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Counterfactual Thinking and Facial Expressions Among Olympic Medalists: A Conceptual Replication of Medvec, Madey, and Gilovich's (1995) Findings

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Counterfactual thinking, or contemplation of "what could have been," influences facial expressions of Olympic medalists. Medvec, Madey, and Gilovich (1995) revealed that bronze medalists appeared happier than silver medalists after competition in Olympic events. Two prominent explanations for this phenomenon exist: the formation of (a) category-based counterfactuals and (b) expectation-based counterfactuals. First, Medvec et al. (1995) demonstrated that silver medalists formed an upward comparison to the gold medalist with thoughts of "I almost won Gold" while bronze medalists formed a downward comparison to a fourth place finisher with thoughts of "at least I won a medal." A second explanation suggests that medalists form expectation-based counterfactuals in which silver medalists are more disappointed since their prior expectations for performance were higher than bronze medalists (McGraw, Mellers, & Tetlock, 2005). To test these 2 explanations, we compiled a large dataset of medal stand photographs from the Olympic Multimedia Library and Getty Images for the 2000–2016 Olympic games as well as *Sports Illustrated's* predictions. Using automated facial expression encoding, we conducted a conceptual replication of prior work and found evidence supporting both category-based and expectation-based counterfactual accounts of Olympic medalists' expressions.

Keywords: counterfactual thinking, facial expression, emotion

It is a natural human tendency to process information in relative, rather than absolute, terms. Indeed, comparison processes are abundant in social psychology and underlie many phenomena. Social comparison implicates another individual as a benchmark for self-evaluation (Festinger, 1954), theories of expectation disconfirmation compare prior expectations with perceived performance (Oliver, 1977), and counterfactual thinking involves comparisons among alternative realities (Roese, 1997). Fundamentally, to whom or to what we choose as a standard of comparison influences emotions and satisfaction.

Comparisons are particularly salient at the conclusion of an Olympic event. Performance is assessed and an objective order is bestowed upon finalists with virtually no ambiguity in these relative standings. While the objective achievements are clear, a medalist's subjective perception of their own achievement may differ. Medalists may reveal this subjective perception through their facial expressions. One might expect a silver medalists to be happier than a bronze medalists due to the objectively superior finish. In contrast, Medvec et al. (1995) revealed an intriguing phenomenon that those who were objectively better off nonetheless felt worse; silver medalists tended to be less happy than bronze medalists.

The intuition is that counterfactual thinking causes an individual to contemplate other realities. This thinking causes people to imagine, "what if" or "if only . . ." and compare the results with an alternative version of what could have occurred. Yet, two plausible counterfactual explanations have been documented in prior work. Medvec et al. (1995) argued that *ex post* counterfactuals of "what could have been" influenced the category to which one was making a comparison. Subsequent research documented that counterfactual comparisons based on prior expectations, or *ex ante* counterfactuals of "what was expected to be," influenced happiness (McGraw et al., 2005). The purpose of our work was to conduct a conceptual replication of counterfactual thinking among Olympic athletes and to test the two dominant counterfactual explanations. To do so, we collected a large dataset of photographs of Olympic medalists from the 2000–2016 Olympic games. We employed a new methodological approach to automatically quantify facial expressions eliminating the need for human coding, which reduced the chance that differences found between medalists were the result of biases in human coding.

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Counterfactual Thinking

Counterfactual thinking is a subset of a larger category of simulation (Kahneman & Tversky, 1981), referring broadly to imaginative mental construction. Counterfactuals, literally meaning contrary to the facts, is the contemplation of alternatives to factual events (Kahneman & Miller, 1986; Kahneman & Tversky, 1981; Roese, 1997). When engaging in counterfactual thought, individuals tend to imagine varying realities surrounding what didn't occur. Simply put, this is a comparison between what occurred and what didn't, but could have, occurred.

Ex Post Counterfactuals

Ex post counterfactual thinking is the contemplation of alternative versions of the past by considering "what might have been." Medvec et al. (1995) argued that these comparisons are fundamentally rooted in category-relevant discontinuities. A gold medal is qualitatively different from a silver medal, and finishing in fourth place is categorically different from earning a medal at all.

Emotions experienced from counterfactual thinking are influenced by the direction of comparison (Markman, Gavanski, Sherman, & McMullen, 1993). In the context of Olympic medalists, bronze medalists form downward comparisons to nonmedalists and feel fortunate to be on the podium. Silver medalists, in contrast, form upward comparisons and lament falling just short of receiving gold. Therefore, the direction of the counterfactual comparison differs such that the medalist who is objectively worse off (i.e., bronze) may express a smile more readily than the medalist who is objectively better off (i.e., silver).

Ex Ante Counterfactuals

An *ex ante* counterfactual is based on expectations prior to an event. McGraw et al. (2005) proposed that an athlete's feelings after completing an Olympic event is a function of prior predictions of performance ahead of the event. These authors argued that recent performances leading up to the Olympic games, predictions of coaches, media forecasts, and standings in qualifying rounds can dominate medalists' thoughts when contemplating actual performance. Rather than thinking about what could have been, this explanation is grounded in the expectations that were formed prior to performance. Athletes with lower expectations than their actual performance were happier than those with higher expectations. Thus, silver medalists would be less likely to express smiles than bronze medalists because they have higher expectations. The influence of these expectations also affirm the result demonstrated by Medvec et al. (1995), that objectively inferior outcomes can feel better than objectively superior outcomes merely due to prior expectations.

These two explanations, while not entirely at odds, postulate different explanations for the medalist phenomenon. The first provides an account based on category comparisons—to whom do I compare my performance? The latter provides an account based on expectation comparisons—what did I expect my performance to be?

Facial Expressions as Communicators of Emotions

Decades of research have investigated cues that signal the emotional states of others. Researchers have claimed that humans communicate intentions and emotions through facial expressions that are relatively universal and independent of culture (Ekman & Friesen, 1971). They suggest that facial expressions can be indicative of feelings, attitudes, and behavior (Matsumoto & Willingham, 2006; Rosenberg & Ekman, 1994). This is referred to as basic emotion theory (or the common view), which holds that emotions consistently cause specific patterns of facial muscle movements, and specific configurations of facial muscle movements are diagnostic of certain emotions (Ekman, 1992, 1994; Izard, 2007). Scientific studies that have tested this view have focused on the six most popular emotion categories including happiness, sadness, anger, disgust, fear, and surprise. This view contends that minor, but specific, changes in muscle movement alter whether a facial expression conveys fear versus surprise, for example. For every emotion category a prototypical facial configuration serves to indicate an individual's emotional state.

But the view that emotional states are reliably inferred from facial expressions has been called into question (e.g., Barrett, Adolphs, Marsella, Martinez, & Pollak, 2019; Fridlund, 1994; Russell, 1994, 2017). An alternative theory, the behavioral ecology view (Crivelli & Fridlund, 2019; Fridlund, 1994), theorizes that people use facial expressions to communicate social information to observers. Facial expressions are attuned to the context of social interactions and serve to shape the trajectories of those interactions (Fridlund, 2017). Modern theories of emotion refute diagnostic facial characteristics as representing each emotion and propose that emotions are defined solely by their subjective experience (Barrett, 2017). This view challenges the notion that facial expressions map directly to felt emotion in a universal way.

In the context of counterfactual thinking in medalists, smiles are one particularly relevant facial expression that have been studied (McGraw et al., 2005; Medvec et al., 1995). Consistent with the behavioral ecology view of emotion, Fernández-Dols and Ruiz-Belda (1995) have shown that medalists most frequently smile when they are socially observed and not during other noninteractive times. Thus, smiles can act as social cues rather than indicators of emotion (Fernández-Dols & Crivelli, 2013; Martin, Rychlowska, Wood, & Niedenthal, 2017; Reisenzein, Studtmann, & Horstmann, 2013). While some prior literature (e.g., Medvec et al., 1995) treats the existence of a smile as an indication of medalists' happiness, aligning with the common view, the data presented here cannot provide strong evidence supporting or refuting felt emotion of medalists. However, for the purposes of this research, we document facial behavior (e.g., smiles) and remain agnostic with respect to felt emotion. Facial expressions continue to be of interest for their communicative power to viewers, independent of actual emotion experienced. For a detailed analysis of facial expressions and theories of emotion, see Barrett, Adolphs, Marsella, Martinez, and Pollak (2019).

Replication Study

This study was a conceptual replication of the first studies in Medvec et al. (1995) and McGraw et al. (2005) with a few key differences. Medvec et al. (1995) used silent video footage from National Broadcasting Company (NBC) of the 1992 Olympic games to analyze facial expressions of 15 bronze and 20 silver medalists. Video files were shown to human coders to rate the expressed emotions of each athlete on a 10-point "agony to ecstasy" scale. Medvec et al. (1995) found support for ex post counterfactual thinking. Both Medvec et al. (1995) and McGraw et al. (2005) consulted *Sports Illustrated* for the expectations of medalists' performance. McGraw et al. (2005) built on Medvec et al. (1995) by using video footage from the 2000 Summer Olympics and (a) included gold medalists and nonmedalists, (b) excluded athletes subject to the "just won"–"just lost" effect,[1] and (c) found support for the expectation-based counterfactual argument.

This current inquiry contributes to our understanding of the medalist phenomenon in five important ways. First, this study investigated the two predominant counterfactual explanations for facial expressions among Olympic medalists. That is, we simultaneously investigated if medalists' facial expressions were influenced by ex post counterfactual thinking or "what could have been" and/or ex ante counterfactual thinking of "what was expected to be." Like the prior work, we also consulted *Sports Illustrated* for Olympic predictions. Second, prior work on this phenomenon was limited due to data available at the time. Both Medvec et al. (1995) and McGraw et al. (2005) had uneven samples across medals depending on coverage, and their relatively small sample sizes per cell made it untenable to test both counterfactual explanations. Third, prior work was affected by selection issues. Using NBC video files, the data was limited due to the coverage decisions of the network, often focusing exclusively on U.S. events. Here, we investigated this phenomenon at scale with photos across country citizenship, year of the games, and events. Fourth, we conducted a conceptual replication using triangulation, which involves using multiple methods or data sources to study the same phenomenon. A strength of this approach was the ability to test the robustness of the theory with similar, but not exact, stimuli and data as the original work. Finally, we reduced important human bias in coding of facial expressions by using a software program for automatic facial expression encoding. Specifically, counterfactual data was not available to the software meaning any differences in expressions across medalists were unlikely to have been caused by biases in the software.

Method

Data Collection

The medal stand is a time-honored tradition within the Olympic community. Invariably, medalists are photographed atop the podium. In recent years, Olympic medal stand photographs have been archived by various media organizations, including Getty Images and The Olympic Multimedia Library.[2] For analysis in this study, we selected photographs of the track and field medalists from the Summer Olympic Games between 2000 and 2016 (see Figure 1). Photographs prior to 2000 were considered, but were too sparse. To ensure comprehensive coverage of available photographs, multiple databases were searched to locate images. Data collection resulted in photographs of 413[3] athletes from 142 sporting events[4] representing 67 countries across five Summer Games (see Tables 1 and 2). All data, coding, and analyses are available on the Open Science Framework (https://osf.io/ypwq3).

In addition, we supplemented these photographs with a variety of personal information on each athlete. We aggregated a database of each athlete's year of competition, actual medal, predicted medal, gender, country, and race. To document each athlete's predicted medal, we followed the procedure of McGraw et al. (2005) and Medvec et al. (1995) and pulled the Olympic predictions made by *Sports Illustrated's* Brian Cazeneuve. The medalists could be predicted to receive gold, silver, bronze, or no medal and were recorded accordingly (see Table 3). Racial determination was made based on publicly available data, and when none were available, determinations were made based on appearance. We used three broad racial categories: White, Black, and Asian. Our constructed dataset enables us to conduct tests that were not possible for Medvec et al. (1995) and McGraw et al. (2005) due to limited availability of data. Our selection guaranteed that we started with all medalists in each event with sufficient numbers to test these hypotheses.

Data Processing

Medal stand photos were cropped to create independent files for each medalist. Photos were processed using Emotient™ Native SDK 4.1, a software for automatic facial expression encoding. Emotient software is based on the facial action coding system (FACS; Ekman & Friesen, 1978). Automated FACS coding has been found to be accurate (Fabian Benitez-Quiroz, Srinivasan, & Martinez, 2016) with some researchers demonstrating that facial encoding software can actually be more accurate than human judges in identifying facial expressions (Lewinski, 2015). Because facial expression algorithms are tested and trained on a database of images, the ability of the software to accurately capture facial expressions is contingent on the breadth of the included images. Thus, it is possible that the software has biases related to factors such as race or gender. However, it is unlikely that the software could introduce biases related to our primary counterfactual explanations since this information was not available to the software during encoding.

Issues can arise with facial expression encoding if there are irregularities in the composition of the photo. Therefore, photos were cropped to include only the athletes' heads. Moreover, the software cannot detect a face and does not generate an output if, for example, an individual obscures a facial landmark by bringing their hands (or in this case, the medal) to their face, turning their head to the side, or wearing a hat that obscures their face. Of 426 athletes, 13 (2.9%) photos failed to produce results from the

[1] McGraw et al. (2005) reported, "We did not include bronze medalists who had just won an event and silver medalists who had just lost an event . . . The "just won"–"just lost" effect interferes with tests of the theory because bronze medalists could appear happier because of their medal and counterfactual comparison or because they won their last competition. Similarly, silver medalists could appear less happy because of their medal and comparison or because they lost their last competition" (p. 440). This issue was also documented by Medvec et al. (1995).

[2] We received permission from the Olympic Committee to access their photo library for research purposes.

[3] For comparison, the medal stand analysis in Medvec et al. (1995) included 35 athletes, McGraw et al. (2005) included 19 athletes, and Fernández-Dols and Ruiz-Belda (1995) included 22 athletes.

[4] We did not include events that succumb to the "just won"–"just lost" effect discussed in Medvec et al. (1995) (e.g., silver medalists who just lost their last competition to the gold medalist or bronze who just defeated the fourth place finisher).

Figure 1. Sample medal stand photo used in analysis. Photo reproduced with the permission of Getty Images. Image Credit: Cameron Spencer/Getty. See the online article for the color version of this figure.

software.[5] These nonprocessed individuals were not included in analyses.

Output from Emotient includes 20 unique elementary facial muscle movements called action units (AU) relevant to the study of emotion. The program automatically integrated these AUs to form composite measures of expressions such as joy, anger, sadness, and so forth. For our purposes, we used the composite measure of joy (i.e., a smile) to test relative differences in medalist's expressions. The emotion-based evidentiary output represents odds in logarithmic (base 10) scale of a target expression being present (Emotient, 2015). So for example, the software provided evidence of a smile being present. A value of 2 indicates that the expression is 100 times more likely than not to be categorized by a human coder as evidence of a smile. After processing the photographs using Emotient, the data were matched with the athlete-specific data (e.g., gender, predicted finish, actual finish).

Results

We used generalized linear mixed models (GLMM) with likelihood of a smile as a (continuous) dependent variable and medal earned (gold, silver, bronze), medal earned relative to predicted finish (better, same, worse), gender (male, female), race (White, Black, Asian), and year of games as independent variables. Predicted finish was based on *Sports Illustrated* predictions. We used a repeated measures design to control for event-related idiosyncrasies (e.g., time since event, time of day, lighting), Type III sum of squares and a robust estimator.

Category-Based and Expectation-Based Counterfactual Results

If athletes were using category-based counterfactuals, silver medalists should make upward comparisons to gold medalists and be less likely to express a smile, while bronze medalists should make downward comparisons to nonmedalists and be more likely to express a smile. Thus, we first attempt to replicate this effect posited in Medvec et al. (1995). As predicted, there was a significant effect of medal earned on smiles ($M_{\text{Gold}} = 3.073$, $SE = 0.299$, $M_{\text{Silver}} = 1.102$, $SE = 0.452$, $M_{\text{Bronze}} = 2.152$, $SE = 0.315$), Wald $\chi^2(2) = 5.499$, $p = .004$. Gold medalists were significantly more likely to exhibit a smile than bronze medalists, $t(389) = 2.230$, $p = .026$ while bronze medalists were more likely to exhibit a smile than silver medalists, $t(389) = 1.869$, one-tailed $p = .031$ (see Figure 2).

If medalists were using expectations formed prior to an Olympic event (McGraw et al., 2005), we would expect that medal expectations would be correlated with the presence of smiles and they were, Wald $\chi^2(2) = 4.316$, $p = .014$. Individuals performing better than expectations were more likely to exhibit a smile ($M_{\text{Better}} = 2.660$, $SE = 0.205$) than people performing worse than expected ($M_{\text{Worse}} = 0.899$, $SE = 0.386$), $t(389) = 3.863$, $p < .001$. These results suggests that both ex post and ex ante counterfactuals influenced medalists' emotions.

It is possible these results are affected by gold medalists responding differently than silver or bronze medalists. Or it could be a measurement issue since gold medalists could not perform better than expected while silver and bronze medalists could. Therefore, we repeated our analyses after removing gold medalists to be consistent with prior work that exclusively compares bronze and silver medalists (e.g., Medvec et al., 1995; see Figure 3).

[5] Medalists whose photos did not produce an output were equally distributed across race (3.4% Asian, 4.5% Black, 1.4% White) and gender (5.8% female, .6% male). This failure rate is similar to prior research using human raters (e.g., Matsumoto and Willingham, 2006).

Table 1
Counts of Medalist Photographs by Event (2000–2016 Summer Olympic Games)

Event	Medalist counts Gold	Silver	Bronze	Total
100	8	9	6	23
10,000	6	6	6	18
100 M Hurdles	4	3	3	10
110 M Hurdles	4	5	5	14
1,500	7	7	7	21
200	6	6	6	18
20 KM Walk	6	6	6	18
3,000 SC	4	4	4	12
400	7	7	7	21
400 M Hurdles	7	8	8	23
5,000	6	7	7	20
50 KM Walk	2	2	2	6
800	5	4	5	14
Archery	4	4	3	11
Decathlon	4	4	4	12
Discus	7	7	7	21
Hammer Throw	6	6	6	18
Heptathlon	2	1	1	4
High Jump	7	7	7	21
Javelin	7	7	7	21
Long Jump	6	6	5	17
Marathon	5	5	5	15
Pentathlon	1	1	1	3
Pole Vault	5	5	5	15
Shot Put	7	6	6	19
Triathlon	2	2	2	6
Triple Jump	4	4	4	12
Total	139	139	135	413

Counterfactual Results—Selecting Silver and Bronze Medalists Only

As predicted and consistent with our earlier results, there was a significant effect of medal earned on likelihood of a smile (M_{Silver} = 1.074, *SE* = 0.420, M_{Bronze} = 2.059, *SE* = 0.348), Wald $\chi^2(1) = 3.208$, one-tailed $p = .037$. Bronze medalists were more likely to express a smile than silver medalists. This result suggests that category-based, ex post counterfactual thinking influences medalists' emotions.

As predicted and consistent with our earlier results, there was a significant effect of prior expectations on likelihood of smile (M_{Better} = 2.467, *SE* = 0.265, M_{Same} = 1.336, *SE* = 0.685, M_{Worse} = 0.895, *SE* = 0.380), Wald $\chi^2(2) = 5.390$, $p = .005$. Individuals performing better than expected were more likely to smile than people performing worse than expected, $t(255) = 3.189$, $p = .002$. There was no significant interaction between medal and predicted finish ($p = .812$).

Race

In general, the likelihood of smile differed based on race, Wald $\chi^2(2) = 4.077$, $p = .018$. The difference between White medalists (*M* = 2.439, *SE* = 0.332) and Black medalists (*M* = 2.077, *SE* = 0.239) was insignificant, $t(255) = 0.891$, $p = .374$, but both White and Black medalists were significantly more likely to express a smile than Asian medalists (*M* = 0.182, *SE* = 0.703), $t(255) = 2.836$, $p = .005$ and $t(255) = 2.613$, $p = .010$, respectively. There was not a significant interaction between medal earned and race, Wald $\chi^2(2) = 1.417$, $p = .244$, nor was there a significant interaction between expectations and race, Wald $\chi^2(4) = 1.398$, $p = .235$, suggesting counterfactuals have the same effect across races. However, it is possible this analysis lacked sufficient power to pick up on these interactions.

Gender

There is a main effect of gender on likelihood of smile such that female medalists were more likely to express a smile than male medalists (M_{Female} = 2.175, *SE* = 0.316, M_{Male} = 0.958, *SE* = 0.348), Wald $\chi^2(1) = 9.963$, $p = .002$. This affirms prior literature that finds that females, in general, tend to be more facially expressive than males, particularly for positive expressions (McDuff, Kodra, el Kaliouby, & LaFrance, 2017). However, gender did not interact with medal earned, Wald $\chi^2(2) = .342$, $p = .570$, or predicted finish, Wald $\chi^2(2) = .416$, $p = .660$, suggesting counterfactuals have the same effect across genders.

Duchenne and Non-Duchenne Smiles

Finally, we investigated whether there was a difference between Duchenne non-Duchenne smiles. Duchenne smiles involve AU12 (lip corner puller) and AU6 (cheek raiser) while non-Duchenne smiles involve only AU12. Some have claimed Duchenne smiles are more genuine and harder to fake than non-Duchenne smiles (e.g., Ekman, 1993), but there has been considerable debate among scholars as to the validity of these claims (Barrett et al., 2019; Krumhuber & Manstead, 2009). Our results do not provide meaningful insights to this debate. Instead, we provide the results here in an attempt to replicate prior studies. For example, Matsumoto and Willingham (2006) demonstrated that gold and bronze medalists displayed mostly Duchenne smiles, while silver medalists either did not smile or displayed negative emotions and Fernández-Dols and Ruiz-Belda (1995) measured Duchenne and non-Duchenne separately in their analysis of the medal ceremony.

To test whether expectations differentially affected Duchenne and non-Duchenne smiles, we ran a similar regression as described above in which we analyzed only silver and bronze medalists except we changed the dependent variable to AU6. AU6 is the cheek raiser which is a necessary component of the Duchenne smile but not other smiles. Presence of this action unit indicates the smile is more likely Duchenne than non-Duchenne. We limited this analysis to participants who were smiling because our goal was to investigate the likelihood of a Duchenne smile conditional on the presence of any smile.[6]

The main effects for medal and expected medal were insignificant, Wald $\chi^2(1) = 0.971$, $p = .326$ and Wald $\chi^2(2) = 0.494$, $p = .611$, respectively. This is consistent with the conclusion that the results were not driven by a difference in Duchenne versus non-Duchenne smiles. However, there was a significant Medal × Expected Medal interaction, Wald $\chi^2(2) = 3.441$, $p = .034$. This suggests the results for bronze and silver medalists are different. Further investigation shows bronze medalists had higher AU6

[6] We selected participants whose likelihood of smile score was greater than all other expressions.

Table 2
Counts of Medalist Photographs by Country (2000–2016 Summer Olympic Games)

Country	Gold	Silver	Bronze	Total	Country Cont.	Gold	Silver	Bronze	Total
Algeria	1	1	0	2	Kenya	9	10	9	28
Australia	4	3	2	9	Latvia	0	1	0	1
Bahamas	2	0	2	4	Lithuania	2	0	1	3
Bahrain	0	0	1	1	Mexico	1	3	1	5
Barbados	0	0	1	1	Morocco	2	1	1	4
Belarus	2	4	4	10	Netherlands	0	1	1	2
Belgium	1	0	0	1	New Zealand	2	1	3	6
Brazil	0	0	1	1	Nigeria	0	1	0	1
Bulgaria	1	1	0	2	Norway	2	0	0	2
Canada	1	1	2	4	Panama	1	0	0	1
China	3	2	8	13	Poland	5	1	2	8
Colombia	0	1	0	1	Portugal	1	1	2	4
Croatia	2	1	1	4	Puerto Rico	0	0	1	1
Cuba	5	3	6	14	Qatar	0	1	0	1
Czech Republic	3	0	5	8	Romania	1	1	0	2
Denmark	0	2	1	3	Russia	10	8	11	29
Dominican Republic	1	1	0	2	Saudi Arabia	0	1	0	1
Ecuador	0	1	0	1	Slovakia	1	0	0	1
Eritrea	0	0	1	1	Slovenia	1	1	1	3
Estonia	1	0	2	3	South Africa	1	4	3	8
Ethiopia	8	7	7	22	South Korea	2	2	0	4
Finland	0	1	1	2	Spain	1	2	2	5
France	1	4	4	9	Sri Lanka	0	1	0	1
Germany	1	7	3	11	Sudan	0	1	0	1
Great Britain	7	4	3	14	Sweden	1	0	0	1
Greece	2	3	1	6	Switzerland	0	1	0	1
Grenada	1	0	0	1	Tajikistan	1	0	0	1
Guatemala	1	0	0	1	Trinidad and Tobago	1	2	1	4
Hungary	1	1	0	2	Tunisia	1	0	0	1
Iran	0	1	0	1	Turkey	1	3	1	5
Italy	2	0	2	4	Uganda	1	0	0	1
Jamaica	9	7	6	22	Ukraine	1	2	7	10
Japan	1	1	2	4	United States	27	32	21	80
Kazakhstan	2	0	1	3					

Note. Medalists were 54.2% male.

scores when they performed better than expected ($M_{\text{Bronze\_Better}}$ = 1.865, SE = 0.202) than when they performed worse than expected ($M_{\text{Bronze\_Worse}}$ = 1.114, SE = 0.279), $t(191)$ = 2.187, p = .030. Bronze medalists performing better than expected also had higher AU6 scores than silver medalists performing better than expected ($M_{\text{Silver\_Better}}$ = 1.069, SE = 0.138), $t(191)$ = 3.280, p = .001. However, silver medalists performing better than expected did not have higher AU6 scores than when they performed worse than expected ($M_{\text{Silver\_Worse}}$ = 1.217, SE = 0.430), $t(191) = -0.341$, p = .733.

Table 3
Counts of Medalists' Predicted Finish by Actual Finish

Predicted finish	Actual finish: Gold	Silver	Bronze	Total
Gold	51	16	17	84
Silver	24	24	19	67
Bronze	14	22	17	53
No Medal	50	77	82	209
Total	139	139	135	413

General Discussion

Using automated facial expression analysis, we conceptually replicated Medvec et al. (1995). We confirmed the phenomenon that bronze medalists appeared happier than silver medalists after competition in Olympic events. Our results are consistent with the theory that facial expressions of Olympic medalists were influenced by two prominent types of counterfactual thinking: category-based and expectation-based counterfactuals. We did this by compiling a large dataset of medal stand photographs from the Olympic Multimedia Library and Getty Images for the 2000–2016 Olympic summer games. We also included expectation-based data from *Sports Illustrated's* medal finish predictions ahead of the event.

Debate continues around the validity of emotional inferences from particular facial expressions (e.g., Barrett et al., 2019). Here, we were not making claims regarding the emotion felt by medalists, but rather revealed differences in facial displays by athletic performance. We evaluated the facial expressions of Olympic medalists by processing photographs in Emotient, an automated system for coding of human facial expressions. Prior work on this phenomenon has used human coders to evaluate emotional expres-

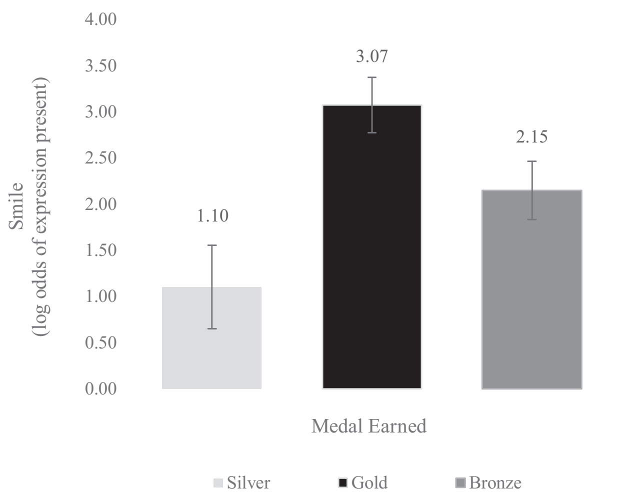

Figure 2. Medalist's smiles by actual medal earned.

sions. Thus, this work provided a test of the well-established phenomenon without human intervention, thereby limiting direct human bias. While it is difficult for any system, including automated facial coding, to be entirely free of bias, it is unlikely that the biases inherent in the coding system were systematically correlated with our measures of counterfactuals.

Supporting prior work, athletes' facial expressions were related not just to their absolute performance, but also to prior performance expectations. The results are consistent with the theory that silver medalists formed an upward comparison to gold medalist with thoughts of "I almost won gold" while bronze medalists formed a downward comparison to a fourth place finisher with thoughts of "at least I won a medal." These category-based comparisons influenced the expressions of these medalists. Results also supported a second explanation that medalists formed expectation-based counterfactuals such that silver medalists were less likely to smile because their prior expectations for performance were higher than bronze medalists. Consideration for "what was expected to be" can haunt medalists and affect satisfaction with actual performance. Importantly, this was captured via their facial expressions on medal stands.

We further demonstrated nuances in how Duchenne and non-Duchenne smiles were expressed across the medal stand. When expectations differed from actual performance, we saw significant differences in expressions of Duchenne and non-Duchenne smiles. Specifically, bronze medalists who performed better than expected were more likely to express a Duchenne smile than those who had performed worse than expected.

Limitations with this work included difficulty obtaining photographs from early Olympic games. Attempts were made to collect photographs from the same events at each games but early year photographs were often restricted to what we could locate in the Olympic Multimedia Library and Getty Images database. Even when we were able to find photographs from Olympic games, not all the photographs were suitable for use. Often the photographs included athletes looking away from the camera or with their medals obstructing their full face. It is also possible that photographers, editors, or media personnel selected photos with this pattern of facial expressions among medalists. Unlike video data which have running documentation of facial expressions with contextual information, photos are inherently a snapshot in time. Perhaps there is a systematic preference among media personnel to portray silver medalists as being less happy with their performance. While this is a possible explanation worth mentioning, the size and diversity of our dataset—which spanned two decades, international communities, and innumerable photographers and content creators—mitigates this risk. Finally, current analyses had limitations in treating race as three broad categories. Future research could consider different classifications based on country of origin or more nuanced racial categories.

Nonetheless, these results documented consistent patterns of facial expressions of Olympic medalists based on performance. Regardless of whether medalists felt the corresponding emotions, facial behaviors may communicate emotional meaning to viewers.

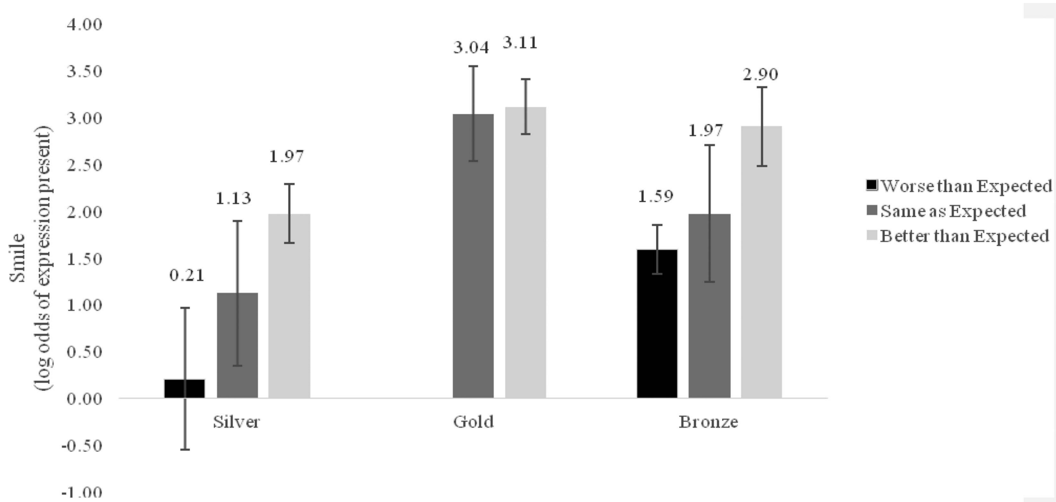

Figure 3. Medalist's smiles by actual medal earned and predicted performance. Because gold medalists cannot finish worse than expected, there are no values presented here.

Facial expressions are sometimes indicators of genuine joy, other times an indication of inauthentic joy. Automatic expression analysis has made detection of expressions easier to capture through subtle nuances in the composition of one's expression. Thus, we detected instances in which medalists may have been forcing a smile, presumably for social niceties. Humans may try to express emotions we think are socially acceptable, even if those facial expressions do not genuinely reflect how one actually feels. In sum, this research demonstrated consistent findings with both Medvec et al. (1995) and McGraw et al. (2005) finding support for both ex post and ex ante counterfactual thinking among Olympic athletes.

Context of This Research

This article originated out of interest in reproducing existing psychological research using new facial expression technologies. With prior studies limited in the ability to test the phenomenon at scale, we were interested to investigate whether the theory held across a diverse set of available image data that were collected in the field, not a lab. The findings of this article intersect well with the authors' expertise and research programs. This first author studies decision neuroscience utilizing a range of techniques including physiological measures, functional brain imaging, and facial expression encoding. The second author studies nonverbal social influence across various modalities including text, image, and in-person interactions. The third author completed an undergraduate honors thesis using this data while serving as a research assistant in the first author's lab. It is our hope that this work spurs future scholars to conduct large-scale conceptual replications of existing facial expression and emotion research.

References

Barrett, L. F. (2017). The theory of constructed emotion: An active inference account of interoception and categorization. *Social Cognitive and Affective Neuroscience, 12,* 1–23. http://dx.doi.org/10.1093/scan/nsx060

Barrett, L. F., Adolphs, R., Marsella, S., Martinez, A. M., & Pollak, S. D. (2019). Emotional expressions reconsidered: Challenges to inferring emotion from human facial movements. *Psychological Science in the Public Interest, 20,* 1–68. http://dx.doi.org/10.1177/1529100619832930

Crivelli, C., & Fridlund, A. J. (2019). Inside-out: From basic emotions theory to the behavioral ecology view. *Journal of Nonverbal Behavior, 43,* 161–194. http://dx.doi.org/10.1007/s10919-019-00294-2

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion, 6,* 169–200. http://dx.doi.org/10.1080/02699939208411068

Ekman, P. (1993). Facial expression and emotion. *American Psychologist, 48,* 384–392.

Ekman, P. (1994). Strong evidence for universals in facial expressions: A reply to Russell's mistaken critique. *Psychological Bulletin, 115,* 268–287. http://dx.doi.org/10.1037/0033-2909.115.2.268

Ekman, P., & Friesen, W. V. (1971). Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology, 17,* 124–129. http://dx.doi.org/10.1037/h0030377

Ekman, P., & Friesen, W. V. (1978). *Facial action coding systems*. Palo Alto, CA: Consulting Psychologists Press.

Emotient. (2015). Emotient™ native SDK user guide [Computer software]. San Diego, CA: Emotient Incorporated.

Fabian Benitez-Quiroz, C., Srinivasan, R., & Martinez, A. M. (2016). Emotionet: An accurate, real-time algorithm for the automatic annotation of a million facial expressions in the wild. *Proceedings of the IEEE conference on computer vision and pattern recognition* (pp. 5562–5570). Retrieved from http://cbcsl.ece.ohio-state.edu/cvpr16.pdf

Fernández-Dols, J. M., & Crivelli, C. (2013). Emotion and expression: Naturalistic studies. *Emotion Review, 5,* 24–29. http://dx.doi.org/10.1177/1754073912457229

Fernández-Dols, J. M., & Ruiz-Belda, M. A. (1995). Are smiles a sign of happiness? Gold medal winners at the Olympic Games. *Journal of Personality and Social Psychology, 69,* 1113–1119. http://dx.doi.org/10.1037/0022-3514.69.6.1113

Festinger, L. (1954). A theory of social comparison processes. *Human Relations, 7,* 117–140. http://dx.doi.org/10.1177/001872675400700202

Fridlund, A. J. (1994). *Human facial expression: An evolutionary view*. San Diego, CA: Academic Press.

Fridlund, A. J. (2017). The behavioral ecology view of facial displays, 25 years later. In J.-M. Fernández-Dols & J. A. Russell (Eds.), *Oxford series in social cognition and social neuroscience. The science of facial expression* (pp. 77–92). Oxford, UK: Oxford University Press.

Izard, C. E. (2007). Basic emotions, natural kinds, emotion schemas, and a new paradigm. *Perspectives on Psychological Science, 2,* 260–280. http://dx.doi.org/10.1111/j.1745-6916.2007.00044.x

Kahneman, D., & Miller, D. T. (1986). Norm theory: Comparing reality to its alternatives. *Psychological Review, 93,* 136–153. http://dx.doi.org/10.1037/0033-295X.93.2.136

Kahneman, D., & Tversky, A. (1981). *The simulation heuristic,* (No. TR-5). Stanford, CA: Stanford University, Department of Psychology.

Krumhuber, E. G., & Manstead, A. S. (2009). Can Duchenne smiles be feigned? New evidence on felt and false smiles. *Emotion, 9,* 807–820. http://dx.doi.org/10.1037/a0017844

Lewinski, P. (2015). Automated facial coding software outperforms people in recognizing neutral faces as neutral from standardized datasets. *Frontiers in Psychology, 6,* 1386. http://dx.doi.org/10.3389/fpsyg.2015.01386

Markman, K. D., Gavanski, I., Sherman, S. J., & McMullen, M. N. (1993). The mental simulation of better and worse possible worlds. *Journal of Experimental Social Psychology, 29,* 87–109. http://dx.doi.org/10.1006/jesp.1993.1005

Martin, J., Rychlowska, M., Wood, A., & Niedenthal, P. (2017). Smiles as multipurpose social signals. *Trends in Cognitive Sciences, 21,* 864–877. http://dx.doi.org/10.1016/j.tics.2017.08.007

Matsumoto, D., & Willingham, B. (2006). The thrill of victory and the agony of defeat: Spontaneous expressions of medal winners of the 2004 Athens Olympic Games. *Journal of Personality and Social Psychology, 91,* 568–581. http://dx.doi.org/10.1037/0022-3514.91.3.568

McDuff, D., Kodra, E., el Kaliouby, R., & LaFrance, M. (2017). A large-scale analysis of sex differences in facial expressions. *PLoS ONE, 12,* e0173942. http://dx.doi.org/10.1371/journal.pone.0173942

McGraw, A. P., Mellers, B. A., & Tetlock, P. E. (2005). Expectations and emotions of Olympic athletes. *Journal of Experimental Social Psychology, 41,* 438–446. http://dx.doi.org/10.1016/j.jesp.2004.09.001

Medvec, V. H., Madey, S. F., & Gilovich, T. (1995). When less is more: Counterfactual thinking and satisfaction among Olympic medalists. *Journal of Personality and Social Psychology, 69,* 603–610. http://dx.doi.org/10.1037/0022-3514.69.4.603

Oliver, R. L. (1977). Effect of expectation and disconfirmation on postexposure product evaluations: An alternative interpretation. *Journal of Applied Psychology, 62,* 480–486. http://dx.doi.org/10.1037/0021-9010.62.4.480

Reisenzein, R., Studtmann, M., & Horstmann, G. (2013). Coherence between emotion and facial expression: Evidence from laboratory experiments. *Emotion Review, 5,* 16–23. http://dx.doi.org/10.1177/1754073912457228

Roese, N. J. (1997). Counterfactual thinking. *Psychological Bulletin, 121,* 133–148. http://dx.doi.org/10.1037/0033-2909.121.1.133

Rosenberg, E. L., & Ekman, P. (1994). Coherence between expressive and experiential systems in emotion. *Cognition and Emotion, 8,* 201–229. http://dx.doi.org/10.1080/02699939408408938

Russell, J. A. (1994). Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychological Bulletin, 115,* 102–141. http://dx.doi.org/10.1037/0033-2909.115.1.102

Russell, J. A. (2017). Toward a broader perspective on facial expressions. In J.-M. Fernández-Dols & J. A. Russell (Eds.), *Oxford series in social cognition and social neuroscience. The science of facial expression* (pp. 93–105). Oxford, UK: Oxford University Press. http://dx.doi.org/10.1093/acprof:oso/9780190613501.001.0001

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