationship with physical health or health-related outcomes, and no paper to our knowledge has reviewed this literature. This is

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likely because there are not a sufficient number of papers using one specific research methodology or outcome to enable a meta-analysis, so aggregating an effect size across such diverse outcomes and designs would be meaningless. Thus, because there are a growing number of papers from diverse areas pointing to the intriguing possibility of a connection between smiling and health, we opted to complete a conceptual/narrative review, which has been specifically pointed to for its usefulness in developing a new theoretical understanding of a field and allowing for creative and meaningful connections to be made between diverse research findings (e.g., Ayala, 2018; Sutton et al., 2019). Further, we felt a conceptual review might also be beneficial in stimulating much needed new research from others on the possible connections between smiling and health, leading to data that could then be included in future systematic reviews or meta-analyses. As subject matter experts in this area, we attempted to search for all articles that 1) included a measure or manipulation of smiling and 2) examined a physical health-relevant outcome (e.g., morbidity, mortality, physiological responses). We also examined the reference sections of published papers for additional relevant findings. It is important for us to note that we did not do this in a systematic way.

We begin this review with a brief description of the history of research within the facial expression field and an overview of the most common types of smiles. Next, we discuss a range of theories/models that have implications for the relationship between smiling behavior and physical health. We then review the existing literature on smiling and physical health, which is organized into two sections based on whether a smile occurs naturally or is manipulated via an experimental setting. It is important to make this distinction because the processes that lead to these outcomes are disparate (i.e., experienced emotion or expression norms versus a set of instructions or covert manipulations involving no precursor of PA). Of note, for the sake of this review, we do not summarize findings connecting poor health to less or more smiling behavior (e.g., Davies et al., 2011). While work on this topic is interesting and related to the questions at hand, our purpose is aimed at reviewing the possible effects of smiling *on* health and health-relevant changes (e.g., physiology, behavior) as opposed to the reverse. As we describe the literature, we provide the effect sizes and qualitative descriptions for each finding in the conceptual review.[1] As previously mentioned, meta-analysis was not possible because there were not sufficient studies with similar designs and outcomes to meaningfully aggregate. We then revisit the theories/models, discuss how the existing data fit into them, and explore potential pathways through which smiling may be associated with physical health. Finally, we finish by highlighting important future directions for research in this area.

History of facial expressions research

One of the most well-known early works on facial expressions is *The Expression of the Emotions in Man and Animals* written by Darwin (1872/1965). This book describes the history and function of various emotional expressions and behaviors such as crying, laughing, and frowning with an evolutionary approach. Although Darwin's conclusions were constrained by a lack of physiological and genetic knowledge at the time, taking an evolutionary lens to facial expressions created endless research questions that are still being pursued today. One such question is what is the *function* of facial expressions? Darwin hypothesized that emotion expressions were both adaptive, in that they prepared the organism to respond to stimuli in the environment, and communicative, in that they relayed important social information.

Research on smiling has supported a possible and important communicative function: expressing a lack of threat to others (e.g., Ramachandran, 1998). Specifically, smiling may have been useful as an easy-to-read signal for our ancestors to announce to others from a distance that they were friendly. Early research on smiling as a social signal has demonstrated that greetings with smiles are more effective in eliciting smiles than greetings without smiles, conveying the important social component of this behavior (Mackey, 1976). When uncertainty is high and related physiological arousal is raised, smiles might signal a lack of threat both externally to others (Becker & Srinivasan,

2014) and internally through reduced physiological stress-related arousal (Pressman et al., 2021). This reduced physiological activity may be key to the health benefits of smiling; thus, we will return to it in detail later.

Categorizing types of smiles

Not all smiles are equal. Smiles can appear in a number of drastically different situations, which has led many researchers to attempt to create a typology of smiling. One of the first individuals to distinguish among smile types was G. B. Duchenne, a French anatomist who determined that the orbicularis oculi muscles around the eyes were activated only when individuals spontaneously smiled with true enjoyment (Duchenne, 1862/1990). In some of the first empirical attempts to classify smiles, Ekman and Friesen (1982) suggested that felt, false, and miserable smiles were distinct categories of smiles. Felt smiles are those in which the individual actually experiences PA (later to be termed 'Duchenne' smiles after their founder), with activation in both the zygomaticus major muscles in the cheeks and the orbicularis oculi muscles around the eyes (often creating 'crow's feet' on the sides of the eyes). False smiles are those in which an individual is trying to convince someone that he or she feels PA that he or she does not actually feel; these smiles do not usually include orbicularis oculi muscle activation. Finally, like false smiles, miserable smiles are those in which the individual does not experience PA and rarely involve orbicularis oculi activation. The distinction between false and miserable smiles is based on context; miserable smiles occur in negative situations (e.g., while watching a disgusting movie or while in distress) and do not necessarily involve an attempt to convey PA. False smiles are more likely to occur in situations that are not necessarily distressing but where smiling is appropriate, for example, in customer service settings. Thus, researchers need to know the specific context in which a smile is being made in order to accurately identify it, but this information is not always accessible.

More recent work on types of smiles has suggested that an additional method of categorizing smiles is by the function of the smile, or the social message that it portrays (e.g., Rychlowska et al., 2017). Within this categorization process, researchers have determined three morphologically distinct types of smiles: dominance smiles, which reflect social control or status; affiliative smiles, which express positive social motives; and enjoyment smiles, which express happiness (Niedenthal et al., 2010). Although work on the connections between these different types of smiles and health is minimal, this is an exciting future area of investigation. Within the smile/health literature, most researchers only distinguish between Duchenne (also referred to as genuine, enjoyment, true, or felt) smiles and non-Duchenne (also referred to as non-enjoyment, false, or social) smiles since these smiles are easily classified by specific facial muscle movements rather than by context.

There is some evidence that non-Duchenne smiles are not as beneficial as Duchenne smiles, and may even be harmful in some circumstances. For example, correlational research on customer service indicates that 'surface acting,' or faking PA one does not feel (e.g., non-Duchenne smiles), is associated with emotional exhaustion, which in turn may increase negative outcomes such as burnout and employee error (e.g., Goldberg & Grandey, 2007). Further, it is well established that non-Duchenne smiles do not typically represent PA while Duchenne smiles do (e.g., Ekman et al., 1990). Thus, due to these differences, it is important for research to code for or manipulate specific types of smiles and to consider the different implications of these two types separately. That said, from a functional approach and evolutionary interpretation, there must be some reason that individuals have the urge to smile under duress (e.g., masking smiles, smiling during pain; e.g., Fredrickson & Levenson, 1998), likely because it is somewhat helpful in altering affect or physiology, although perhaps not to as great of a degree as Duchenne smiling (e.g., Kraft & Pressman, 2012; Pressman et al., 2021).

How do researchers determine the typology of a smile? The gold standard for coding smiles is the Facial Action Coding System (FACS; Ekman & Friesen, 1978), an elaborate method that trains coders to identify an array of facial action units, as well as how to identify specific expressions based on

those action units. For smiling, the action units of interest are AU 6 (cheek raiser), AU 7 (lid tightener), and AU 12 (lid corner puller), which broadly map on to activation of the zygomaticus major and orbicularis oculi muscles. Given the time intensity of this method (coding a facial photograph can take as long as 15 min if looking for the presence of *any* emotion; Prince et al., 2017), researchers interested in this complex approach have been greatly aided by improvements in automated facial expression algorithms to detect emotion based on the FACS or similar methods (e.g., Noldus FaceReader; Loijens & Krips, n.d.). These computer programs can rapidly provide researchers with intensity and duration of a number of basic facial expressions (e.g., Tuck et al., 2017). In addition to speed of processing, many of these programs have high accuracy; for example, Noldus FaceReader has an accuracy of 85-86% when recognizing human emotions compared to FACS (Lewinski et al., 2014; van Kuilenburg et al., 2005). Although some recent work has investigated convergence between automated and human coding (for example, the emotion of joy has moderate-to-high convergence; Gupta et al., 2020), more work is needed to determine emotion detection accuracy of different automated programs. It is also important to consider racial bias in automated programs; for example, these systems frequently fail to accurately identify individuals who are female and dark in color (e.g., Buolamwini & Gebru, 2018; Klare et al., 2012), and they have been shown to disproportionately label darker colored individuals as angrier (Rhue, 2018). Thus, although automated programs show promise for the future of coding facial expressions, there is much work left to be conducted in this area (e.g., Cross et al., 2022).

In studies uninterested in expressions beyond smiling, simpler methods can be used such as coding for the presence of a smile (e.g., Fredrickson & Levenson, 1998) or whether a smile is Duchenne, non-Duchenne, or absent (e.g., Cross & Pressman, 2020; Kushlev et al., 2019). These latter methods are advantageous since the cost and time commitments are lower, and can be done with lower quality videos or photographs. A final technique to measure facial muscle activation is facial electromyography (EMG), which involves placing small electrodes on specific facial muscles in order to capture muscle movements that may not be visible to the human eye. There are multiple advantages and disadvantages to each of these approaches (Cross et al., 2022; Wolf, 2015), so investigators who are interested in the connections between smiling and health should carefully consider which method best addresses their specific research question(s).

Theories and models

Before we begin our review, we first describe several relevant theories and models that will help frame explanations for why smiling may be beneficial to physical health. These theories and models are not mutually exclusive; in fact, it is often the case that studies support two or more. We later return to each theory/model when discussing how existing research on smiling and health fits into each of them.

First, the facial feedback hypothesis posits that the mere act of smiling may alter or induce state PA (Tourangeau & Ellsworth, 1979). In a seminal study of this hypothesis conducted by Strack and colleagues (1988), participants were given a pen and assigned to one of three conditions: holding the pen with their lips (neutral facial expression), holding the pen between their teeth (smiling), or holding the pen in their nondominant hand (control). Importantly, a cover story was told to participants so they would not be aware of the facial expression manipulations. Participants were shown a series of cartoons and asked to rate the funniness of each cartoon. Individuals in the smiling condition found the cartoons significantly funnier than participants in either of the other two conditions (Strack et al., 1988), providing evidence for the facial feedback hypothesis. This study among others of its period kick started decades of exciting research connecting induced expressions to downstream emotional and cognitive changes (for an overview, see Coles, Larsen, et al., 2019).

However, a recent replication of this seminal study by 17 different labs failed (Wagenmakers et al., 2016), casting some doubt on the validity or universality of facial feedback work. That said, a recent meta-analysis of 138 studies investigated whether there was an overall effect of facial feedback on

emotional experience using random effects meta-regression with robust variance estimates. Results indicated that there was indeed a small yet significant effect ($d = .20$). Twelve different moderators within the realm of the facial feedback hypothesis were also examined in this meta-analysis and three were shown to influence effect sizes: type of emotional outcome (facial feedback influenced affective judgments [$d = .38$] more than emotional experience [$d = .17$]); presence of emotional stimuli (facial feedback effects on emotional experience were larger in the absence [$d = .32$] vs. the presence [$d = .13$] of emotional stimuli); and type of stimuli (for example, facial feedback effects were larger in the context of emotional sentences [$d = 1.29$] than pictures [$d = .16$]; Coles, Larsen, et al., 2019). In addition, a recent pre-registered, multi-site replication of the facial feedback hypothesis found expected facial expression effects on emotion, but these effects were more robust when using techniques that approximated real smiles (i.e., using the pen in the mouth technique; Coles et al., under review). Thus, while large, multi-lab replication attempts like the one conducted by Wagenmakers and colleagues (2016) are valuable, it is important to note that this study only represents one situation through which smiles are elicited (via holding a pen in the mouth) and one outcome connected to smiling (amusement from observing cartoons). Therefore, smiling should continue to be studied in a number of different domains, including the investigation of a wider variety of outcomes.

If the facial feedback hypothesis is correct in that the act of smiling creates or increases state PA, then the main effect model and stress buffering model of PA come into play to help explain how higher levels of PA are connected with better physical health (Pressman & Cohen, 2005). In the main effect model, PA is hypothesized to benefit health via increasing healthy behaviors (e.g., more exercise, more sleep, healthier eating), improving social connections, and emotion-altering physiological changes. The stress buffering model hypothesizes that PA is helpful via its alteration and improvement of stress perceptions, stress reactivity, and stress recovery. The undoing hypothesis (Fredrickson & Levenson, 1998) is a more specific variant of the stress buffering model that indicates that PA may influence health by hastening stress recovery; that is, PA 'undoes' the harmful effects of stressors on physiology. Insofar as smiling induces PA (via facial feedback) or reflects experienced PA, this theory may explain mechanisms through which smiling can offer protective benefits against the pernicious effects of stress.

Another way that smiling may protect against or buffer responses to stress is through increased vagal tone, which is associated with better emotion regulation (e.g., Appelhans & Luecken, 2006), less perceived threat (e.g., Hill et al., 2017), less inflammation (Thayer, 2009; Williams et al., 2019), and improved cardiovascular health outcomes (e.g., Thayer & Lane, 2007). Vagal tone represents resting activation of the vagus nerve, which is responsible for the parasympathetic nervous system (i.e., the rest-and-digest system) and reduces sympathetic nervous system activity (i.e., the fight-or-flight system; Thayer & Lane, 2000). Two complementary theories that highlight the role of the vagus nerve in emotion and health are polyvagal theory and the generalized unsafety theory of stress.

Polyvagal theory emphasizes the physiological connections (via the vagus nerve) between the cranial nerves responsible for facial and vocal expressions and the cardiovascular system (Porges, 1997, 2001). Polyvagal theory suggests that facial muscle actions send information to brain areas that then have an influence on vagal activity at the heart's pacemaker (Porges, 2003). Therefore, the social sharing of contextually appropriate emotions through facial expressions like smiling could predict better health via higher vagal tone.

In contrast, the generalized unsafety theory of stress emphasizes how a number of common conditions (e.g., obesity, loneliness, stressful events) can lead to chronic activation of the physiological stress response over time (Brosschot et al., 2016, 2017, 2018; Verkuil et al., 2016). These common conditions can then produce a perception of threat or unsafety and, in turn, reduced vagal tone. Unlike the other theories and models reviewed in this section, neither the polyvagal theory nor the generalized unsafety theory of stress explicitly predict that there is anything unique about smiling compared to other facial expressions in relation to health. Specifically, polygvagal theory might posit

that it is the expression of *any* emotion at appropriate times that should be associated with higher vagal tone and, in turn, better physical health outcomes. On the other hand, the generalized unsafety theory of stress might propose that insofar as smiling signals safety or perceptions of safety within an individual and/or their broader social environment, it should foster higher vagal tone. Additionally, we argue that smiling may have further benefits to health compared to other facial expressions that result in greater reflexive activation of the vagus nerve which, in tandem with the social, emotional, and cognitive benefits discussed below, may increase vagal tone and result in improved mental and physical health outcomes.

Smiling, physiology, and physical health review

Studies investigating the connections between smiling and physical health fall into two distinct categories: naturally occurring smiles and experimentally manipulated smiles. Naturally occurring smiles are those that happen naturally in response to some type of environmental, internal, or laboratory provocation. Thus, effects arising from these types of studies cannot unpack the question of whether smiling is driving the effect, or whether the effect is due to some other third factor related to both smiling and wellness such as PA, self-presentation drives, emotional expression characteristics (e.g., ability to express emotions), or sociability. Experimentally manipulated smiles, on the other hand, involve changing the activity of the specific muscles involved in smiling in the lab, often, but not always, without awareness of the smile. This is typically done via a combination of a clever cover story and holding implements such as pencils or chopsticks in the mouth that manipulate muscle activity in the desired manner. By removing participants' awareness that they are smiling, researchers can also remove the cognitive expectancies and, potentially, the effect of different cultural beliefs and norms surrounding smiling. They can then focus their study interpretations on the psychological and physiological effects of specifically activating the muscles involved in smiles. These groups of studies provide more direct and causal evidence for smiling behavior itself directly impacting physical health and health-related outcomes. However, with all of this experimental control, one major drawback to these studies is the inability to understand the function of smiling in the contexts where they naturally occur.

Naturally occurring smiles

Smiles in photographs

Coding facial expressions in photographs is an easy method to incorporate in research since archival photographs are readily available from a wide range of sources such as yearbooks or social media sites. Further, participants completing studies in person can quickly be photographed. One potential confound to note, however, is that in posed photographs, people are often told to smile or 'say cheese' (or a different language equivalent) by the photographer to generate a smile (meaning that smile absence or presence is influenced by an external source or the norms surrounding taking photographs). We still consider these to be naturally occurring smiles since they typically occur outside of the laboratory, are not physically forced, and participants still have flexibility in varying the type and intensity of their smile as well as whether they smile at all.

A number of studies have investigated smiling in photographs with psychosocial outcomes such as marital stability and satisfaction (Hertenstein et al., 2009), life satisfaction (Seder & Oishi, 2012), and personal well-being (Harker & Keltner, 2001), revealing a myriad of positive outcomes tied to smiling in photographs. To the best of our knowledge, however, there are only three studies that investigate the connections between smiling in photographs and physical health. The first of these studies coded type of smile (Duchenne, non-Duchenne, and no smile) in the Major League Baseball cards of 162 players (Abel & Kruger, 2010). Individuals with Duchenne smiles in their photographs were half as likely to die in any given year compared with individuals who were not smiling on their baseball cards (*hazard ratio [HR]* = 0.5, $d = -0.54$). However, non-Duchenne smilers did not

differ from either Duchenne smilers or non-smilers (Abel & Kruger, 2010). This study was the first to link smiling in photographs with mortality, but it had a few notable limitations. First, Duchenne smiles were only scored if crow's feet appeared around the eyes. However, it is possible to activate the orbicularis oculi muscles without crow's feet appearing, suggesting that the coders may have miscoded a number of Duchenne smiles as non-Duchenne smiles. In addition, the sample of this study was limited to men who played professional baseball. Many studies have found important sex differences in both frequency and intensity of smiling (see LaFrance et al., 2003, for a meta-analysis), so this type of work should be replicated in samples that include women, especially given data showing future psychological and relational benefits connected to smiling in photographs in a female sample (Harker & Keltner, 2001). Furthermore, a replication attempt of the findings of Abel and Kruger (2010) was unsuccessful (original sample $HR = 1.12$, $d = 0.09$; non-overlapping replication sample $HR = 0.82$, $d = -0.15$; Dufner et al., 2018), questioning the validity of the connection between smiling in baseball photographs and health. It may be the case that smiling is a less useful predictor in this specific type of photograph sample, perhaps due to confounds relating to self-presentation in professional and publicly available baseball cards (e.g., player image demands or desires, player managers helping to select the photograph for the baseball card). It may also be the case that smiling in photographs is not connected to mortality, but more research is needed on this topic to draw a firm conclusion.

The other study that examined smiles in photographs and physical health investigated the number of times participants visited a health care center within the past year (Cross & Pressman, 2020). Participants provided the photograph from their student identification card and these photographs were coded for type of smile (Duchenne, non-Duchenne, or no smile). In addition, participants were asked how often they had visited a health care center within the past year for preventive, illness, injury, or mood-related purposes. Results indicated that participants who were making either a Duchenne smile or non-Duchenne smile were more likely to have visited a health care center *for preventive purposes* (e.g., a regular check-up, filling a regular prescription, vaccination) than non-smiling participants (*odds ratio [OR]* = 3.08, 95% CI [1.61, 5.90], $d = 0.62$). There were no significant differences in visits made for other reasons indicative of poor health, showing that in young healthy samples, smiling in photographs may be suggestive of a characteristic connected to positive health behaviors. One intriguing third variable in this study was social desirability, as it is socially desirable to both maintain one's health and smile in photographs (in U.S. culture). Although this study did not have a measure of social desirability, future research should investigate this possibly related factor.

Naturally occurring smiles in research and clinical settings

There are a handful of studies that have investigated the connections between spontaneous smiling in the lab and various indicators of physical health. One study recorded participants' facial expressions while viewing a sadness-eliciting film clip and then measured their cardiovascular recovery from the clip, or the time it takes the cardiovascular system to return to baseline following a stressor (Fredrickson & Levenson, 1998). Cardiovascular recovery is an important physiological variable to study because prolonged recovery from stress predicts a number of negative outcomes such as subclinical cardiovascular disease and mortality (e.g., Chida & Steptoe, 2008; Panaite et al., 2015). Participants were coded for whether or not they spontaneously smiled (any type of smile) during that film clip, and the results indicated that those who did had quicker (i.e., healthier) cardiovascular recovery after viewing the clip (omega-squared = 0.05; Fredrickson & Levenson, 1998). Thus, smiling may be particularly helpful during the cardiovascular recovery process.

Another study investigated whether facial expressions made during the first two minutes of the stress-inducing Type A Structured Interview were connected with myocardial ischemia (Rosenberg et al., 2001). Participants were videoed during the interview and facial muscle activation was coded using FACS. Individuals with myocardial ischemia displayed more non-Duchenne smiles than individuals without myocardial ischemia (estimated $d = 0.87$); however, occurrence of

Duchenne smiles did not differ between those with or without myocardial ischemia (Rosenberg et al., 2001). One explanation for these findings is that non-Duchenne smiles may have been attempts to mask negative emotions such as anger or anxiety during the interview. The different effects between non-Duchenne and Duchenne smiles in this study serve as an important example of why distinguishing between types of smiles should be a consideration for all researchers who want to investigate presence or absence of smiles in their studies.

An additional study that looked at natural smiles and physical health in a research setting was a prospective longitudinal study with a large representative sample from Nova Scotia, Canada (Davidson et al., 2010). In this study, participants went through an interpersonally stressful interview while their levels of expressed PA were coded. Expressed PA was defined in this study as a combination of behavior (e.g., any type of smiling), tone of responses (e.g., cheerful), and other verbal cues. Participants who expressed higher levels of PA (including smiling) during the interview had significantly lower rates of coronary heart disease 10 years later ($HR = 0.78$; $d = -0.19$; Davidson et al., 2010). However, one notable difference in this study was the broad operationalization of expressed PA, which included a wide variety of expressions/behaviors. Although this muddies the waters in terms of determining whether smiling in and of itself is beneficial for physical health, the inclusion of expressions/behaviors that often co-occur with smiling during social interactions may help investigators determine the sincerity of smiles in their studies. For example, if a smile is accompanied by laughter or a cheerful tone of response, is this smile more likely to be a Duchenne smile? It is rare for smiles in the real world to occur without additional expressions or behaviors, and investigators should consider using these to help them more easily categorize smiles.

In addition to these studies that have investigated natural smiles in the context of research settings, one study instead looked at natural smiles in a clinical setting (Aoun et al., 2020). The participants in this study were hemodialysis patients in Lebanon. When these patients arrived for their hemodialysis sessions, a social worker noted whether or not they displayed a Duchenne smile during their first contact with a healthcare worker in the unit. Over the course of three hemodialysis sessions, patients were classified as 'smiling' if they displayed Duchenne smiles more than 34% of the time (i.e., during more than one of the sessions) and 'non-smiling' if they displayed Duchenne smiles less than 34% of the time (i.e., during one or none of the sessions; non-Duchenne smiles were not counted as smiles in this study). At baseline, higher numbers of Duchenne smiles over the course of three hemodialysis sessions were positively correlated with older age, vitality (measured with the SF-36), and low number of hospitalizations, along with a number of additional quality of life indicators. Furthermore, 52.6% of those who were not smiling died within one year of the study, compared with only 26.9% of those who were smiling ($HR = 0.19$, $d = -1.28$; Aoun et al., 2020). Although this study is intriguing, it also has limitations such as using a single coder to classify smiles and a lack of investigation into potential moderators (e.g., do older individuals smile more because they are coping with the disease process more effectively than those who are younger?). In addition, a possible alternative explanation for these findings is that those who smiled less were already sicker than those who smiled more; this explanation is supported by the fact that Duchenne smiling was significantly correlated with general health as measured by the SF-36. That being said, it highlights the possible value of investigating smiling behavior in clinical settings, as well as the ease with which researchers can integrate these types of measures into their studies.

Summary of research on naturally occurring smiles

Taken together, the current research on naturally occurring smiles has some evidence that smiling and physical health are connected. The effect sizes for the studies included in this section range from small to large, most likely because such disparate physical health outcomes were investigated. The most consistent findings involve studies of individuals smiling during stressful or negative situations, resulting in benefits (e.g., improved stress recovery) or ties to better health (e.g., reduced illness or mortality over time). However, studies of photographs where the context is not known are more difficult to interpret and there are few with health-relevant outcomes. Yearbook and student ID

photographs may be a more useful archival data source given the consistency of the environment (i.e., all taken for the same reason with the same photographer) as compared to professional photographs or photographs on social media, although some of these have been tied to health-relevant outcomes as well (e.g., Seder & Oishi, 2012). It may be that data scraping from the Internet (e.g., from social media) can also be useful as a health predictor given that individuals have control over how they choose to portray themselves and the types of expressions in photographs that they share.

One important future direction for this area of work is that there is little examination of possible pathways connecting these types of naturally occurring smiles to health. This highlights the need for more longitudinal work, especially that which uses experience sampling methods, tests mediators, and investigates the dynamic influence of smiling, trait PA, social relationships, and health behaviors on health outcomes.

Experimentally manipulated smiles

Experimentally manipulated smiles involve specifically activating the muscles involved in smiling in the lab. Researchers have accomplished this using a number of different methods, including telling participants which facial muscles to activate; having participants hold a device in their mouth like chopsticks or pens; or merely telling participants to smile (see Cross et al., 2019, for a comparison of some of these methods). There are also a number of studies that have investigated emotion expression skill in which participants are instructed to create a facial expression that reflects a certain emotional term, like 'joy.' In addition, some experimental studies examine the effects of disabling facial muscles (e.g., via tape or toxins that block nerve/muscle connections; e.g., Davis et al., 2010; Neal & Chartrand, 2011), but those methods have not been examined in the context of smiling and health.

Experimentally manipulated smiling has mainly been examined in the context of physiological changes known to have potential downstream effects on health. One of the earliest studies of the connections between smiling and physiological change used a small sample of 16 participants (Ekman et al., 1983). These participants were told which facial muscles to activate and held each expression for ten seconds, during which their heart rate was continuously measured. Heart rate increased more when participants were making angry or fearful facial expressions than when they were making happy facial expressions (participants were told exactly which facial muscles to activate but it is unclear whether they were directed to make Duchenne or non-Duchenne smiles). These results demonstrate that happy facial expressions were not as physiologically arousing as angry or fearful facial expressions (Ekman et al., 1983). Efforts were made in this study to ensure that these effects were not due to other muscle activity. Another important aspect of this study is that non-adherent expressions were excluded. Adherence to facial expression condition is extremely important to code in facial expression studies so that participants who do not adhere to their condition (e.g., do not activate the correct facial muscles) can be excluded in analyses or adherence can be controlled for in analyses. Another study replicated these results with larger samples, again finding larger cardiac accelerations for anger, fear, and sadness than for happiness (Levenson et al., 1990). Interestingly, another lab replicated these results again, but questioned whether effects were due to the difficulty of the expressions rather than the expressions themselves (Boiten, 1996). In response, Levenson and Ekman (2002) reanalyzed their data from the original study and found that reported difficulty did not mediate the heart rate differences across expressions, reinforcing the idea that the specific facial expressions themselves led to these differences. This body of work demonstrates that facial expressions themselves induce changes in cardiovascular physiology, which may in turn influence responses to stress and/or general downstream health outcomes.

More recent research on experimentally manipulated smiling and cardiovascular physiology has suggested that smiling has beneficial effects during recovery from acute stress. In a study conducted by Kraft and Pressman (2012), participants were instructed to hold chopsticks in their mouths so that

they activated the facial muscles associated with either a Duchenne smile, non-Duchenne smile, or neutral facial expression. All participants were given a cover story that the study was investigating multitasking so that they would not be aware that they were smiling. However, in order to manipulate awareness of expression, half of the participants were told to smile, and half were not given this instruction. Adherence to facial expression condition was coded on a 1 (poor adherence) to 5 (excellent adherence) scale and was controlled for in analyses. Regardless of whether or not participants knew they were smiling, smiling participants had lower heart rates during recovery from two stressful tasks, with a slight advantage for those who were making Duchenne smiles (Kraft & Pressman, 2012). In line with the naturally occurring smiles study conducted by Fredrickson and Levenson (1998), this study provides additional evidence that smiling during stress may be particularly helpful for cardiovascular recovery.

A more recent conceptual replication and expansion of Kraft and Pressman (2012) examined whether manipulated facial expressions during acute pain (from a 25-gauge needle saline injection) buffered the negative psychological and physiological effects of receiving the injection (Pressman et al., 2021). Participants in this study were assigned to one of four facial expression conditions: neutral, non-Duchenne smile, Duchenne smile, or grimace. Grimaces are negative facial expressions that activate the same muscles as Duchenne smiles *and* a number of other muscle groups, including the corrugator supercilli (the major muscles in between the eyebrows), which are activated in most negative facial expressions. Grimaces are natural reactions to pain and served as an interesting contrast to Duchenne smiles in this study, given their similarity in muscle activation but differences in emotional tone (negative versus positive). Participants held chopsticks in their mouths in order to create one of these four facial expressions, and were told the same multi-tasking cover story as in Kraft and Pressman (2012). Adherence to facial expression condition was coded on a 1 (adherent to condition less than 25% of the time) to 10 (adherent to condition more than 75% of the time) scale, and individuals who adhered less than 50% of the time were dropped from analyses. Those making Duchenne smiles ($d = -0.56$) or grimaces ($d = -0.52$) reported approximately 40% less pain in response to the injection than those making neutral facial expressions. Additionally, those who were Duchenne smiling had lower heart rates (d's between −0.59 and – .056) and lower skin conductance than the neutral group (d's between −0.58 and −0.56), while grimacing did not statistically significantly reduce physiological stress responses (d_{HR} between −0.45 and −0.34; d_{SC} between −0.47 and −0.42; Pressman et al., 2021). This study demonstrates that both Duchenne smiling and grimacing may improve subjective experiences of stress and have physiological benefits. However, self-reported PA was not found to mediate these smiling effects, likely due to measurement timing issues and the emotional complexity of the experimental needle context.

Finally, smiling has also been investigated in the context of physical activity. In this study, 24 participants were instructed to Duchenne smile, frown, relax, or focus on their normal thoughts (control condition) while running on a treadmill (all participants completed each condition; Brick et al., 2018). Their VO2 max, or the maximum amount of oxygen that could be utilized, was measured during each six-minute block on the treadmill. Duchenne smiling reduced the oxygen cost of running by 2.78% compared with frowning ($d = -0.23$) and 2.23% compared with the control condition ($d = -0.19$). Interestingly, heart rate did not vary between conditions, but this may have been because the physical stress was sustained for a longer period of time than many studies in this review (four bouts of six minutes of physical activity versus short psychological or acute pain stressors typically lasting 1-2 min). It is also important to note that the measurement of heart rate in this study did not allow inferences about whether participants viewed this physical stressor as a challenge (perceiving that they had enough resources to overcome current demands) or a threat (perceiving that they did not have enough resources to overcome current demands; e.g., Weisbuch et al., 2009). Past research has determined that heart rate does not effectively discriminate between challenge vs. threat; rather, more nuanced measures of cardiovascular output (e.g., total peripheral resistance, pre-ejection period) may have revealed different information regarding facial expressions and

physical stress (e.g., Blascovich et al., 2004; Moore et al., 2012). In addition, because participants were wearing oxygen masks, activation of specific muscles in the face could not be objectively coded for adherence to condition. Still, this study demonstrates that smiling during extreme physical stress can also have beneficial health-relevant physiological implications.

Emotion expression skill

Relevant to the above experimental studies, recent research has also considered the value of knowing whether individuals are able to express an emotional expression accurately on command. This is an important study quality issue in facial expression work given that past studies have shown that adherence to expression condition (i.e., the quality/accuracy of expression) is a predictor of the effectiveness of facial feedback on emotion and health-relevant physiology (e.g., Coles, Larsen, et al., 2019; Levenson et al., 1990; Pressman et al., 2021). Critically, this expressive ability has also been associated with health-relevant outcomes. In these studies, participants are shown a number of emotional terms and asked to create the corresponding facial expression as quickly and accurately as possible. They are then asked to press a button on a computer in order to take a photograph of themselves making these expressions. Thus, smiles created in response to a 'joy' prompt differ from naturally occurring smiles because participants are being asked to express a specific emotion in a lab setting but are similar to some experimentally manipulated smiles (i.e., those where individuals are asked to make an expression/are not covert in the manipulation). This is an intriguing line of work because the ability to make accurate expressions might be connected with how often or how well participants smile in the real world, or how effectively they communicate with others. Studies that have investigated this skill have found that it is connected with outcomes such as greater self-rated health ($d = 0.65$) and lower concentrations of tumor necrosis factor, a pro-inflammatory cytokine ($d = -0.72$; Tuck et al., 2016). In addition, another study found that across three different indices of cardiovascular risk, joy expressive skill was associated with lower cardiovascular disease risk ($d_{FHS} = -0.43$; $d_{NZ} = -0.75$; $d_{ASCVD} = -0.58$) in a sample of mostly female adults in New Zealand (Tuck et al., 2017). A follow-up study collected a second wave of data focusing on male participants in order to examine sex differences in the association between expressive skill and cardiovascular disease risk. This study found a moderate-to-large negative association between joy expressive skill and cardiovascular disease risk in males ($d_{FHS} = -0.95$; $d_{NZ} = -0.82$; $d_{ASCVD} = -1.01$), but this association was attenuated in females ($d_{FHS} = 0.02$; $d_{NZ} = -0.24$; dASCVD = −0.24; Thompson et al., 2020). Unfortunately, none of these studies specifically coded for Duchenne smiling during the expression of joy, but instead coded for signaling accuracy (whether or not participants activated the facial muscles involved in each expression). Perhaps individuals who express joy using a Duchenne smile are coded as having better skill at expressing joy and, in turn, are more likely to have greater vagal tone compared to individuals who express joy using a non-Duchenne smile.

Summary of research on experimentally manipulated smiles

Although there are only a handful of studies that have investigated the connections between experimentally manipulated smiles and health, the findings from these studies strongly suggest that smiling may beneficially impact our physiology, especially during acute stress. As with the studies on naturally occurring smiles, the effect sizes for these experimentally manipulated smile studies also range from small to large. The majority of this work focuses on cardiovascular physiology (e.g., Kraft & Pressman, 2012; Levenson & Ekman, 2002; Pressman et al., 2021), although the connections between smiling and inflammatory markers is a budding new area (e.g., Tuck et al., 2016) with obvious health relevance (e.g., Reuben et al., 2002). Notably, smiling has yet to be investigated in a number of other bodily systems, such as the hypothalamic-pituitary-adrenal (HPA) axis. It is difficult to generalize this work to natural conditions since experimentally manipulated smiles are precisely controlled in the lab. However, this basic science work has immense value because it is necessary for us to understand how smiles might be helpful within a controlled setting in order for us to determine

how they might be helpful in the real world. Experimental work can continue to elucidate the potential physiological mechanisms underlying smiling and health, while naturalistic work can include intensive longitudinal studies that tap into daily social and emotional processes so that we can better understand the social mechanisms of this relationship. These two lines of work can inform each other and help us strengthen our overall understanding of the different pathways through which smiling can influence health.

Placing the data into theory

All of the theories/models discussed earlier in this paper are supported in the current smiling and health literature. However, stress-related pathways and hypotheses such as the undoing hypothesis, the stress buffering hypothesis, and polyvagal theory currently have the most support. The undoing hypothesis is directly supported in both a naturally occurring smile study (Fredrickson & Levenson, 1998) and experimentally manipulated smile studies (Kraft & Pressman, 2012; Pressman et al., 2021), which is especially intriguing because we would expect the pathways to health to be different for these two categories of smiles. It may also be the case that smiling has more general stress buffering effects (including appraisal, reactivity, and recovery) given recent work indicating that smiling during stress is helpful at all points (Brick et al., 2018; Pressman et al., 2021). Further, those individuals who smile naturally during stressful encounters (e.g., stressful interviews) sometimes show later health benefits (e.g., lower rates of coronary heart disease; Davidson et al., 2010), perhaps indicating that this general emotion regulation strategy of activating PA expressivity during stress is also beneficial for health in the real world due to stress buffering benefits. Taken together, these studies suggest that smiling, whether self-induced or not, is helpful in improving our ability to handle acutely stressful or negative circumstances. Smiling may have direct physiological and psychological effects that reduce stress during negative experiences (e.g., Kraft & Pressman, 2012; Pressman et al., 2021). Given the extensive evidence of the negative effects of stress on almost every health outcome (e.g., Cohen et al., 2007), it is plausible that smiling reduces the negative impact of stress on the body and leads to better health. It is important to note that while these PA-oriented theories do seem to align with the effects of smiling in stressful situations, most studies do not test for or find PA effects (e.g., as a mediator connecting smiling to changes in physiology). That said, finding elevated self-reported PA in the middle of a highly distressing or painful task is a high order and may be difficult, if not impossible, to detect.

The other theory/model that is most supported by the literature is polyvagal theory (e.g., Ekman et al., 1983; Rosenberg et al., 2001; Thompson et al., 2020). The emotional expression skill studies discussed earlier in this paper are particularly supported by this theory because they focus on the benefits of the ability to express emotion when these expressions are appropriate (i.e., when participants are being asked to do so). However, this theory does not predict that certain types of facial expressions like smiling might be more beneficial to health-relevant vagal activation.

How could smiling influence physical health?

The studies we have reviewed generally did not test possible mechanisms through which smiling may affect physical health. To help provide a framework for understanding this literature and to assist investigators in creating future studies, we propose two models (one for natural smiles and one for experimentally manipulated smiles) representing possible pathways linking smiling to health outcomes. Although these models could be combined, we keep them separate for ease of interpretation. These models indicate pathways moving in only one causal direction, from smiling to health. Alternative pathways are excluded for the sake of simplicity, but their exclusion is not intended to imply that they do not exist.

Pathways connecting natural smiles to physical health

There are several pathways that may account for the connection between natural smiling and physical health (see Figure 1). We outline three that we believe are most supported by the existing literature.

Trait positive affect

Naturally occurring smiles, especially Duchenne smiles, are often a reflection of trait, or stable dispositional, PA. For instance, in the previously discussed study of women who smiled in yearbook photos, smiling was tied to reports of higher contentment and cheerfulness and less negative affect approximately 30 years later (Harker & Keltner, 2001). Thus, it is possible that people with higher trait PA smile more because they experience and express more PA. That said, research on facial expressions as universal expressions of emotion (e.g., Ekman et al., 1987; Russell, 1994) suggests that there is at least some overlap between trait PA and more frequent PA expression. This is an enticing interpretation given that trait PA can influence physical health through numerous behavioral and physiological pathways (Pressman et al., 2019), but the pathway that may be especially important in the context of smiling is social support (e.g., Ong, 2010). High trait PA is associated with larger and higher quality social networks, which have also been linked to better health outcomes (e.g., Diener & Seligman, 2002; Holt-Lunstad et al., 2010). Thus, it may be that smiling merely reflects high trait PA, which means that the individual is more likely to have larger and better quality social relationships, resulting in better physical health. That said, given the social communicative function of smiling (Lotzkar & Bottorff, 2001; Mackey, 1976), it is also likely that, like high trait PA, more frequent smiling facilitates the formation of more and better relationships, at least in cultures where smiling is desirable.

Social relationships

Smiling may be directly connected to improved social relationships because it has long been shown to be a social cue to indicate friendliness and lack of threat (Ramachandran, 1998). People smile more when they are in the presence of other people than they do when they are alone, and greetings with smiles are more effective at eliciting smiles than greetings without smiles (Ekman & Friesen, 1978; Mackey, 1976). People also use smiling to make connections with others and facilitate successful interactions (Lotzkar & Bottorff, 2001). Both emotional mimicry (the imitation of the emotional expression of another person; Hess & Fischer, 2013) and emotional contagion (converging emotionally with another person; Hatfield et al., 1993) can play roles in these relationships; for example, mimicry has been shown to improve the quality of social interactions (e.g., Yabar & Hess, 2007).

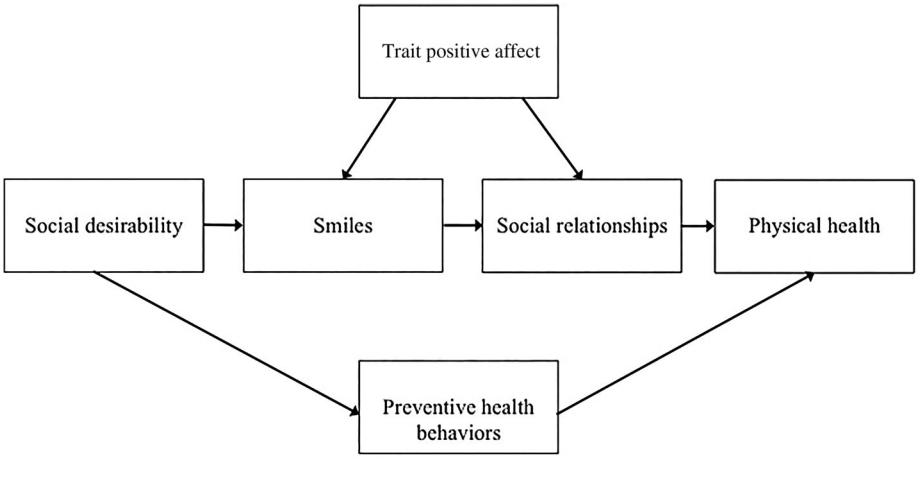

Figure 1. Hypothesized pathways through which natural smiling may affect physical health.

Past work on mimicry of smiles has found that mimicry occurs even when the presentation of smiling faces is subconscious (Dimberg et al., 2000), although more recent research on emotional mimicry has suggested that this may depend on the specific social context (Hess & Fischer, 2014). Furthermore, people who smile are generally perceived as more attractive, sincere, sociable, healthy, and competent, drawing others to them (e.g., Gunnery & Ruben, 2016; Reis et al., 1990). Studies such as these provide evidence that smiling behavior is inherently social, and people who smile more may have higher levels of social integration and support. Given that these social variables are intimately and strongly tied to an array of health benefits (e.g., Cohen, 2004; Holt-Lunstad et al., 2010), this provides a possible reason why more frequent natural smiling is connected to physical health. Thus, it seems plausible that smiling is connected to health because of the benefits associated with social ties and characteristics that facilitate them.

Social desirability

A final variable that may play a role in the relationship between naturally occurring smiling and health is social desirability. People who place a greater emphasis on social desirability and self-presentation may smile more, at least in cultures where smiling is desirable. Therefore, it could be that individuals who respond to social pressure to smile also respond to social pressure to take better care of themselves. This may include pressure to engage in things like preventive health behaviors and adherence to medical regimens. An extensive literature has shown that health practices such as these are predictive of overall decreased morbidity and mortality (e.g., Khaw et al., 2008; McGinnis & Foege, 2004).

Pathways connecting experimentally manipulated smiles to physical health

There are a number of different variables that may play a role in the connection between experimentally manipulated smiling and health (see Figure 2). We discuss one possible pathway that we believe is most supported by the existing literature, and one possible pathway that, although largely untested, is nevertheless intriguing.

State positive affect

One of the main mechanisms through which experimentally manipulated smiling may influence health-relevant physiology is via changes in state PA, or transitory PA felt in the moment. The mere act of smiling may alter or induce state PA, as posited by the facial feedback hypothesis

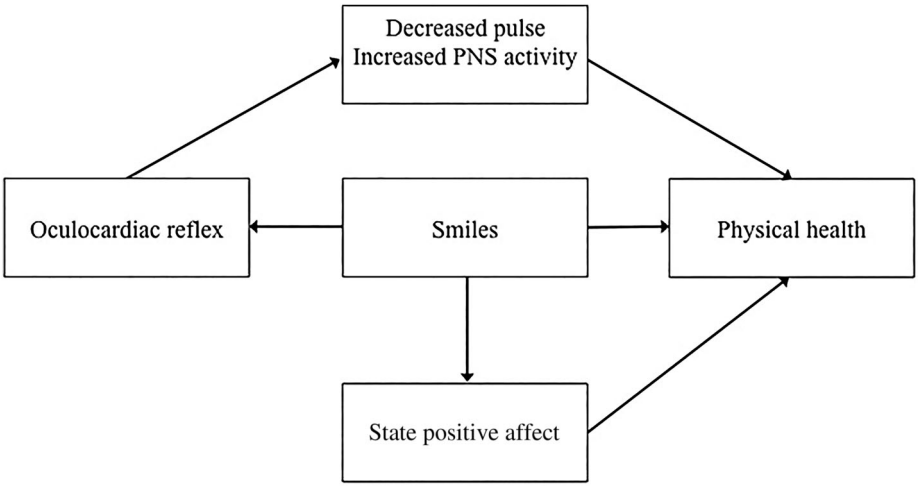

Figure 2. Hypothesized pathways through which experimentally manipulated smiling may affect physical health.

(Tourangeau & Ellsworth, 1979). Whether smiling influences state PA is important to determine because state PA has been connected with a number of health and health-relevant outcomes, such as lower cortisol output (a hormone released during stress; Steptoe et al., 2005) and fewer reports of physical symptoms (Benyamini et al., 2000). In addition, state PA has also been connected with survival, such that individuals with higher levels of state PA over the course of one day were less likely to die than individuals with lower levels of state PA (Steptoe & Wardle, 2011), although this is likely due to ties with trait PA. Studies such as these indicate that state PA may have important effects on various physiological systems (see Pressman & Cohen, 2005, for a review), which may eventually result in significant differences in health outcomes such as survival. Thus, if smiling is connected with increases in state PA, smiling could impact both short- and long-term health.

Oculocardiac reflex

One largely untested possible mechanism through which smiling may directly impact physiology is the oculocardiac reflex. The oculocardiac reflex is a decrease in pulse rate when pressure is applied to muscles around the eyes and/or the eyeball is compressed. Activation of the orbicularis oculi muscles during Duchenne smiles may trigger the oculocardiac reflex through a number of nerve activations, which in turn could lower pulse rate through stimulation of the vagus nerve (Lang et al., 1991).

A first step to test the role that the oculocardiac reflex might play in the connection between smiling and physiology would require comparing orbicularis oculi activation with a measure of vagus nerve/parasympathetic nervous system activation such as respiratory sinus arrhythmia (RSA), where higher values indicate greater vagus nerve/parasympathetic nervous system activation. Only one study to our knowledge has tested this step by experimentally manipulating Duchenne smiles in participants in the context of pain-inducing manipulations (Cross, 2019). Higher orbicularis oculi activation (assessed via EMG) during pressure-induced pain was significantly associated with higher RSA during recovery, providing evidence that orbicularis oculi activation mediated the relationship between Duchenne smiling and RSA recovery (though this did not replicate in a cold pain task). The interesting aspect of this pathway is that it does not require emotional involvement, making it distinct from many of the pathways that have been previously discussed. Past research has demonstrated that eye constriction is also present in facial expressions that are associated with negative emotion (e.g., Mattson et al., 2013), which leads to the intriguing question about whether negative facial expressions such as grimaces could also activate the oculocardiac reflex. Findings from the needle injection study discussed earlier in this review shed some light on this question because participants who made Duchenne smiles during the needle injection had lower heart rate trajectories than participants who grimaced (Pressman et al., 2021). That said, grimacing participants did report comparable stress reduction to Duchenne smilers when examining self-reports. These findings suggest that cardiovascular effects from the oculocardiac reflex could possibly be negated with the activation of certain additional facial muscles such as the corrugator supercilii, which are activated during grimaces. Clearly there is much remaining work to be conducted on this topic, but should this prove to be a replicable mechanism producing physiological stress reduction, it opens the doors to emotion altering and stress reducing treatments focused simply on muscle stimulation around the eyes and/or behavioral focused activation of muscle groups as an alternative or adjuvant to other stress-reducing and positive psychology interventions that focus on altering mood.

The role of context and types of smiles

When testing any of these hypothesized pathways, researchers should pay close attention to the *type* of smile (e.g., Duchenne vs. non-Duchenne) and the *context* of the smile (e.g., miserable vs. false). Although the Duchenne vs. non-Duchenne smile distinction has been investigated in a handful of studies, consideration of the context in which smiles are made and the possible purpose of these smiles is currently lacking in the existing literature. Miserable smiles are especially intriguing

because they are smiles that are made during unpleasant experiences such as acute stress. Indeed, a number of studies in this review found that smiles, even Duchenne smiles that are supposed to reflect genuine PA, were naturally displayed during negative experiences (Davidson et al., 2010; Fredrickson & Levenson, 1998; Rosenberg et al., 2001). In addition, several studies found smiling to naturally occur during acute stress (Davidson et al., 2010; Fredrickson & Levenson, 1998; Rosenberg et al., 2001) and when manipulated, to improve stress responses (both physiological as well as stress-related perceptions like how painful a stimulus is; e.g., Kraft & Pressman, 2012; Pressman et al., 2021). Thus, reduced stress (and the concomitant lack of harm to the body) may be another path by which smiling can help individuals protect their health. This intriguing area of research leaves a number of unanswered questions. For example, do miserable smiles during acute stress have a specific function? Is the goal to distract the participant from the negative experience they are currently going through, or to possibly attempt to induce PA as the facial feedback hypothesis would suggest? Coding for both the type of smile and context of the smile is imperative in order to understand both when and how smiles can be beneficial for health.

Another large gap within this literature is the lack of consideration of contextual factors that may influence whether or not someone smiles and the type of smile that they produce. Few of the studies discussed above controlled for contextual variables such as socioeconomic status, education, or occupation. In fact, few variables were controlled for in these studies at all, demonstrating a need for statistical rigor and consideration of contextual moderators within this field. It is easy to imagine that impactful variables such as these could affect smiling characteristics, and this is an important and necessary future direction for work in this area. Further, if it is the case that circumstances (e.g., greater safety, wealth, societal features) determine smiling, then it may not be the smile itself causing health, but rather the circumstances operating as a confounding variable. While experimental studies that manipulate facial expressions help to resolve this potential noise in controlled lab settings and indicate some direct effects from smiling itself, it is likely that in naturalistic studies, more than smiling is predicting health and physiology. Future studies will need to consider these potential moderators carefully.

Limitations

Because this review is conceptual and not systematic, we did not have explicit criteria for article selection and did not comb through various databases to collect all existing data on the topic of smiling and health. While we are confident that we captured the majority of published studies on the topics at hand, we did not include dissertations, unpublished data, or null studies that may not have been accepted for publication. This may mean that there are studies out there that did not find connections between smiling and health that may alter our narrative and interpretation of the current small literature (i.e., a file-drawer problem). Thus, although we selected what we viewed as the most representative literature on this topic, our selection was biased toward published materials. This is a budding, yet currently limited, area of research, and our goal was to stimulate additional research on smiling and health. Once more research has been conducted on the topic, a systematic review and/or meta-analysis will be warranted.

Future directions

There are a number of future directions for research on the connections between smiling and physical health to take. One exciting area in which smiles have been notably under researched is within clinical settings. To the best of our knowledge, there is only one study that has investigated smiles in this context (Aoun et al., 2020) and it revealed both physical health and quality of life findings related to smiling. Smiles measured in healthcare contexts may be especially important because they may affect the relationship between patients and healthcare providers. For example, smiles from healthcare providers could affect factors like comfort and adherence levels of the patient, whereas smiles

from patients could affect outcomes such as trust, communication, assessment of symptoms, and satisfaction with treatment. Therefore, in addition to smiles being researched within a number of different healthcare settings (e.g., clinics, emergency rooms, cancer wards), researchers should also investigate the extent to which smiles from patients are reciprocated from healthcare providers (and vice versa) and to what outcomes this reciprocation is related.

Also relevant to clinical settings is work on BOTOX or similar treatments for wrinkles in the face and emotion. Studies have already revealed that paralyzing the muscles involved with negative emotions (i.e., corrugator supercilli) changes interpretations of affective stimuli (e.g., Bulnes et al., 2019; Davis et al., 2010). Orbicularis oculi muscles, which are responsible for 'crow's feet' around the eyes, are also popular BOTOX injection sites. It is possible that the inability to Duchenne smile due to BOTOX injections may make people appear 'fake' to others and interfere with effective communication. This in turn could influence the formation of positive social relationships and result in long-term physical health consequences. However, more research on the effects of injecting BOTOX specifically into the orbicularis oculi muscles is needed; multiple muscles are often injected during the same session, so it is difficult to isolate findings due to specific muscle groups.

Future research should also examine the smile-health association within different races/ethnicities and cultures. The majority of the studies included in this review either did not provide racial/ethnic breakdowns of their samples or had samples that were largely White, which means racial/ethnic differences were not investigated. However, there are known cultural differences in types of smiles displayed (e.g., Thibault et al., 2012; Tsai et al., 2002). For example, past work has found that non-Duchenne smiles may be employed at different rates and for different reasons between East Asians and European Americans (Tsai et al., 2002). In addition, Duchenne smiling may not indicate a genuine expression of PA across cultures (Thibault et al., 2012). Thus, understanding what other qualities of facial expression or behavior imply genuineness in other cultures is an important area of future research.

Additional research is also needed to test the pathways discussed in this review and potential moderators. For example, a true test of the facial feedback hypothesis is needed to understand whether smiling induces or alters existing PA (e.g., not amusement/enjoyment of a comic), represents higher trait PA or extraversion, or can independently predict future physical health due to the pathways outlined in this review. Potential moderators like sex and characteristics of social interaction (e.g., power dynamics, intergroup/intragroup context, relationship quality) also must be considered in order for researchers to understand when and under what context smiling is most beneficial to health. For instance, there is a robust literature that suggests that there are differences in smiling between men and women. A meta-analysis of 162 studies determined that women are more likely to smile than men (LaFrance et al., 2003), yet studies do not always include sex as a moderator or covariate within analyses. Additionally, fine-grained methodologies like ecological momentary assessment (EMA) that have not yet been used in the smiling and health literature should be considered for future studies. Although potentially difficult to design, studies that use methodologies like EMA would allow researchers to investigate smiling 'in the moment' and its immediate connections with outcomes like heart rate in the real world, as well as the downstream health benefits for individuals who smile more often.

In addition to smiling, there are other behaviors that are connected with the display of positive emotion, such as laughter, that would be exciting topics for future review papers. Laughter can convey the same social signals as smiles (Haakana, 2010), but there are also important distinctions between laughter and smiling, including the fact that laughter provides both visual and audible information to others. Research has demonstrated that communication that is solely audible may enhance empathic accuracy (e.g., Kraus, 2017), so it may be the case that laughter has distinct advantages as a method of emotion communication. There is evidence that laughter is connected to a number of physical health outcomes such as stimulating circulation, decreasing stress hormones, and elevating pain threshold and tolerance (Mora-Ripoll, 2011). Thus, it would be interesting to investigate whether any of the proposed pathways between smiling and health in this review

also play a role in the connection between laughter and health, and to determine additional pathways that might play a role solely in the laughter and health connection.

Finally, the issue of replication should be considered within the smiling-physical health literature. Replication is an extremely important topic in the field of social psychology, and the lack of replication of a few notable studies within this broad field (e.g., Ranehill et al., 2015; Wagenmakers et al., 2016) has led some to use the term 'replication crisis.' The issue of replication has more slowly reached the field of health psychology, partially because studies with biomarkers are more expensive to replicate. Because of this, we may have to rely on conceptual replications and expansions, such as that done by Pressman and colleagues (2021) to revisit the findings from Kraft and Pressman (2012), since grant funding for direct replications can be difficult to secure. It is impressive that existing work on smiling and physical health across a number of diverse outcomes has converged on the idea that smiling might be beneficial for physical health; replication within this field and the use of open science practices will help strengthen the evidence and is an important direction for future research to take.

Conclusion

Overall, the current literature on the connections between smiling and physical health suggests that both naturally occurring smiles and experimentally manipulated smiles are associated with positive physical health and health-related outcomes. We are not suggesting that smiling can undo physical illness and disease, but may have small benefits for health over the course of the lifespan. The evidence currently suggests that smiling may be most beneficial in the short-term, such as its ability to possibly undo physiological strain from acute stress, which may lead to long-term benefits over time. Although both naturally occurring smiles and experimentally manipulated smiles seem to be beneficial for health, it is important that studies not lump these two categories of smiles together. The pathways we hypothesized that could explain *why* smiles are beneficial are distinctly different between these two categories. We cannot, and should not, generalize from smiles in photographs to smiles that have been manipulated in the lab, or vice versa. That being said, though some of the pathways underlying these relationships are likely different, it is impressive that both categories of smiles seem to have benefits for health. Smiling is a fairly straightforward variable to measure and code for within studies in the health sciences, and more investigators should consider including it in their research. Although the current literature is limited, we hope that this review will spark interest in other health researchers and encourage them to expand this topic in a number of different domains. The assessment of smiling can reduce the heavy reliance that most health researchers have on self-reported emotion. It is not difficult to assess these overt behavioral displays of PA and including them adds breadth and depth to those interested in the effects of emotion on well-being. It is only with more data that we can truly understand the connections between smiling and health as well as capitalize on its likely wellness benefits to enhance the health of others.

Note

1. When possible, Cohen's *d* effect sizes were calculated when sample sizes, means, and standard deviations were provided in the full text of the article. Zero-order correlations presented in full text were transformed according to Rosenthal (1994). Odds ratios presented in the full text were transformed according to Borenstein and colleagues (2009). The *r* to *d* and *OR* to *d* transformations were calculated using Lenhard and Lenhard (2016). Hazard ratios presented in full text were transformed according to Azuero (2016).

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