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WHY DO PEOPLE SEEK NEGATIVE EMOTIONS? A SOLUTION TO HUME'S PUZZLE

by

WILLIAM J. BRADY

Under the Direction of Dr. Andrea Scarantino

ABSTRACT

In his 1757 essay "Of Tragedy", Hume reflected on a curious puzzle about emotions. Sometimes people seek out emotions or experiences that are typically negative and associated with displeasure or pain. People often desire to watch horror films that will make them scared or listen to music that will make them sad. Some people even engage in the pursuit of negative emotions on a regular basis such as in the case of thrill-seeking. In this paper my goal is to update Hume's puzzle with empirical evidence from the affective sciences and argue for two conclusions. First I will argue that Hume's puzzle still runs deep. Though some recent scientific and philosophical accounts of emotions have tried to solve it, they have thus far failed. Second I attempt to construct a psychological account that solves the puzzle. Instead of focusing on how emotions are generated as previous theories have done, I argue that what is important is how emotions are regulated.

INDEX WORDS: Emotion, Valence, Regulation, Pleasure, Pain, Hume, Thrill-seeking

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Master of Arts

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2012

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by

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DEDICATION

To my Grandparents Joe and Marilyn Brady, and Gerry and Sheila Schneiderman, with love

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS ..... **v**

1 HUME'S PUZZLE INTRODUCED **1**

2 WHAT WOULD IT TAKE TO SOLVE HUME'S PUZZLE? **4**

3 EVALUATION OF CURRENT ATTEMPTS TO SOLVE HUME'S PUZZLE **8**

3.1 The Safe Practice Account **8**

3.2 The Opponent Processing Account **14**

3.3 The Mixed Emotions Account **17**

4 A NOVEL EXPLANATION OF HUME'S PUZZLE **25**

4.1 Emotion Regulation Defined **25**

4.2 Accounting for Thrill-Seekers **29**

4.2.1 ERA and the Why Question **29**

4.2.2 ERA and the How Question **31**

4.2.3 ERA and the Valence Dichotomy **39**

4.3 Explaining Hume's Puzzle **40**

4.4 Objections **43**

5 CONCLUSION **45**

REFERENCES **46**

1 HUME'S PUZZLE INTRODUCED

> "It seems an unaccountable pleasure which the spectators of a well-written tragedy receive from sorry, terror, anxiety, and other passions that are in themselves disagreeable and uneasy".
>
> "What is it then which in this case raises a pleasure from the bosom of uneasiness, so to speak; and a pleasure which still retains all the features and outward symptoms of distress and sorrow".
>
> (David Hume, *Of Tragedy*)

Theories of emotion vary significantly, but they tend to share the view that some emotions are "positive" while other emotions are "negative". One reason for the distinction between positive and negative emotions is that the division clearly has intuitive appeal. For example, emotions such as anger, sadness and shame appear negative, whereas emotions such as joy, gratitude and awe appear positive.

Contemporary emotion theorists have provided empirical evidence for the claim that we intuitively categorize emotions as either positive or negative. Relying on judgments about the similarity between different emotion terms (e.g. "fear", "anger"), some researchers have used statistical analysis to make a visual map, or "circumplex", that categorizes different emotions in similarity classes (e.g. Russell 1980). The research uses data from people making judgments about emotions to suggest that emotions are reliably distinguished based on two dimensions: "arousal" and "valence". Arousal refers to the intensity of the emotion. We think of anger as more intense (higher arousal) than boredom (low arousal). Valence refers to the positivity or ne-

gativity of the emotion. We think of sadness as more negative than happiness. The empirical evidence suggests that when we automatically categorize emotions, we use their positivity or negativity as a key criterion in organizing them.

Besides our intuitions that emotions can be positive and negative (as well as high and low on the arousal scale), there is also neuroscientific evidence suggesting that positive and negative emotions may be supported by different brain areas (e.g. Northoff et al. 2000). In other words, there appears to be evidence suggesting that the valence dichotomy may reflect a biological division in the occurrence of human emotions. For instance, Northoff found that emotions occurring in response to negative pictures cause activation in the medial orbitofrontal cortex, while emotions occurring in response to positive pictures cause lateral orbitofrontal activation. In another study, Sutton & Davidson (1997) found that positive emotions caused increased left prefrontal brain activation while negative emotions caused increased right prefrontal activation. Moreover, in a more recent meta-analysis of neuroimaging studies investigating emotions (Lindquist et al. in press), it was found that brain activations for typically negative emotions (e.g. fear) shared similar areas and were distinct from areas shared by typically positive emotions (e.g. happiness). For example, the amygdala was mainly implicated in the experience and perception of negative emotions such as fear, disgust and anger. The dorsomedial prefrontal cortex however was most strongly associated with happiness. While it is unclear exactly which brain areas underlie each specific emotion, what seems to be a consistent finding is that positive and negative emotions are supported by different brain areas. To sum up, there is evidence that emotions are realized in the brain in a way consistent with our intuitive distinction between positive and negative emotions.

Combining the intuitive appeal and empirical evidence from neuroimaging, it is clear that the valence dichotomy is a key taxonomic principle for emotion theory. The distinction between

positive and negative emotions, however, seems to lead to an often overlooked puzzle. The puzzle arises from two observations. First, the negativity of an emotion is intuitively a reason to avoid it, whereas the positivity of an emotion is intuitively a reason to seek it out. We typically do not enjoy emotions such as fear, and if one has a fear of snakes, she will try to avoid snakes. Conversely, we tend to seek out situations that elicit happiness, and if one is happy when spending time with a friend, she will seek out more interactions with that friend.

The second observation, as discussed by Hume is his 1757 essay *Of Tragedy*, is that people often seek out emotions that are intuitively negative. For example, people often desire to watch horror films that will make them scared, listen to music that will make them sad, or read about details of gruesome bodily injury that will appall them. Perhaps what is most impressive is that some people do not engage in the pursuit of negative emotions only once, but on a regular basis. A prime example is that of thrill-seekers, who repeatedly jump out of airplanes, bungee jump, or engage in mountain climbing without any safety gear. If the emotions involved in all such cases are *negative*, why do people continue to seek them out? Answering this question amounts to solving what I will call *Hume's Puzzle*.[1]

Solving Hume's puzzle is an important task for contemporary emotion theories since they draw heavily on the valence dichotomy when organizing and making sense of the difference between individual emotions. If some people often seek out typically negative emotions, it becomes unclear what makes the emotions they seek *negative*. Failure to solve Hume's puzzle would threaten the use of valence in emotion theory (e.g. Solomon 2007), leading to the need to revise a tenet shared by practically all emotion theories.

[1]There may also be much rarer cases of people who voluntarily avoid positive emotions. A potential example that comes to mind is an artist who prefers to be depressed or sullen (and avoids being content) because the artist only feels creative during the negative states. Because I am not aware of documented cases of these sorts, I leave out of the discussion the possibility of avoiding positive emotions. However, such cases may add a layer of complication to Hume's Puzzle and thus could be a fruitful avenue for future research.

This paper reviews a number of attempts to solve Hume's puzzle, it argues that none of them is fully successful, and it defends a novel proposal. The proposal draws upon contemporary affective neuroscience to construct an explanation of Hume's puzzle that is importantly different from previous explanations. While previous attempts to solve the puzzle are based upon ideas of how, or why, negative emotions are *generated*, the new proposal is based on people's ability to control, or *regulate* negative emotions.

2 WHAT WOULD IT TAKE TO SOLVE HUME'S PUZZLE?

In this paper, by 'emotion' I mean the widespread recruitment throughout the body of physiological changes that leads to (1) good and bad feelings, and / or (2) the assignment of value to stimuli that either reinforces behaviors ("more of this!") or reduces behaviors ("less of this!") (see, e.g., Prinz 2005). Thus, a negative emotion is widespread physiological change in the body that in isolation leads to bad feelings and to the assignment of negative value (reduction of behavior) to the stimuli that caused the physiological changes. A positive emotion is widespread physiological change in the body that in isolation leads to good feelings and to the assignment of positive value (reinforcement of behavior) to the stimuli that causes the physiological changes.

With emotions defined as such, the fact that some people tend to seek typically negative emotions is puzzling from almost any perspective that invokes the notion of valence, whether it is intuitive, evolutionary, or psychological. To understand the puzzle, we need only reflect on our own experience. When we introspect we can tell the difference between emotions that *feel bad* such as anger at having been mistreated, and emotions that *feel good* such as joy from re-

ceiving an award. Based on our emotional experiences, it appears strange that we ever *desire* or *seek* emotions that typically make us feel bad.

Shifting to a scientific perspective, the puzzle thickens. Many scientists utilizing the valence dichotomy have assumed that what makes an emotion negative is that it *leads to avoidance behavior*, and what makes an emotion positive is that it *leads to approach behavior* (e.g. Gray 1981; McLean 1993). The distinction makes sense if we think of emotions from an evolutionary perspective: negative emotions evolved to motivate an organism away from harmful or dangerous stimuli, while positive emotions motivate it toward stimuli that can increase survival.

The evolutionary perspective is supported by the fact that a majority of people are afraid of stimuli such as extreme heights and animals such as bears and snakes. Avoiding such stimuli makes it less likely for us to become seriously injured, because the stimuli are clearly dangerous and potentially lethal. In terms of positive emotions, we are attracted to things that make us happy such as caring for our newborn children or spending time with family and close friends. Continuing such activities provides a survival advantage in ensuring the survival of offspring and gaining support from other individuals.

As Hume's Puzzle indicates, however, the approach/avoid distinction breaks down when we examine some instances of human behavior. People occasionally seek, or approach, typically negative emotions, whether in the context of fiction such in watching tragedies or horror films, or in non-fictional cases such as thrill-seeking. Given this fact about human behavior, the approach/avoid distinction is an overly simplified account of what makes an emotion positive and negative.

There are several other philosophical and scientific accounts that have been proposed in an attempt to explain what it is that accounts for the supposed difference between positive and

negative emotions. Some accounts rely on neurobiological differences (e.g. Panksepp 2004; Prinz 2010), while others rely on differences in experience (e.g. Russell 2003). Evaluating whether or not these more recent proposals can account for the behavior described by Hume's puzzle requires first discussing what a satisfactory solution to Hume's Puzzle would look like. I contend that it should satisfy three main desiderata.

First, a successful explanation should answer the broadest conceptual question raised by Hume's puzzle, namely *why* people seek negative emotions. Call this an answer to the "why-question". Consider an account according to which "some people like to watch grotesque horror films because they do not feel any disgust". This account would fail to answer the why-question. This is because the fact that someone is not disgusted by horror films does not in itself explain *why* they seek them out. For example, I am not disgusted by leafy green vegetables (they taste just fine to me), but I do not seek them out. A successful answer to the why-question would have to provide an understanding of the *seeking* out of horror films, and a failure to get disgusted just does not do it.

The second criterion for a successful explanation is that it also provides details about the underlying mechanisms involved in seeking out negative emotions. Call this an answer to the "how-question". An explanation that merely provides a reason why people seek negative emotions, but no further details about *how* the seeking is implemented would not be fully informative. Consider the following explanation of Hume's puzzle: "People seek negative emotions because they enjoy them". The explanation provides an answer for why people seek negative emotions: they enjoy the negative emotions and so they return to them. However, the explanation lacks details on how a negative emotion comes to be enjoyable for some people.

The answer to the how-question should shed light on the psychological or neuroscientific mechanisms underlying the seeking of negative emotions. An explanation of Hume' Puzzle that is consistent with recent empirical evidence (or makes explicit empirical predictions that draw support from empirical evidence) should be preferred over an explanation that is inconsistent. The second desideratum becomes important after the first is satisfied. Between two explanations that answer the why-question, the one that provides empirical details on the underlying mechanisms is to be preferred to the one that does not.

The last criterion for a successful explanation of Hume's puzzle is that it should preserve the valence dichotomy if at all possible. If an explanation can explain why and how some people seek negative emotions and at the same time preserve the idea that emotions are either negative or positive, then it should be preferred over an explanation that does not. We want to preserve the valence dichotomy because there is empirical evidence suggesting that the way in which we intuitively taxonomize our emotions terms (and report our experience of emotions) is robustly tied to the valence dichotomy. Furthermore, there is neuroscientific evidence suggesting that the brain areas underwriting emotions may be consistent with the valence dichotomy (positive and negative emotions may rely on different brain areas).

In order for an explanation of Hume's Puzzle to properly preserve the valence dichotomy, the explanation should preserve the idea that the emotion sought is indeed *negative*. For example, an explanation of thrill-seeking that preserves the valence dichotomy would not suggest that fear of extreme heights is a positive emotion for thrill-seekers, but rather that it is sought out *despite being negative*.

To summarize, a successful explanation of Hume's Puzzle should explain why some people seek negative emotions (why-question) and which mechanisms they rely on for seeking

negative emotions (how-question) while preserving the idea that the emotions being sought are indeed negative (valence dichotomy).

3 EVALUATION OF CURRENT ATTEMPTS TO SOLVE HUME'S PUZZLE

In this section I consider some recent attempts to solve Hume's Puzzle by psychologists, neuroscientists and philosophers. I distinguish between three main explanatory frameworks: the Safe Practice Account, the Opponent Processing Account, and the Mixed Emotions Account. Throughout the section I describe the strengths and weaknesses of each account.

3.1 The Safe Practice Account

The Safe Practice Account (SPA) has been proposed mainly in the psychological literature (e.g. Bloom 2010; Panksepp 2004). SPA draws intuitive appeal from its explanation of cases in which we seek negative emotions in fictional contexts or other common situations such as playing sports and eating spicy foods. Paul Bloom (2010) offers a concise summary of SPA: "[w]e are drawn, then, toward worst-case scenarios…these exotic cases serve as useful practice for bad times, exercising our psyches for when life goes to hell" (Bloom 2010, p. 194).

Bloom argues that we seek things such as horror films or tragedies because we know these events are "safe practice". That is, we know that the negative states that may occur in these situations are based in fiction and thus we have some level in control over them. For example, the fictional context of movies and theatre produces a low-risk version of a real world situation. The fear experienced while watching a horror film is much less intense and less dangerous than a non-fictional context that evokes fear. This allows us, without much risk, to acquire skills that enable us to become better equipped for the handling of threats in the real world. For example,

when we play sports we achieve skills for handling physically dangerous situations (e.g. physical confrontations), but the risk of getting seriously injured is far less than in an actual fight. Similarly, when watching a horror film we gain practice coping with our own fear reactions at a low risk in that we can always turn the movie off or walk away from the theater. With such practice we may be better able to cope with fear and anxiety produced in non-fictional contexts in the future.

SPA is not committed to the claim that we engage in negative emotions in fictional situations with explicit awareness that they are safe practices for real world threats. In fact, this explanation would be counter-intuitive because we tend to enjoy the experience of theater tragedies and horror films for what they are, not because we conceive of such experiences as functional to our well-being. SPA can account for the lack of awareness of the potential benefit of the 'safe practice' by relying on an evolutionary explanation. The desire for being in mild or low-risk negative situations clearly provides organisms with a survival advantage. When confronted with a high-risk negative situation, an organism that has practiced coping with low-risk negative situations will be better equipped for survival than an organism that had never experienced the type of situation at all. For this reason, it is likely that a desire for mildly negative situations was selected for in the environment of evolutionary adaptation. In this case we would desire mildly negative situations but not necessarily be aware of the reason why.

Evidence of the validity of the above evolutionary story comes from cross-species examples of "play" behavior (e.g. play fighting with in-group members). The fact that humans, non-human primates, and rodents have all been shown to engage in play behavior (see e.g. Panksepp 2004) suggests that the instinct or desire to play serves an important functional role in the surviv-

al of mammalian species. SPA provides an intuitive answer as to what the functional role is; namely, practice for handling similar future events in competitive rather than playful situations.

Before assessing how well SPA handles Hume's puzzle, it is useful to examine one key element of the account: the suggestion that an element of *control* is involved in cases in which we seek negative emotions. The element of control is precisely the "safe" component of the "safe practice". Having control is what creates the low-risk situations so that skills can be acquired without suffering large amounts of loss. Bloom goes as far as to argue that the element of control appears to extend to more extreme cases of seeking negative emotions or negative states such as sadomasochism (i.e., the receiving of physical and psychological pain for means of pleasure) (Bloom 2010, p. 196). Even these participants have a ‘safe word’ that can be muttered such that the activity will cease.

Given SPA's emphasis on control, it is important at this point to unpack exactly what 'control' means. Bloom states that, "[t]he lover of spicy foods needs to have power over what's going in her mouth; the horror-movie fan gets to choose the movie and is free to close his eyes or turn his head" (*ibid.*, p. 196). Bloom argues that in cases of seeking negative emotions one always has the ability to change or prevent the negative experience from continuing. We can summarize this notion of control as *the ability to alter present or subsequent events at will, so as to quickly extinguish the negative emotion*.

While SPA provides a seemingly plausible explanation of some instances of Hume's puzzle in which control is present, it is limited in scope. The counter-example I have in mind involve cases of thrill-seeking, in which more visceral, intense negative emotions are regularly sought.

I define thrill-seeking as the *continual seeking of hyper-arousing, typically negative emotions when perceived danger and minimal control are present*. Let us consider each component of the definition in turn. By “continual seeking” I mean seeking on multiple occasions. The fact that a person might try a thrilling activity once does not constitute an instance of Hume’s Puzzle, because the person may have no clear idea of what emotions he or she will experience. The puzzle emerges when a person does experience the negative emotion involved in an activity, and yet continues to seek the same activity in full awareness of what follows.

By “hyper-arousing” emotions I mean emotions that produce highly significant increases in physiological response as compared to resting physiology. This will include measurable autonomic responses such as increased blood pressure, respiration, heart rate and skin conductance. Evidence of such hyper-arousal comes from a study on novice skydivers. Sterlini & Bryant (2002) measured resting, pre-jump and post-jump physiology and subjective anxiety ratings of 100 novice skydivers. They found that almost all skydivers reported experiencing extreme anxiety, hyper-arousal, and even feelings of dissociation that are normally reported by individuals who experience severely traumatic events.

By “typically negative emotions” I mean emotions that we typically categorize as negative. Paradigm examples of typically negative emotions include fear, anxiety or anger. By "perceived danger" I mean a subjective assessment of the activity as involving potential risk. For example, a skydiver knows that her activity can potentially lead to death. One caveat to be pointed out is that perceived danger can be contrasted with objective danger (danger based on statistics of accidents or death). For an activity to count as thrill-seeking (at least in the typical sense), besides a perceived danger there must also be at minimum some objective potential risk

associated with the activity. A man who fears for his life when he must walk through Central Park during lunch is at least not a typical thrill-seeker.

Finally, there is the condition of “minimal control”. Under Bloom's definition of control, one does not have control over a situation if she cannot alter present or subsequent events at will so as to quickly extinguish the negative emotion. Let us call this form of control 'robust control'. We can contrast this form of control with ‘minimal control’, which I define as *the ability to create contingency plans for events that can go wrong but are not caused by the individual*. An example of an event that can go wrong without an individual causing it is a chance environmental factor. If I shoot a basketball outside, and a strong wind gust randomly makes my ball miss the goal, then something has gone wrong with my shot that I did not cause.

Thrill-seekers fit under the definition of ‘minimal control’ but they do not have the sort of ‘robust control’ that is a necessary component of the SPA explanation. Consider the example of skydiving. If one changes her mind due to extreme fear about the skydive *after* she jumps out the airplane, there is no way to change the course of events to come (free-falling toward the ground) so as to extinguish the occurrent fear. A parachute can be opened to slow down the free-fall, but the parachute can only be opened close to the end of the jump and still does not cause the fear to immediately cease. If one jumps from a plane, not only is she committed to finishing the skydiving session, but there are also environmental and chance factors beyond her control. As it turns out, about 20 percent of skydiving accidents occur due to random equipment malfunction such as parachute failure (USPA 2012).

A skydiver can, however, take precautionary measures to make her jump as safe as possible, and in this sense minimal control is present. She can have backup parachutes that acts as a contingency plan if things go wrong. However, minimal control does not confer the same safety

that robust control confers on a situation. The reason is that in cases of minimal control even if one desires to cease an activity to extinguish a negative state or a potentially dangerous situation, she cannot. If someone is rock climbing and her safety strap fails, death is imminent regardless of what she does. In contrast, with the cases of horror films or play fighting, if danger is detected (e.g. I am accidentally given a broken nose from my brother while we are wrestling) one can cease the activity before the situation worsens.

The lack of robust control involved is the first reason why thrill-seeking cannot be explained by the idea of “safe practice”. The point is that thrill-seeking activities cannot be quickly stopped at will once they have been initiated, and are in this sense not ‘safe’. Furthermore, thrill-seeking also does not seem to be "practice". First, there is a psychological element that is importantly different from other cases. The amount of perceived danger involved is significantly greater in skydiving than in activities such as watching a horror film. It is true that some people can become extremely frightened during a movie, but there is not the same element of intensity or of immediate physical danger as is present in skydiving. The Sterlini & Bryant (2001) study showing extreme anxiety, hyper-arousal, and feelings of dissociation supports this claim. Thrill-seeking seems to involve extremely high physical and psychological distress, but it would be misleading if not outright false to claim that eating spicy foods, watching horror films, or even performing sadomasochism produces the same subjective and physiological fear or anxiety.

If thrill-seeking involves high amount of physical and psychological distress, then is unclear that thrill-seeking helps us practice for future events, especially from the evolutionary perspective SPA endorses. As an analogy, if I want to receive practice for dealing with physical confrontation, I should not pick a fight with an alpha male figure, because such a decision would be high-risk and might leave me with substantial injury. Rather, I should pick the lower intensity

and low-risk situations such as picking a fight with my younger brother. Similarly, it makes little sense to call the full-blown fear responses involved in thrill-seeking low-risk practice. The intense response involved is supposed to be what, according to SPA, we are practicing for. This point is further supported by the fact that the emotional and physiological response often involved in thrill-seeking is more intense than most of the cases in the non-fictional context that according to SPA we are supposed to be practicing for. If I run into a poisonous snake on a trail, or I am being yelled at by an enraged driver, I will surely have a fear response, but for most people it will not be as great as that involved in thrill-seeking. Because thrill-seeking involves such full-blown negative emotions, SPA is an unsatisfying explanation for why people thrill-seek.

If what I have said thus far is right, SPA has difficulty explaining a set of behaviors (thrill-seekers) that are included in Hume's puzzle. Thus, SPA fails to meet the first desideratum described in section 2. It cannot explain *why* people in a subset of cases seek the intense negative emotions during thrill-seeking. This is a fatal problem for SPA. As articulated in section 2, failure to successfully answer the why-question makes any attempted solution to Hume’s Puzzle unsatisfactory.

3.2 The Opponent Processing Account

The Opponent Processing Account (OPA) is another explanatory strategy for understanding why some people seek negative emotions (e.g. Prinz 2004; 2010). OPA postulates that strongly valenced emotions lead to an oppositely valenced emotion shortly after because of “opponent processes that work to restore homeostatic equilibrium” (Prinz 2010, p. 11). This idea has a tradition of empirical support from the literature on drug addiction (Solomon 1974). Solomon's research suggests that emotional states are automatically "opposed" by central nervous

system mechanisms that reduce the intensity of emotions. A comparison can be drawn to the mechanisms that control heart rate. When the sympathetic nervous system is activated (which leads to increased physiological arousal), the body will then activate the parasympathetic system, which decreases physiological arousal so that the body does not experience unbridled increase in physiology. The homeostatic system exists for good reason: if increases in physiological arousal were uncontrolled, we would die of cardiac arrest.

Solomon's research suggests that there is a nervous system mechanism that attempts to balance our emotional states somewhere around a neutral state between positive and negative emotions. The opponent processing idea is further supported by the observation that emotional responses are often heavily tied to the massive recruitment of physiological changes in the body. When we become frightened, our blood pressure, respiration and heart rate may all increase. If the body tends to generally moderate physiological changes toward equilibrium via the sympathetic and parasympathetic nervous systems, it would not be surprising if emotions and their associated physiology were similarly moderated.

Applying the opponent processing idea toward Hume's puzzle would lead to the following explanation: the initial negative emotion sought during situations such as horror-film viewing, listening to sad music, or thrill-seeking triggers an oppositely-valenced positive emotion (such as euphoria). This second response has the ability to “overshadow” the initial negative response (Prinz 2004, p. 175). As an example, we can consider the case of skydiving since Prinz specifically anticipates potential objections to his account from the cases of thrill-seeking. He argues that a skydiver may feel fear when jumping from the plane, but then feel euphoria quickly after the initial onset of fear due to opponent processing. It is the euphoria that overpowers the initial fear response, such that the skydiver continues to jump from planes because she seeks the

euphoria. In this way, a negative emotion becomes associated with a separate positive feeling such that even though they co-occur, the positive feeling can overshadow the negative.

OPA has intuitive force, but its explanation of thrill-seeking is unsatisfactory. The main problem with the explanation is that the argument proves too much. If we assume that opponent processing is a general mechanism involved in skydiving and thrill-seeking, then it should be at work in any case of high-arousal negative emotion. However, if this is true, then is it puzzling as to why *all* cases of hyper-arousing negative emotions (e.g. sexual abuse, domestic violence, being attacked by a predator) are not sought after by their victims. If we assume an opponent processing mechanism is at work, the question is why these other cases do not become associated with reward from the euphoria that (according to the opponent processing reply) comes after an episode of a high-arousal negative emotion. The opponent processing approach has no clear way to distinguish between high-arousal negative situations that lead to approach and others that do not.

The OPA proponent may reply that cases of rape or physical violence involve an importantly different sort of negative experience than thrill-seeking. During physical violence for example, not only is the experience during the action negative, but the resulting consequence (bodily injury) is always highly negative as well. Compare this to a thrill-seeking activity such as skydiving, in which the experience might be negative but the end result is usually positive (e.g. a safe landing).[2]

My counter reply is that the more negative an experience becomes, the more of a resulting positive emotion should be activated to balance the negative experience if OPA is right. A prediction of OPA therefore should not be that in cases with both a negative experience and negative consequences people end up feeling worse. Rather the prediction should be that they end

[2]I thank Jesse Prinz for this point during the SSPP conference, March 2012

up feeling *more* euphoria afterwards. The idea that an opponent processing mechanism is at work only in thrill-seeking and not in other hyper-arousing negative states is unmotivated. Thus, the objection that OPA proves too much still stands.

Summing up, OPA potentially satisfies the first desideratum for a satisfactory solution to Hume's Puzzle because it answers the why-question: people seek negative emotions because a negative emotion triggers a positive emotion that creates an overall rewarding experience. OPA also appears to satisfy the third desideratum since it preserves the idea that what is being sought is a negative emotion. Even though an overall positive experience is created through opponent processing, it is the original negative emotion that causes the positive experience. However, OPA falters on the second desideratum, failing to provide a good answer to the how-question. The mechanism according to which people seek negative emotions does not seem to be the one posited by OPA. If it were, then contrary to fact people would enjoy all types of high arousal negative emotions (e.g. those produced by rape).

3.3 The Mixed Emotions Account

The main tenant of the Mixed Emotion Account (MEA) is that the seeking of negative emotions is explained through a process of mixed emotions. MEA is roughly what Hume suggested in attempting to solve his own puzzle. Hume mused:

> "What is it then which in this case raises a pleasure from the bosom of uneasiness, so to speak; and a pleasure which still retains all the features and outward symptoms of distress and sorrow? I answer: this extraordinary effect proceeds from that very eloquence with which the melancholy scene is represented I say, of these noble talents, together with the force of expression and beauty of oratorial numbers [*rhythms*], diffuse the highest satisfaction on the audience, and excite the most delightful movements. By this means, the uneasiness of the melancholy passions is not only overpowered and effaced by something stronger of an opposite kind, but the whole impulse of those passions is converted into pleasure, and swells the delight which the eloquence raises in us". (Hume 2010)

The process of mixed emotions Hume refers to here seems to involve feeling two emotions at the same time, where one emotion eventually grows to dominate the other. Mixed emotions in this sense ("dominant mixed") can be distinguished between mixed emotions in which one genuinely feels two emotions simultaneously and neither seems to dominate the other ("ambivalent mixed"). As an example of the ambivalent case, consider one who scales up a tall mountain in the Alps (Tappolet 2005). If one has to travel across a cliff she may feel fear from the danger of falling, but she will at the same time feel delight from the idea of getting across the cliff to see the beautiful view. Neither the fear nor delight dominates, and thus the emotion experience is ambivalent.

Because for Hume's puzzle we want to know why people have a desire to seek out, or return, to activities that are typically negative, the ambivalent mixed emotion cases may not fit the job. If I genuinely experience the same exact amount of a positive and negative emotion, there is nothing in that experience that should lead me to enjoy, rather than dislike, the experience consistently. Thus, to explain the consistent pattern of behavior in the seeking of negative emotions, we need a proposal that explains that consistent pattern. Thus, Hume's dominant mixed emotion case seems more appropriate.

Returning to the dominant mixed emotions account (henceforth: MEA), Hume thought that works of art cause negative emotions because of the "melancholy scenes" that are evaluated as sad. But the works of art simultaneously elicit a positive emotion because of the "eloquence" by which the events are presented. The eloquence is evaluated as wonderful. Hume argued that the positive emotion in the mixed experience comes to *overpower* the negative emotion. Because the works of art evoke a positive emotion that is stronger than the negative emotion, it

eventually overpowers the negative emotion which leads to one unified positive experience based out of the original mixed emotions.

What "overpowering" is supposed to mean is particularly important. Hume uses both the words "overpower" and "efface". These verbs imply that the positive emotion in the mixed experience in some way *dominates* the negative emotion by some power the emotion has in itself. The most obvious way to cash out the notion of overpowering (and this seems to be what Hume has in mind) is to suggest that the positive emotion is *stronger*, or more intense than the negative emotion. An emotion can be stronger or more intense than another emotion in at least two ways. An example can help distinguish the first. Imagine that I am rocking climbing like in Tappolet's example, so that I might be afraid of climbing across a narrow ledge, but I am also delighted by the inspiring scenery that I expect to see around the ledge. Now also imagine that I am slightly afraid of heights. The first sense of "stronger" we can imagine is *attentional* and involves experience and felt physiology. During the actual climbing, even though I am experiencing some delight, the occurrent fear draws my inner attention more because I am fixated on the fact that I am currently crossing the narrow ledge. The more we attend to an emotion in our experience, the more we become aware of that emotion in our experience (see Prinz 2004, Chapter 9). So an emotion can be stronger if it is more salient (attracting more of my attention) in my emotional experience than other emotions. We can also imagine my fear being stronger due to attention to physiology. If the physiology I have associated with fear is increasing more (e.g. increased respiration, blood pressure, heart rate) than that associated with delight, then fear will be stronger than delight. If I associate a pounding heart with fear but not delight, and I feel the pounding heart over anything else, then the fear will dominate my experience. In the attentional sense of

stronger, when the positive emotion dominates, the sum of the total experience ends up being positive.

The second way we can imagine an emotion being stronger is that some emotions may simply have a stronger effect on learning processes that drive behavior. A primary example is with a disgust response. It is easy for one to develop a lifetime aversion to a food that caused food poisoning (consistent vomiting, etc) only once. Presumably the aversion can occur so quickly because the brain happens to be easily reinforced to avoid stimuli that elicit disgust, which in many cases provides a survival advantage. It could be the case that some emotions, even if experienced with other emotions, are stronger in that they tend to cause reinforcement learning faster than others. As another example, emotions that elicit euphoria may be an example of emotions triggered by the brain's reward pathways that quickly reinforces approach toward the stimuli that caused the euphoria (e.g. Koob &Volkow 2010). If the positive emotion leads to more reinforcement, then the sum experience is rewarding.

With the different notions of "stronger" on the table, one more clarification about MEA is appropriate. It is important to note that MEA is a true mixed emotion account and not merely the same as the Opponent Processing Account. MEA emphasizes the idea that there are multiple appraisals (conscious or unconscious evaluation of stimuli) of a situation; namely, there is a negative appraisal that leads to negative emotions, and also a positive appraisal that leads to a positive emotion. These simultaneous appraisals lead to a co-occurrence of emotions in which one may be stronger and eventually dominates the experience. Compare this to the Opponent Processing Account, which supposes that a strong negative emotional response will occur initially, and then that initial negative emotion will *cause* a positive response of greater or equal weight due to homeostatic mechanisms that temper emotions. Notice that MEA's causal picture is very

different. For MEA, two separate appraisals cause two emotions to co-occur. The sad objects of the drama are appraised as sad, and then elegant aspects are appraised as pleasurable. This is distinct from the idea that a negative emotion causes a positive emotion as in the Opponent Processing Account.

MEA has available a potential explanation of thrill-seeking. We can imagine that a sky-diver experiences fear but also experiences excitement or pride from, e.g., the idea of accomplishing a difficult task. The experience of both emotions could be viewed as the coupling of a visceral, automatically generated appraisal of fear with a top-down, cognitively generated appraisal of excitement or pride. MEA would hold that the co-occurrence of fear and excitement causes one to seek out skydiving because even though a negative emotion is experienced, the co-occurrent positive emotion is stronger than the negative emotion.

This notion cannot be understood in the reinforcement power sense. Between the emotions involved in the putative mixed experience (fear, anxiety, excitement, pride) it seems clear that fear or anxiety are the likely candidates for having the most powerful reinforcement properties. Evidence of this idea comes from decades of animal-based research suggesting that fear responses can serve as powerful reinforcement in learning (and inhibiting behaviors) due to the associations it quickly creates in memory (e.g. Phelps and Ledoux 2005). So it would be empirically unmotivated to suggest that excitement or pride might be stronger than fear in having the power to reinforce the skydiving behavior.

The notion that the positive emotions involved in skydiving are stronger than the negative ones in terms of attention is also unpersuasive. There are a number of recent studies investigating physiology during skydiving suggest that skydivers feel hyper-arousing fear similar to that felt in traumatic events (e.g. Cavenett & Nixon 2006; Campbell & Bryant 2007). An argument

that excitement or pride could be so intense in itself so as to dominate the felt physiology (which would also include fear and anxiety) is unconvincing. For the same reasons, the idea that excitement or pride could dominate attention to the general experience of the emotions is unconvincing. Attention will be drawn toward the emotions producing the greatest increases in physiology which would be the fear and anxiety.

There may be a way, however, to alter MEA such that the attentional sense of "stronger" could be motivated for explaining thrill-seeking. The amendment to the explanation is inspired by research on the psychopathic population that suggests psychopaths have *underactive* emotional responses. Two general findings produce a story that might be applied to thrill-seeking. First, it has been shown that psychopaths have underactive affective responses, and show reduced activation in the amygdala which is a brain area implicated in processing negative affective stimuli and fear and sadness responses (e.g. Kiehl et al. 2001). Second, it has been shown that psychopaths are extremely likely to engage in behaviors of drug abuse, risk-taking and violence (Buckholtz et al. 2010).

What is important to note is that psychopaths appear to have little to no negative emotional responses, and this fact is strongly correlated with high risk-taking behavior. MEA can apply the general explanation to thrill-seekers. Though it is generally the case that negative emotions such as fear are the strongest in terms of attention or physiology, it could be the case that for thrill-seekers, the negative emotional response is extremely underactive. If this is the case, then MEA may be more coherent. For example, while there are multiple appraisals that produce both fear and excitement, someone who enjoys skydiving has a relatively small fear response and a full excitement response. Because the fear response is underactive, the total experience of skydiving is mostly positive at the outset. Similarly, if the fear response is minimized, we would

expect lower physiological change such that the positive emotion is the strongest throughout the experience.

While the idea of thrill-seekers having underactive emotional responses may seem promising, its main problem is that it seems to be empirically false. First, I refer to multiple studies (Sterlini & Bryant 2002; Cavenett & Nixon 2006; Campbell & Bryant 2007) that measure baseline, pre and post-jump physiology suggesting that skydivers have full-blown fear and anxiety responses. These data fly in the face of an explanation suggesting that thrill-seekers experience low levels of fear. As a second testament to the fact that thrill-seekers have full negative responses intact, I refer to an interesting anecdote about one famous thrill-seeker who partakes in what is considered a highly dangerous activity even for the most dedicated thrill-seekers.

There is a rock climber, Alex Honnold, who is one of the only climbers in the world brave enough to climb difficult mountain terrain thousands of feet high without the use of *any* safety equipment of any kind (this is generally called "free soloing"). Upon quick reflection we might think that Honnold is either "crazy" or simply "has no fear". But in a documentary that records some of his climbs, there is a striking scene (The North Face 2010). In the middle of one of his climbs, for a few moments he pauses, resting on a ledge only inches wide and thousands of feet above ground. In between short breaths he tells the cameraman to pause because he is terrified and that he might have to stop. After freezing for a few moments, however, Honnold decides to keep going, later citing that he "toughed it out", even though he had a moment of intense fear and doubt.

The anecdote illustrates that even thrill-seekers performing the most dangerous activities may not be much different than the normal population in terms of negative emotional reactivity. Thrill-seekers do not seem to be abnormal like psychopaths who have no emotional response.

The underactive emotion response seems empirically false and also fails to satisfy the third desideratum. It does not preserve the fact that people are genuinely seeking *negative* states when they thrill-seek. It is true that an underactive negative response may still count as *some* negative response, but if the positive emotions are stronger at the outset of the experience then it is misleading to suggest that the experience counts as negative. In support of this claim, consider the following example. There are Pentecostal religious groups known as "snake handlers" that historically reside in the Appalachian Mountains. In the groups as part of a custom, they "tame" highly poisonous snakes and handle them during church services. Imagine a man who is brought up in this tradition and learns to handle dangerous snakes. When he is older he becomes one of the people who handles the snakes in the church service. In his older age, the man might still have hints of fear when he first goes to pick up the dangerous snake, as he knows a bite could kill him. However, he has grown accustomed to the snake and dominantly feels the joy of following God's word. It is clear that we would not consider the man's experience negative, because the negative emotion involved is negligible as it does not draw the man's attention.

If I am right about the snake handler, then it should be clear that by adding the underactive emotions hypothesis MEA does not preserve the idea that the experience sought is negative. The dilemma for MEA is that it can either use the underactive emotion hypothesis and fail to satisfy the third desideratum, or it has no available option for explaining how a positive emotion could be *stronger* than the negative emotions in the mixed experience.

4 A NOVEL EXPLANATION OF HUME'S PUZZLE

In this section I construct a new proposal for explaining Hume's Puzzle, which I call the *Emotion Regulation Account* (ERA). ERA draws on the insights of the Opponent Processing Account and the Mixed Emotion Account. Borrowing from OPA, ERA supposes that to answer the why-question, a positive emotion must be involved that can somehow end up stronger than the negative emotion involved. In doing so, ERA also borrows from MEA in that it supposes that multiple appraisals must always be involved in a case of seeking negative emotions such that there is a mixed emotion experience (involving both negative and positive emotions). ERA departs from previous proposals, however, in that it shifts the focus away from a sole examination of how the negative and positive emotions are *generated* to a shared focus of how emotions are generated and also *regulated*. Thus, rather than merely examining about how emotions are produced and compete during mixed experience, ERA focuses on how emotions are regulated in different ways during a mixed emotion experience.

In this section, I first outline the concept of 'emotion regulation' in section 4.1 and then examine how it may be applied toward an understanding of thrill-seeking in section 4.2. Finally, in section 4.3, I will argue that ERA should be the preferred account because it can satisfy all three of our desiderata. In section 4.4, I will consider and rebut some objections to the account.

4.1 Emotion Regulation Defined

The basic idea behind 'emotion regulation' is that there is a distinction between the point in which an emotion is initially produced (generation), and when the emotion can be modulated by cognitive processes (regulation). This general idea can be traced back to early philosophers such as Descartes who stated that "[t]he principle use of self-control is that it teaches us to be

masters of our passions" (Descartes 1989). Various situations make us angry, but we often have the ability to regulate or control the extent to which we get angry (or if we even get angry at all). I may get mad at my spouse for spilling water on my computer keyboard, but knowing it was an accident I can modulate my initial anger response.

To better understand what emotion regulation entails, it is helpful to define more clearly emotion *generation*. Emotion generation involves roughly three steps. A person (1) is in a real or imaginary situation, (2) attends to specific aspect of the situation and evaluates it (the "appraisal"), and (3) produces coordinated changes in physiology and experience due to the evaluation (the emotion). Thus we can understand emotion regulation as acting upon a situation-evaluation-response cycle (Gross & Thompson 2007).

Emotion regulation then is generally defined as "individuals' deliberate or automatic attempts to influence which emotions they have, when they have them, and how these emotions are experienced or expressed" (Mauss, Bunge & Gross 2007). Thus, emotion regulation involves changing different aspects of an emotion including the situation that elicited it, altering attention to the situation, modifying an appraisal of the situation, modifying subjective experience of an emotion, or even modifying behavior or physiology that occurs after an emotion has been elicited.

Emotion regulation often results in dampening an emotional response, or decreasing the intensity and duration of a negative emotion ('down-regulation'). However, it may also involve the increasing the intensity and duration of positive emotions ('up-regulation').[3] Various strategies for emotion regulation have been studied in the literature. "Cognitive reappraisal" refers to thinking about or interpreting details of a situation differently such that one feels better about it (down-regulation). If I feel highly stressed due to writing a long thesis, I could think to myself

[3] For a review see Gross (1998)

that the paper writing is making me smarter. One may also reinterpret a stimulus such that it produces even more of the evoked emotion (up-regulation). If I find a video clip amusing I might reinterpret the clip to make it even funnier to me personally (e.g. "that guy in the video looks just like my friend when he has had too many beers!").

There is neuroscientific evidence suggesting that reappraisal is efficacious for both down and up-regulation. By using reappraisal most people are able to reduce not only the subjective experience of emotion, but are also able to cause decreased activation in areas of the brain implicated in negative emotions (e.g. amygdala) (McRae et al. 2008). Furthermore, it was shown that if participants were instructed to up-regulate amusement through reappraisal after viewing amusing video clips, participants increased subjective experience of amusement and also increased associated physiology (heart rate, respiration and blood pressure) (Guiliani, McRae & Gross 2008).

Another regulation strategy is "distraction" in which one can distract attention away from the negative stimulus in order to down-regulate. A popular anger-reduction strategy that utilizes distraction is counting backwards to oneself when angry. There is evidence suggesting that distraction involves the recruitment cognitive processes to regulate an emotion before it has been fully generated. For example, using event-related potential (ERP)[4], one study found that if participants distracted from or reappraised a negative emotional image, they showed reduced negative affect compared to controls that simply viewed the image (Thiruchselvam et al. 2011). However, those that distracted showed a reduced late positive potential (LPP) (brain activity related to emotional appraisal) response to the stimulus *before* the neural time marker in which meaning is typically extracted from a visual stimulus. From these data it appears that an emo-

[4] An ERP is an electrophysiogical response by the brain to stimuli. It is measured by placing electrodes on the scalp, and various electrophysiological signals have been implicated in different behavioral phenomena such as language, memory, attention, etc.

tional response is down-regulated before an appraisal that produces an emotion occurs. This is due to distracting attention away from the stimulus. For reappraisal, however, the reduced LPP occurred *after* the neural marker time point. The results provide evidence that cognitive goals can literally block emotional processing of a stimulus, and also reduce the emotion after it comes "online".

Another broad regulation strategy involves "situation selection" in which one purposely chooses a situation because she knows it will either up or down-regulate an emotion. If a certain song brings me joy, the fact that I play that song on repeat for a few hours is an example of up-regulating that joy by specifically selecting the situation. In contrast, I may purposely avoid a certain route walking home because I do not want to experience the fear of being chased by the neighbor's angry dog.

Finally, there is also a sense in which emotions have been shown to be regulated automatically, without deliberate effort. For example some individuals automatically, without awareness, bias their visual attention toward positive stimuli in scenes compared to negative stimuli (Isaacowitz et al. 2006). This is similar to distraction in that is involves attentional deployment, but it involves up-regulation rather than down-regulation. Moreover, it has been shown that participants who are primed with emotion regulation words are more successful at down-regulating their emotions even though they were unaware of the purpose of the prime. The study suggests that unconscious biases or goals towards regulating emotions may have important effects on the efficacy of regulation (e.g. Mauss, Bunge & Gross 2007). There is also recent data (Brady et al. In Prep) suggesting that distraction driven automatically through the narrowing of visual attention can down-regulate negative emotional experience with as much efficacy as deliberate reappraisal.

4.2 Accounting for Thrill-Seekers

I will now argue that the Emotion Regulation Account (ERA) offers a satisfactory solution to Hume's Puzzle, answering the why-question and the how-question while preserving the distinction between positive and negative emotions. I will focus on the case of thrill-seeking, which turned out to be fatal to the prospects of success for the Safe Practice Account (SPA), the Opponent Process Account (OPA) and the Mixed Emotions Account (MEA). ERA's core proposal is that thrill-seekers have an increased ability to *down-regulate* the hyper-arousing fear response they experience during skydiving once it is elicited, but also are more likely *up-regulate* the positive experience of skydiving.

4.2.1 ERA and the Why Question

Let us consider first how this proposal answers the why-question: Why do thrill-seekers seek negative emotions? In a typical thrill-seeking event, there are multiple appraisals, both negative and positive. As articulated above, in skydiving there may be appraisals that lead to fear and anxiety, but also of pride and excitement for completing a challenging activity. The first component of ERA's proposal is that the typical skydiving enthusiast has an ability to down-regulate the fear and anxiety response, such that even though the full negative emotion is initially generated, it is subsequently dampened.

The dampening could come from multiple sorts of regulation processes. First, it may be the case that skydivers can deliberately *reappraise* the situation to make themselves feel less afraid (e.g. they think to themselves, "there is no reason to be afraid, the chances of an accident are slim and I have back-up parachutes just in case"). The reappraisal might start out as delibe-

rate, but could become more automatic over time such that the situation is automatically viewed in terms of the safety reappraisal originally made.

Thrill-seekers may also be able to *distract* themselves away from (ignore) certain aspects of the situation that could cause a fear response. For example, they may be better able to ignore the increased physiological response that most people may perceive in their bodies during a fear or anxiety response. They may also be better able to focus attention on the positive aspects of the skydiving and ignore the fear-inducing aspects. For example, someone with poor regulation may fixate on the height of the airplane in the sky when she is about to jump. A good regulator may see the height but focus attention on other aspects such as the fact that she has multiple safety devices.

There is also a sense in which one can regulate merely due to *exposure*. Zajonc (1968) showed that by merely seeing a stimulus once, people are more likely to judge it favorably the second time they see it as compared to novel stimuli. Especially for repeat skydivers, the experience of skydiving may become less fearful overtime merely due to exposure which can be construed as an automatic regulation strategy. This effect has also been called *desensitization*, in which skydivers become less afraid as the knowledge of what to expect from the experience increases. In this sense mere exposure is a sort of automatic reappraisal process because the space for possible interpretations of the experience is constrained by previous expectations that the experience will not be so bad.

The proposal of ERA is that by virtue of these down-regulation strategies the negative emotions involved in skydiving are dampened, and the positive emotions can become stronger. The positive emotions can become stronger not only because the negative emotions are down-regulated, but also because thrill-seekers can *up-regulate* the positive emotions. Stronger here

could mean that attention is pulled to the positive emotion because the reward response occurs without as much distraction (decreased divided attention) from the negative emotion since it is tempered. It could also mean that the associated physiology of the positive response is more salient to inner attention due to the up-regulation. Finally, it could mean that the positive appraisals produce a larger reinforcement effect such that the brain learns to return to the activity.

If the negative emotions are dampened, and the positive emotions are increased such that the positive emotions become stronger, then the net result of the experience will be positive. If the net result of skydiving is a positive experience, then the skydiver will return to that activity. Thus far, it appears that the ERA satisfies the first desideratum by providing a broad conceptual answer to the question of why people seek negative emotions. In order to support the conceptual possibility, I now turn to empirical details about how emotion regulation can work toward creating net positive experience.

4.2.2 ERA and the How Question

A successful solution to Hume's Puzzle cannot be limited to an answer to the why-question. The Safe Practice Account (SPA) provided a potential conceptual possibility that people seek negative emotions because they provide safe practice for difficult life events. However, the details of SPA were not consistent with what occurs during thrill-seeking and so SPA cannot be utilized.

I will now argue that ERA also offers a promising account of the mechanisms by virtue of which negative emotions are tempered while positive emotions dominate in order to produce a net positive experience. Such an account amounts to a successful answer to the how-question.

There are a number of studies examining the different characteristics of people who show high tendencies of thrill-seeking traits. Perhaps the best known scale for determining such ten-

dencies is the "Sensation Seeking Scale" (SSS) developed by Marvin Zuckerman which is currently used in its fifth revised edition (Zuckerman 2007). The scale surveys a number of characteristics including desire for thrills and novel experiences, susceptibility to boredom and behavioral disinhibition tendencies. By using the scale, studies can investigate the difference between high scoring individuals (high-SS) who are most likely to be thrill-seekers, and low-SS individuals who are unlikely to partake in any sort of thrill-seeking.

Turning to the data, ERA makes at a few explicit predictions. We can begin with predictions related to down-regulation of negative emotions. One key prediction is that thrill-seekers, or high-SS individuals, should perform better in general compared to non-thrill-seekers in any tasks that require participants to regulate fear or anxiety responses. If thrill-seekers are better regulators, we should see a behavioral response of less negative emotions compared non-thrill-seekers as a result of the down-regulation that occurs. Another key prediction is that emotion regulation abilities should show at least some association with risk-taking behaviors that may be associated with the likelihood to thrill-seek. There is empirical evidence that fits well with these predictions.

Lissek et al. (2005) investigated fear and anxiety responses in participants who were high in sensation-seeking personality traits (high-SS) compared to those low on the traits (low-SS). The study examined fear and anxiety responses in terms of a fear-potentiated startle (FPS) from both anticipated aversive stimuli (participants knew when the stimulus was coming) and surprise aversive stimuli (did not know stimulus was coming). The FPS was measured by skin conductance response (SCR) and eye-blink reflexes, and participants were exposed to air puffs and white noise bursts as the fearful stimuli. The study found that in both the predictable and unpredictable stimulus condition, high-SS participants had lower FPS responses than low-SS partici-

pants. This result is in line with the emotion regulation account, since it predicts thrill-seekers can better down-regulate their emotions and thus have reduced fear response after initial onset. However, the mere fact that high-SS participants had lower fear responses leaves the question open as to *why* the response was lower. It could be the case that high-SS participants merely have underactive fear responses and no regulation is occurring.

Upon closer inspection of the results, however, it appears that the data align very well with ERA. Even though high-SS participants generally showed lower eye-blink startle responses than low-SS participants, there was a clear difference in the startle response between the unpredictable and predictable fear conditions when comparing the high-SS and low-SS participants. When the fear aversive stimulus was unpredictable, high-SS and low-SS showed only a very slightly significant difference in startle response. But when the aversive stimulus was predictable, high-SS and low-SS showed a much larger significant difference in startle response.[5]

There is a simple way to explain this discrepancy in results that accords nicely with ERA. When an aversive stimulus is predictable (the participant can anticipate when it is coming) participants have time to actively recruit cognitive processes that can make the aversive stimuli less fear-inducing. In other words, participants can be prepared to down-regulate a fear response they know will be coming. Another way to put the idea is this: If high-SS and low-SS participants both have the same ability to regulate emotions, we should see no change (or a higher change in the unpredictable condition) in the difference between high-SS and low-SS in both the predictable and unpredictable conditions. However, we do the see a change in which the difference increases during the predictable condition, which aligns with the prediction of the emotion regulation account articulated above.

[5] In other words, the effect size (a measure of the strength of the relationship between the two variables) was much lower when comparing group differences in the unpredictable condition than in the predictable condition.

There is another line of recent behavioral data that also conforms to the prediction of ERA. Bender et al. (2012) found that the extent to which one was a thrill-seeker (high-SS) increased the likelihood that one had high "distress tolerance" and the capacity for suicidal behaviors. As the study explains, distress tolerance is a clinician's term for a patient's ability to accept their situation, or handle negative and aversive events in a calm fashion without being overwhelmed by negative emotions. In this sense, distress tolerance is a type of emotional down-regulation, in which people tend to reappraise the negative situations they are in such that they temper the evoked emotions. The high-SS individuals tended to have the most distress tolerance, and this relationship predicted the extent to which those individuals had high physical pain tolerance and the capacity for suicidal behaviors.

The Bender study fits well with ERA for two main reasons. First, it establishes a clear relationship between thrill-seekers and increased negative emotion regulation tendencies that is a key prediction of ERA. Second, it presents a link between the thrill-seekers' emotion regulation abilities and actual behaviors related to aversive situations that many people would avoid. In other words, the study provides evidence that those with the ability to down-regulate negative emotions may subsequently engage in more aversive behaviors.

Thus far, I have argued that one main prediction of ERA has empirical support; namely, that thrill-seekers are better regulators of negative emotions. This prediction, however, only tells a part of the story in ERA's explanation of why thrill-seekers return to the negative experiences. Thrill-seekers are able to down-regulate the negative emotional response such that it is not as intense as normal people. But we are still left with the question of why the reduced negative experienced has the potential to produce a sum experience that is positive overall. As it turns out,

there is also evidence supporting the ERA's proposal that thrill-seekers tend to up-regulate positive emotions.

One traditional characterization of thrill-seekers is that they have an abnormally high attraction to new experiences and novel stimuli (e.g. Zuckerman 2007). One conceptual possibility stands out from this observation, particularly when thinking through the lens of emotion regulation. Consider the possibility of differential regulation tendencies between emotional responses from different stimuli. The data I have presented only investigated regulation in *negative* situations or with negative emotional responses such as fear. It could be the case that thrill-seekers have selective tendencies in regulation such that even though they are good at down-regulating negative emotions, they tend to *up-regulate* positive emotions. When it comes to positive, rewarding or novel stimuli they tend to up-regulate the evoked emotions due to their natural attraction toward such stimuli.

Down-regulation reduces the onset, duration and intensity of emotions, but up-regulation may lead to uninhibited emotional reactivity. If thrill-seekers have a selective tendency to up-regulate emotional responses that are caused by positive or novel stimuli, then they would be highly attracted to any situation that evoked the uninhibited positive emotion. As is turns out, a study comparing high-SS individuals to low-SS individuals found one relevant and intriguing finding. Zald et al. (2008) found that high-SS individuals had lower levels of a midbrain dopamine receptor that regulates the release of dopamine in response to novel and arousing stimuli. In other words, high-SS individuals may have higher amounts of dopamine release in response to novel stimuli. Dopamine is a neutrotransmitter (chemical released by neurons to signal other neurons) that is causally implicated in reward pathway activation and also reinforcement learning. Many drugs create abnormally large dopamine releases in the brain which is a key factor in

addiction and associated problems with inhibition of behaviors (Koob&Volkow 2010). If thrill-seekers have higher dopamine release in response to novel and arousing stimuli then we should expect a high reward response. A stimulus with a high reward response is a prime candidate for deliberate or automatic up-regulation. Just as we enjoy immersing ourselves in our favorite music, or focus attention to our favorite parts of the song, the thrill-seeker may immerse herself in situations involving novel stimuli or focus attention to the novel / positive aspects of a thrill-seeking activity.

Utilizing these data suggests an interesting characterization of thrill-seekers. They may be efficient down-regulators when it comes to emotions evoked from negative stimuli, but when it comes to positive or novel stimuli they are likely to engage in up-regulation due to an abnormal reward response. If someone is prone to up-regulation in regards to a large positive experience produced by certain stimuli, she may become extremely drawn to whatever that stimulus is that produced the uninhibited positive experience. For example, if one up-regulates the pleasurable arousal produced by watching pornography, the pornography will become highly rewarding and the person may seek pornography more than someone who does not tend to up-regulate the positive emotional response as much.

A relevant parallel comes from cases of addiction. One major component of addiction is that the addict returns to drug-seeking activities even though a conscious intention to stop may exist (Graham 2010). The abnormal reward response created by the drug's activation of the reward pathway creates intense positive experiences that lead to automatic up-regulation. Indeed the paradox of many addicts is that they claim they want to stop abusing drugs, but their behavior that involves seeking out drug situations suggests otherwise.

In combining the two sets of data I have presented, we get the key claim of ERA in regards to thrill-seekers. ERA argues that thrill-seekers have both down-regulation and up-regulation tendencies. When it comes to negative emotions, they are better regulators than the normal population. When they perform an event that produces hyper-arousing negative emotions, they can down-regulate those emotions with relative ease such that positive emotion produced from other appraisals is stronger. Not only is the negative emotion down-regulated, but the positive emotions may be up-regulated due to an abnormal reward response. Dampening the negative emotion but also increasing or allowing the strong positive emotion to intensify leads to an even stronger positive emotion than in normal individuals. From our earlier discussion, stronger here could mean that attention is pulled to the positive emotion because the reward response occurs without as much distraction from the negative emotion since it is tempered. If attention is pulled to the positive experience, then the positive experience can consume attention and it will intensify over other occurrent emotions. Under the attentional interpretation of "stronger emotion", the up-regulation involved pertains to the focus of attention as a result of the combination of dampened negative emotions and a large reward response from other existing appraisals.

Another way in which the attentional sense of 'stronger' could be employed is to suggest that the associated physiology of the positive response is more salient. If the physiology associated with the negative emotions is down-regulated, then thrill-seekers can feel more of the physiology associated with the positive emotions. As Guiliani, McRae & Gross (2008) demonstrated, focusing on the aspects of stimuli that produce positive emotions can actually increase physiology associated with the positive emotion.

Finally, ‘stronger’ could also mean that the positive appraisals produced a larger reinforcement effect such that the brain learns to return to the activity. The reinforcement interpretation is complex but empirically defensible. Drawing on multiple studies discussed above, there are a few important empirical findings that speak to the plausibility of the reinforcement interpretation. First, as studies from Ledoux and Phelps show (Phelps &Ledoux 2007), amygdala activation is fundamentally important for negative reinforcement that occurs through negative emotions. In other words, the amygdala plays a large role in the brain assigning negative value to stimuli that cause fear, which is stored in memory for future behaviors. It was also shown that when one down-regulates negative emotions such as fear, they can actually modulate amygdala activation such that it shows a decrease in activity from the deliberate attempt of emotion regulation. This is most likely possible due to neural pathways that connect the cognitive control areas (e.g. orbitofrontal cortex) that underlie emotion regulation to the amygdala. If attempts at emotion regulation can decrease the activation in the amygdala, then it is possible that emotion regulation can limit the reinforcement properties of negative emotions that have been shown to occur through the activity of the amygdala. If the reinforcement properties of the negative emotions in thrill-seeking are limited, and the reward response (which is shown in addiction studies to have extreme reinforcement properties) is uninhibited or even increased, then it would be no surprise that for a thrill-seeker the positive emotions have stronger reinforcement properties.

This explanation of ERA is supported by existing data, and it also yields a clear empirical prediction: in cases involving positive emotions or reactions to positive and novel stimuli, high-SS individuals should have higher emotional reactivity than others. As it turns out, this prediction appears to be supported by recent neuroscientific data. Joseph at al. (2009) presented high and low SS participants with high arousing and novel stimuli (e.g. erotica). The study found that

in high-SS individuals, after viewing highly arousing stimuli, had higher and earlier brain activation in the right insula and the posterior medial orbitofrontal cortex compared to low-SS participants. These brain regions are associated with the conversion of bodily arousal into subjective emotional experience and also reinforcement learning. Moreover, the *low*-SS participants showed higher and earlier activation in the anterior cingulate and anterior medial orbitofrontal cortex. Importantly, these brain areas are associated with the *down*-regulation of emotions.

From the results it appears that high-SS individuals have higher emotional reactivity to arousing, novel or rewarding stimuli and lower amounts of down-regulation in the early stages of emotional processing. If this is the case, then the prediction of ERA is supported.

In this section I have used empirical data to construct an account of thrill-seeking that explains why they seek the hyper-arousing negative emotions. They seek the negative situations due to the selective tendencies in down and up-regulation of emotion that leads to a stronger positive emotional experience in terms of attention, reinforcement properties, or both. By providing substantive details backed by empirical evidence, ERA also satisfies the second desideratum or the how-question.

4.2.3 ERA and the Valence Dichotomy

ERA also satisfies the third desideratum since it preserves the idea that the events sought after are ones that elicit genuine negative emotions. ERA suggests not that thrill-seekers show a lack of negative emotional response, but rather that they show normal reactivity but are able to regulate their negative emotions. It is true that over time, the most veteran thrill-seekers may be able to automatically regulate emotions such that the negative emotions generated are not as strong to begin with (decreased emotional reactivity). However, even if the regulation of veteran thrill-seekers can simply decrease their negative emotional reactivity, and the experience is more

positive from the outset, the idea that the negative emotions would be intact *if* they were not to be regulated is still preserved. In this sense, ERA is consistent with the traditional valence dichotomy. If thrill-seekers could not regulate their negative emotions, the overall experience would not be positive and they would not be returning to those activities.

ERA solves the puzzle of thrill-seeking while staying consistent with assumptions of the valence dichotomy. In doing so, ERA also provides a reply to one potential counter-example to the valence dichotomy. The counter-example involved the fact that the case of thrill-seeking appeared to be problematic through the lens of the valence dichotomy, because the dichotomy assumes that negative emotions should never attract organisms. ERA provides a reply to this problem because it shows how people can be attracted to thrill-seeking even though the negative emotions are primarily involved. ERA explains that a genuinely negative emotion can be involved in attracting people when cognitive control mechanisms influence that negative emotion. ERA in fact upholds the valence dichotomy because it assumes that no case of seeking negative emotions involves a purely negative experience without either cognitive modulation or an experience mixed with a positive emotion. Negative emotions are always aversive when experienced in isolation without modulation.

4.3 Explaining Hume's Puzzle

If the Emotion Regulation Account can handle the thrill-seeker case, can it be applied to more mundane cases such as those discussed by each reviewed account? It is important to note that ERA is a proposal that can admit of degrees, such that different amounts of down and up-regulation can occur between individuals or even between different stimuli. Some people who are the best regulators and have the highest reward response are most likely to be thrill-seekers.

But other members of the population may fit this profile only slightly more than the typical population. So when explaining more mundane cases we must look at each case to determine how salient the difference in regulation abilities will be. Consider the examples of eating spicy foods discussed by the Safe Practice Account. I most likely enjoy eating more spicy foods than the average person. I enjoy putting jalapeños and occasionally habeneros in my food, a practice I have discovered most people cannot handle. I may a have slightly better ability to regulate my negative emotional response to the pain than others that allows the reward response from the capsasin (the chemical in spicy food that causes the "burning" sensation) in hot peppers to affect me more. However, consider my Uncle Jim for an even clearer case of increased regulation abilities at work. Jim competes in hot peppers eating contests, and eats peppers that require a signature to buy due to the fact that they are so spicy they are potentially lethal. He eats peppers so hot that handlers must wear gloves so that peppers do not damage the skin on their hands. There is clearly a difference between Jim and the normal individual, and even me. In these most extreme cases, the plausibility of ERA becomes the most clear. Jim must have a much better ability to cope with and down-regulate the negative responses due to the immense pain, and he must have an abnormal reward response or else he would not be returning to the peppers that could potentially rip his stomach apart. For example, he may be able to actively suppress the pain of the spice reaction with high efficacy.

A similar story can be told for the viewing of horror films. The film viewer who enjoys the worst of the horror films may have the best ability to regulate a disgust response, and the biggest response from the novel stimuli they are watching. I remember watching a cult Italian film entitled “Cannibal Holocaust” (1980), which many hold to be one of the most disturbing films ever made. There were scenes in which I had to turn away from the screen. There are live

rape scenes and a scene where a large tortoise is shelled, gutted, and eaten live. Most people are unable to watch, let alone enjoy this type of movie. But some people can, and ERA provides a compelling reason as to why. Some people are better able to regulate the disgust response from viewing such films, and also have increased emotion reactivity to the novelty of what they see from a high reward response that leads to up-regulation of the positive emotion. A common example of down-regulating the negative emotions in horror films may be distracting oneself by shifting attention away from the film momentarily, or also reappraising the situation to remind oneself that the scenes are fictitious.

Moving to Hume's original observation about viewing theatre that makes us sad: ERA supposes that the enjoyment of sad theatre comes from the ability to regulate the amount of sadness experienced, coupled with the up-regulation of positive appraisals such as marveling at the beauty of a perfect production. For example, when we feel start to feel very sad from the most depressing tragedies, we are able to reappraise our situation such that we know it is not actually real, or we may focus on the positive aspects of the situation for the characters involved in the tragedy. For those unable to regulate the sadness at all, ERA supposes that such people are the least likely to enjoy and return to the tragedies.

The upshot is that it should be no surprise that we find different amounts of people pursuing different levels of negative intensity in their activities. The range may be from play fighting all the way up through climbing a mountain with no safety gear. If what I have said is right, the Emotion Regulation account can successfully explain the wide range of cases involved in Hume's Puzzle. Not only does it fulfill each desideratum, but it also leads to explicit empirical predictions that can be tested in future research. If the Emotion Regulation Account is successful, then Hume's Puzzle upon closer inspect does not threaten the valence dichotomy. People do

not return to negative emotions themselves, which would be extremely puzzling given the traditional characterization of positive and negative emotions that falls out the valence dichotomy. Rather, what drives their return is the positive experience that results from an initial regulation of the negative emotion combined with an uninhibited reward response.

4.4 Objections

The proponent of the Mixed Emotion Account (MEA) may argue that ERA is actually just a species of the MEA genus. ERA involves a mixed emotion experience, and thus is a form of MEA at its core. My reply is two-fold. First, while mixed emotions are a necessary component of ERA's explanation, ERA departs significantly from MEA in that it focuses on emotion regulation rather than emotion generation. Second, it might be right that ERA could be considered as a species of the MEA genus, but this does not hurt the point that ERA is the best explanation of Hume's Puzzle. I have shown in this paper that another species of MEA, one which focuses on the generation of emotions, has no available option for showing how positive appraisals in the mixed emotion experience can be stronger in terms of attentional focus or reinforcement properties. ERA might be best construed as an update to Hume's original suggestion based on mixed emotions, and this would be no mark against ERA.

Another objection is that there might be some cases of thrill-seekers that actually do have hypoactive emotions, and ERA would not be able to explain those cases. Consider the example of psychopaths who have been shown to have underactive emotions in general, and also tend to engage in risky behaviors. My reply about such cases is that if they really exist, they are neither relevant to the present discussion, nor the explanatory scope of ERA. ERA is meant to explain cases in which people seek negative emotions, and such cases are of interest because they present

a problem for the valence dichotomy. Individuals who do not feel negative emotions and approach situations that elicit negative responses in normal subjects cannot be characterized as seeking negative emotions. For example, part of our definition of a thrill-seeker was that some objective danger *and* subjective fear must be involved. If a man suffers bilateral amygdala damage, and subsequently does not feel any fear when he jumps out of airplanes it is unclear that he is actually thrill-seeking. So if the objection grants that some people really do not feel negative emotions during thrill-seeking activities then we should conclude that those cases are qualitatively different than normal thrill-seekers and are not within the scope of Hume's Puzzle.

The last objection leads to another based on a criticism by Solomon (2007). Might it the case that typically negative emotions are actually positive for some people? Solomon argues that, "It is an essential datum in the study of emotions …within an emotion there can be a number of different 'valences'..." (Solomon 2007, p. 170). As an example of an emotion with mixed valence, Solomon gives the example of 'righteous anger'. While anger is often negative or painful, when it involves righteousness it may be positive or pleasurable (*ibid*, p. 170). If I judge that an innocent man has been sentenced to the death penalty, my anger may be pleasurable insofar as I know that the man's sentence is the morally right action to take. If emotions involve mixed valence, then when asking which emotions fit in which valence category of positive / negative, "there is no simple set of answers, and the question ultimately doesn't make sense" (*ibid*, p. 170). Solomon's point is that the valence dichotomy is supposed to capture a clear distinction between emotions and also to taxonomize them. However, if there are many cases of emotions in which the dichotomy cannot serve such a purpose then it may not be useful for the categorization of emotions. For example, we might think that there as many cases in which fear appears to be pos-

itive as there are cases of fear seeming negative, and thus it might not be helpful to try and categorize fear as either positive or negative.

I reply that Solomon conflates the valence of a mixed emotion experience with the valence of individual emotions. I again submit that no negative emotion in isolation, and without cognitive modulation, can be positive. If there are cases in which fear appears to be acting like a positive emotion due to the fact that it attracts people, there is most likely a mixed emotion experience. No typically developing individual is attracted to full-blown fear without any other emotions present and without any regulation occurring. Solomon's example of righteous anger is an example of a mixed emotion experience. People might be angry at a murderer on Death Row for the crimes he committed, but insofar as the righteous anger brings a positive experience, they are also feeling relief from a separate appraisal of justice being served (e.g. the thought of fairness for the victims). Anger in isolation, however, should not be positive. This is an empirical claim in the end, because we can investigate in the lab, or observe in natural settings whether or not there *are* clear instance of negative emotions in isolation that are perceived as positive or attract people. However, on the face of it such cases are counter-intuitive and certainly fly in the face of overwhelming evidence that typically negative emotions are aversive. Because Solomon does not offer empirical evidence for his claim about mixed valence, the jury is still out. ERA, however, has multiple sources of evidence that confirm some of its key predictions.

5 CONCLUSION

In this paper I have utilized contemporary affective science to construct an account that I argued can solve Hume's puzzle. I showed that multiple accounts from influential scientists and

philosophers fell short, but the Emotion Regulation Account shows the most promise in the solution it offers. Not only does ERA solve Hume's puzzle, but it protects the valence dichotomy. If ERA protects the valence dichotomy from the potential counter-example of thrill-seeking, then it also protects numerous influential contemporary emotion theories that invoke valence. Examples of current theories of emotion invoking valence are James Russell's circumplex model (Russell 2003), Lisa Barrett-Feldman's conceptual act model (Lindquist & Barrett-Feldman 2008), Jaak Panksepp's evolutionary model (Panksepp 2011), and Jesse Prinz' embodied perception model of emotions (Prinz 2004).

Finally, ERA leaves open empirical possibilities to explore and to further understand individual phenomena within the larger umbrella of Hume's puzzle. The main contribution of ERA is that is suggests a novel perspective – that of emotion regulation – for investigating behaviors involving the seeking of negative emotions including thrill-seeking. In the end, ERA is falsifiable, and even if future studies provide evidence against it, it will have in the least advanced progress on an age-old puzzle about emotions.[6]

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