



Sourires de joie, d'affiliation et de domination : Approche simulationniste

Magdalena Rychlowska

► To cite this version:

Magdalena Rychlowska. Sourires de joie, d'affiliation et de domination : Approche simulationniste. Psychologie. Université Blaise Pascal - Clermont-Ferrand II, 2014. Français. NNT : 2014CLF20006 . tel-01090419

HAL Id: tel-01090419

<https://theses.hal.science/tel-01090419>

Submitted on 3 Dec 2014

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

UNIVERSITE CLERMONT-FERRAND II - BLAISE PASCAL
UFR DE PSYCHOLOGIE - LAPSCO
ECOLE DOCTORALE DES LETTRES, SCIENCES HUMAINES ET SOCIALES

THESE

PRESENTEE A L'UNIVERSITE BLAISE PASCAL
POUR L'OBTENTION DU GRADE DE

DOCTEUR D'UNIVERSITE

SPECIALITE : PSYCHOLOGIE

MAGDALENA RYCHLOWSKA

SOURIRES DE JOIE, D'AFFILIATION ET DE DOMINATION : APPROCHE SIMULATIONNISTE

SOUS LA DIRECTION DE :
PROF. DR. PAULA NIEDENTHAL
PROF. DR. SYLVIE DROIT-VOLET

SOUTENUE LE 15 AVRIL 2014
DEVANT LE JURY COMPOSE DE

PROF. DR. MARIE IZAUTE, UNIVERSITE BLAISE PASCAL – PRESIDENT DU JURY

PROF. DR. AGNETA FISCHER, UNIVERSITE D'AMSTERDAM – MEMBRE DU JURY

PROF. DR. FRANÇOIS RIC, UNIVERSITE DE BORDEAUX – RAPPORTEUR

PROF. DR. PHILIPPE SCHYNS, UNIVERSITE DE GLASGOW – RAPPORTEUR



UNIVERSITY OF CLERMONT-FERRAND II – BLAISE PASCAL
DEPARTMENT OF PSYCHOLOGY - LAPSCO
ECOLE DOCTORALE DES LETTRES, SCIENCES HUMAINES ET SOCIALES

A DISSERTATION

SUBMITTED IN PARTIAL SATISFACTION
OF THE REQUIREMENTS FOR THE DEGREE

DOCTOR OF PHILOSOPHY

IN PSYCHOLOGY

BY MAGDALENA RYCHLOWSKA

PLEASURE, AFFILIATIVE AND DOMINANCE SMILES: AN EMBODIED SIMULATION ACCOUNT

ADVISORS :
PROF. DR. PAULA NIEDENTHAL
PROF. DR. SYLVIE DROIT-VOLET

APRIL 15, 2014

COMMITTEE :

PROF. DR. MARIE IZAUTE, BLAISE PASCAL UNIVERSITY – CHAIR
PROF. DR. AGNETA FISCHER, UNIVERSITY OF AMSTERDAM
PROF. DR. FRANÇOIS RIC, UNIVERSITY OF BORDEAUX
PROF. DR. PHILIPPE SCHYNS, UNIVERSITY OF GLASGOW

ACKNOWLEDGMENTS

The work presented in this dissertation would not have been possible without the time, the invaluable advice, and the support of my two advisors, Paula Niedenthal and Sylvie Droit-Volet. I am especially grateful to Paula Niedenthal for her guidance, patience, and energy that influenced every stage of my research since I met her in 2008.

I would also like to thank Agneta Fischer, Marie Izaute, François Ric, and Philippe Schyns for accepting to be part of my thesis committee and providing me with helpful feedback on this and previous work.

Writing this thesis would be much less enjoyable without the friendship and help of my academic sister, Adrienne Wood, and my fellow colleagues: Elise Bausseron, Elena Canadas, Will Cox, Patrick Forscher, Sebastian Korb, Chelsea Mitamura, Anabel Fonseca, Mathilde Lamotte, Mickaël Jury, and Marlène Oppin. All American and French members of the Niedenthal Lab, especially Oriane Grodzki, Fabienne Lelong, Nolan Lendved, Kamilla Khamzina, and Quentin Viteur, considerably helped my work by contributing to data collection and analysis and to endless revisions and corrections. I am also grateful to Sophie Monceau, Pierre Chausse, Julien Guegan, Mickaël Berthon, and Nadia Jeanmaire for making many experiments and travels possible. Finally, I could not have got to where I am today without the love and support of my dear friends, my French family and, most of all, my companion David Bourdier, and my mother Alina Rychlowska.

Data presented in **Chapter 2** are published and reproduced with permission: Rychlowska, M., Zinner, L., Musca, S.C., & Niedenthal, P.M. (2012). From the eye to the heart: Eye contact triggers emotion simulation. Proceedings of the 4th Workshop on Eye Gaze in Intelligent Human Machine Interaction (ICMI 2012), ACM Digital Library. PMN, SCM, LZ, MR conceived and designed the experiments, MR collected the data, SCM and MR analyzed the data, MR and PMN wrote the paper.

Chapter 3.1 is a manuscript published and reproduced with permission: Rychlowska, M., Canadas, E., Wood, A., Krumhuber, E. G., Fischer, A., & Niedenthal, P. M. (2014). Blocking mimicry makes true and false smiles look the same. *PLOS ONE*, 9. PMN, AF, EC, EGK conceived and designed the experiments. EC and MR collected the data. EC and MR analyzed the data. EK contributed materials. PMN, MR, EC, AW wrote the paper.

Chapter 3.2 is an article published and available upon request: Niedenthal, P.M., Augustinova, M., Rychlowska, M., Droit-Volet, S., Zinner, L., Knafo, A. & Brauer, M. (2012). Negative relations between pacifier use and emotional competence. *Basic and Applied Social Psychology*, 34, 387-394. PMN, SDV, MA, LZ, MB conceived and designed the experiments. PMN, SDV and MR collected the data. MB and MR analyzed the data. PMN, MA, SDV, LZ, AK wrote the paper.

Chapter 4.1 is a manuscript submitted for publication and available upon request: Niedenthal, P.M., Rychlowska, M., Miyamoto, Y., Matsumoto, D., Hess, U., Gilboa-Schechtman, E., Kamble, S., Muluk, H., Masuda, T. (2014). *Historical homogeneity, emotional expressiveness and the social functions of smiles*. PMN, YM, UH, EGS, MR conceived and designed the experiments. PMN, YM, DM, EGS, SK, HM, TM, MR collected the data. DM contributed materials. MR analyzed the data. PMN, MR, YM wrote the paper.

Chapter 4.2 is a manuscript submitted for publication and available upon request: Rychlowska, M., Jack, R. E., Garrod, O.G.B., Schyns, P.G., & Niedenthal, P. (2014). *What's in a smile? Specific facial actions combine with zygomaticus major in expressions of pleasure, affiliation and dominance*. PGS, OGB, RJ, PMN, MR conceived and designed the experiments. MR collected the data. PGS, OGB, RJ contributed materials. RJ and MR analyzed the data. MR, RJ, PGS, PMN wrote the paper.

KEYWORDS: SMILE, EYE CONTACT, MIMICRY, EMOTION, EMBODIED SIMULATION, PACIFIER, CULTURE

MOTS-CLES: SOURIRE, CONTACT VISUEL, IMITATION FACIALE, EMOTION, SIMULATION INCARNEE, TETINE, CULTURE

TABLE OF CONTENTS

Abstract of the Dissertation	8
Résumé en Français	9
Résumé Substantiel en Français	10
List of Figures	25
List of Tables	26
Chapter 1	27
Introduction	27
1.1 So easy, yet so difficult: smiles and their multiple meanings	27
1.2 Simulation of Smiles Model and routes to decode facial affect.....	29
1.3 The role of facial mimicry and eye contact.....	30
1.4 Culture and the use of nonverbal behavior.....	31
1.5 A social functional classification of smiles.....	32
1.6 Goals of the dissertation.....	34
Chapter 2	37
Triggering Embodied Simulation: The Role of Eye Contact	37
2.1 Introduction	37
2.1.1 The Simulation of Smiles (SIMS) Model	37
2.1.2 Eye contact as a trigger to simulation	38
2.2 Study 1.....	40
2.2.1 Method	40
2.2.2 Results	42
2.2.3 Discussion	43
2.3 Study 2.....	44
2.3.1 Method	44
2.3.2 Results	45
2.3.3 Discussion	45
2.4 Study 3.....	46
2.4.1 Method	46
2.4.2 Results	47
2.4.3 Discussion	49
2.5 General discussion.....	50
Chapter 3	52
Why Do We Mimic? Implications of Facial Mimicry for Smile Judgments and the Development of Social Competences	52
3.1. Blocking mimicry makes true and false smiles look the same	52

3.1.1 Introduction	52
3.1.2 Experiment 1	58
3.1.3 Experiment 2	63
3.1.4 Experiment 3	66
3.1.5 Discussion	69
3.2. Consequences of blocking mimicry on the development of emotional competence	75
3.2.1 Introduction	Erreur ! Signet non défini.
3.2.2 Study 1.....	Erreur ! Signet non défini.
3.2.3 Study 2.....	Erreur ! Signet non défini.
3.2.4 Study 3.....	Erreur ! Signet non défini.
3.2.5 Discussion	Erreur ! Signet non défini.
Chapter 4.....	76
Beyond Authenticity: Functional Smiles and Their Endorsement Across Cultures	76
4.1 Emotional expression and smiling across cultures.....	77
4.1.1 Introduction	Erreur ! Signet non défini.
4.1.2 Study 1.....	Erreur ! Signet non défini.
4.1.3 Study 2.....	Erreur ! Signet non défini.
4.1.4 Discussion	Erreur ! Signet non défini.
4.2 What's in a smile? Specific facial actions combine with <i>zygomaticus major</i> in expressions of pleasure, affiliation and dominance	77
Chapter 5.....	78
Integration of Results and Future Directions	78
5.1 Eye contact as a trigger for embodied simulation	79
5.2 Facial mimicry and its importance for smile interpretation	80
5.3 Pacifier use and emotion processing	81
5.4 Historical homogeneity as a predictor of nonverbal expressiveness.....	84
5.5 Pleasure, affiliative and dominance smiles: their functions and morphology.....	85
5.6 Conclusions	86
References	88
Appendix A	109
4.1 Emotional expression and smiling across cultures.....	109
1. Study 2 : questionnaire assessing feelings and motives producing smiles	109
2. Study 2 : details of the procedure.....	110
3. Study 2 : K-Means clustering.....	110
4. Study 2 : Respondents in Cluster 1 and Cluster 2: Comparison of the TwoStep and K-Means solutions.....	111

5. Cluster membership and endorsement of reward, bonding and hierarchy motives as a function of Homogeneity and related constructs.....	112
Appendix B	113
4.2 What's in a smile? Specific facial actions combine with <i>zygomaticus major</i> in expressions of pleasure, affiliation and dominance	113
Stage 1: Reverse correlation: reconstructing mental representations of functional smiles	113
Stage 2: Detection of functional smiles.....	115
Stage 2: Ratings of social motives	117

ABSTRACT OF THE DISSERTATION

Facial expressions are the core of our social life, but the exact mechanisms underlying their perception and interpretation are yet to be explained. The goal of this dissertation was to use the human smile as a case study in order to shed more light on the processing of facial expression. We first examined the role of eye contact and facial mimicry in the judgments of smiles. The findings revealed that smiles accompanied by eye contact have more emotional impact and elicit more corresponding smiling than smiles accompanied with averted gaze (Chapter 2). Moreover, studies involving children and adult participants (Chapter 3) show that facial mimicry is involved not only in perceptions of smile authenticity but also in the development of general emotional competence. Still, in order to define facial mimicry and explore its effects we need to specify what exactly is mimicked. A second series of studies (Chapter 4) provided initial support for the social-functional typology of reward, affiliative and dominance smiles and showed that the endorsement of these smiles – as well as general expressivity norms – can be predicted by a country's demographic history, namely the homogeneity of its population over the centuries. The ongoing experiments investigate the morphology and the time course of the three functional smiles. Combined, our findings highlight the role of embodied simulation and bodily experience in the processing of smiles in particular and facial expression in general.

RESUME EN FRANÇAIS

Bien que la perception et l'interprétation des expressions faciales soient critiques pour notre vie sociale, leurs mécanismes restent largement incompris. Le but de ma thèse a été d'essayer de comprendre ces processus en analysant le sourire, qui est la plus complexe des expressions.

Dans une série de 9 études, nous avons examiné le rôle du contact visuel et du mimétisme facial dans la perception des sourires. Les résultats d'une première série d'études (Chapitre 2) ont révélé que les sourires accompagnés du contact visuel ont plus d'impact émotionnel et sont plus imités par les observateurs que les sourires sans échange de regards. De plus, les études que nous avons réalisées auprès des enfants et d'adultes (Chapitre 3) révèlent que le mimétisme facial est effectivement important non seulement pour un jugement correct de l'authenticité des sourires, mais aussi pour le développement des compétences émotionnelles en général. Afin d'estimer les effets du mimétisme facial, il est important de mieux comprendre les expressions faciales que l'on imite. Dans une deuxième série d'études (Chapitre 4) nous avons donc cherché à regarder les différentes fonctions de sourire en validant une typologie fonctionnelle des sourires, ceux de joie, d'affiliation et de domination. Les résultats montrent que l'usage de ces sourires dans 9 pays, ainsi que les normes gouvernant l'expressivité faciale dans 31 pays peuvent être prédits par l'homogénéité de la population de ces pays à travers les siècles. La morphologie des sourires de joie, d'affiliation et de domination est l'objet des expériences en cours. En somme, ce travail de recherche sur le sourire révèle l'importance de l'expérience corporelle et de la simulation des expressions faciales perçues chez l'autre dans l'interaction sociale.

RESUME SUBSTANTIEL EN FRANÇAIS

Dans le monde complexe qui nous entoure, il y a peu de choses qui nous touchent autant que les visages humains et leurs expressions. Les interactions sociales de tous les jours exigent qu'on produise, reconnaisse et interprète ces expressions de manière rapide et efficace. Les grimaces, les froncements des sourcils, les sourires ou les moues nous informent sur les émotions et les intentions des personnes qui nous entourent. Par conséquent elles déterminent nos propres émotions et comportements. Parmi toutes les expressions faciales, le sourire est probablement la plus important, et le plus complexe. Sa première fonction est de communiquer la joie et le bonheur (Izard, 1971; Ekman, 1994; Frank & Stennett, 2001, Niedenthal, Mermillod, Maringer, & Hess, 2010). Voir quelqu'un sourire est un plaisir (Shore & Heerey, 2011). Il n'est donc pas surprenant que les sourires contribuent à des premières impressions positives (Hess, Beaupré, & Cheung, 2002) et que les personnes souriantes soient perçues comme agréables (McGinley, McGinley, & Nicholas, 1978), honnêtes (Thornton, 1943), chaleureuses (Bayes, 1972), et compétentes (Reis, Wilson, Monestere, Bernstein, Clark, & Seidl, 1990). Mais, bien que le sourire soit universellement reconnu en tant qu'expression de bonheur (Ekman, 1989; Frank & Stennett, 2001) et que ses effets bénéfiques aient été observés dans différentes cultures (Lau, 1982; Matsumoto & Kudoh, 1993; Otta, Abrosio, & Hoshino, 1996), le langage des sourires est source de malentendus entre des individus, entre des groupes sociaux différent et des nations différentes. En effet, la production des sourires, ainsi que les normes sociales qui guident leur expression, varient largement à travers les cultures (Ekman & Friesen, 1982; Matsumoto, Takeuchi, Andayani, Kouznetsova, & Krupp, 1998; Matsumoto, Yoo, Fontaine et al., 2008; Wiseman & Pan,

2004). Les différences dans les contextes où il est approprié de sourire peuvent contribuer à expliquer des différences dans la signification des sourires eux-mêmes.

En effet, les fonctions des sourires ne se limitent pas à l'expression du bonheur. Les gens sourient lorsqu'ils se sentent embarrassés (Kraut & Johnston, 1979), tristes (Klineberg, 1940), dégoûtés (Landis, 1924) ou supérieurs (Abel, 2002; LaFrance, 2009, 2011). Ces nombreux types des sourires engagent différents muscles faciaux, différentes parties du visage, et peuvent varier dans leurs dynamiques temporelles. Il s'agirait ainsi d'une classe hétérogène d'expressions produites dans de nombreuses situations sociales. Quels sont les mécanismes qui nous permettent de comprendre la signification – souvent très subtile - de différents sourires ? Comment peut-on classer les différents types de sourires ? Et pourquoi les sourires sont-ils source de tant de malentendus à travers les cultures ? Le but de la présente thèse était d'explorer ces questions afin d'approfondir les connaissances sur le traitement des expressions faciales en général et le sourire en particulier. Nos hypothèses de recherche ont été guidées par le Modèle Simulationniste des Sourires (SIMS, Simulation of Smiles Model, Niedenthal et al., 2010), qui est une théorie récente de la production et perception des sourires intégrant des données comportementales, neuroscientifiques et psychophysiologiques. Plus précisément, les études proposées ont testé les prédictions du modèle SIMS sur le rôle du contact visuel et de l'activité faciale dans le jugement des sourires (**Chapitre 2 et 3**) et sur une nouvelle typologie fonctionnelle des sourires (**Chapitre 4**).

Selon Niedenthal et ses collègues (2010), plusieurs mécanismes permettent aux gens de comprendre la signification des expressions faciales. Ces stratégies ne sont pas mutuellement exclusives et leur application dépend du contexte dans lequel l'expression est observée (Adolphs, 2002; Atkinson, 2007; Kirouac & Hess, 1999). Tout d'abord, il est possible de reconnaître un sourire en analysant ses *caractéristiques perceptives* de bas niveau, telles que la forme de la bouche ou des yeux, ou la visibilité des dents, et en les comparant à des

représentations prototypiques des sourires. Cette stratégie est utile notamment lors des tâches simples de catégorisation ou lorsque le jugement précis d'un sourire n'est pas très important pour l'observateur (Buck, 1984; Dailey, Cottrell, Padgett, & Adolphs, 2002; Smith, Cottrell, Gosselin, & Schyns, 2005). Elle peut pourtant ne pas être suffisante pour interpréter les expressions faciales moins prototypiques et plus réalistes. Dans ces situations, l'observateur aura besoin d'autres sources d'information non-visuelle. Il est possible de recourir à des *croyances ou stéréotypes* pour prédire la signification du sourire chez une personne et dans une situation donnée (Hess, Adams, Kleck, 2005; Kirouac & Hess, 1999; Niedenthal, 2008). Par exemple, nous avons tendance à penser que les sourires des commerciaux ne sont pas forcément sincères. Ces connaissances peuvent influencer les processus de base liés au traitement des expressions faciales (pour exemple, Halberstadt & Niedenthal, 2001; Halberstadt, Winkielman, Niedenthal, & Dalle, 2009; Hess & Thibault, 2009; Mermillod et al., 2013). Enfin, les sourires et d'autres expressions faciales peuvent être interprétés grâce à la *simulation incarnée*, c'est-à-dire une représentation active de l'état émotionnel de l'autre, générée chez l'observateur par ses circuits de récompense ainsi que par les systèmes moteurs et somatosensoriels (pour exemple, Adolphs et al., 2000; Decety & Chaminade, 2003; Gallese, 2005; Goldman & Sripada, 2005; Keysers & Gazzola, 2007; Niedenthal, 2007; Pitcher, Garrido, Walsh, & Duchaine, 2008).

La simulation incarnée est le concept-clé du modèle SIMS de Niedenthal et al. (2010). Selon ces auteurs, si la reconnaissance d'un sourire peut se faire à l'aide de stratégies différentes, seule la simulation permet de partager l'état émotionnel de la personne qui sourit ainsi que de juger les expressions faciales complexes, nuancées et importantes pour l'observateur. C'est également la seule voie d'interprétation susceptible de changer les émotions de l'observateur. Dans ce cadre, deux comportements – le mimétisme facial et le

contact visuel – peuvent être spécialement importants dans l’interprétation des expressions faciales.

Le terme du mimétisme facial désigne les contractions visibles ou invisibles des muscles faciaux afin de reproduire l’expression faciale de l’autre personne (Dimberg & Thunberg, 1998). Le fait d’imiter cette expression ajoute une composante proprioceptive à la représentation de l’état émotionnel de l’autre. Un nombre croissant d’études suggère que le mimétisme facial non seulement influence le ressenti émotionnel de l’observateur mais aide aussi la reconnaissance de l’expression faciale et le traitement de l’information émotionnelle en général (Havas, Glenberg, Gutowski, Lucarelli, & Davidson, 2010; Maringer, Krumhuber, Fischer & Niedenthal, 2011; Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001; Oberman, Winkielman, & Ramachandran, 2007; Ponari, Conson, D’Amico, Grossi, & Trojano, 2012; Stel & Knippenberg, 2008; Strack, Martin, & Stepper, 1988).

Le deuxième comportement potentiellement important pour l’interprétation des expressions faciales est le contact visuel ou l’échange de regards. Selon le modèle SIMS, le contact visuel suffit pour déclencher la simulation incarnée, sans pour autant être nécessaire à cette simulation. En effet, il s’agit d’un signal social puissant qui dirige les ressources attentionnelles vers l’interaction (George & Conty, 2008; Stein, Senju, Peelen, & Sterzer, 2011) et augmente les motivations d’approche (Hietanen, Leppanen, Peltola, Linna-aho, & Ruuhiala, 2008). Le contact visuel joue un rôle important dans l’attraction (Walsh & Hewitt, 1985; Guéguen, Fischer-Lokou, Lefebvre, & Lamy, 2008), l’intimité (Iizuka, 1992) et l’attachement (Lohaus, Keller, & Voelker, 2001). Les messages émotionnels forts sont accompagnés davantage de contacts visuels que les messages de faible intensité (Kimble & Olszewski, 1980). Enfin, les expériences de Bavelas, Black, Lemery et Mullett (1986) et Schrammel, Pannasch, Graupner, Mojzisch et Velichovsky (2009) ont mis en évidence le lien

entre le contact visuel et le mimétisme facial, montrant que les expressions faciales déclenchent plus d'imitation lorsqu'il y a échange de regards.

Le but de nos trois premières études (**Chapitre 2**) a été de tester le rôle du contact visuel en tant que déclencheur du processus de simulation incarnée des sourires, lesquelles étaient présentées sur des peintures et des photographies. Nous avons prédit que, si l'échange des regards contribue à la simulation incarnée, les sourires accompagnés du contact visuel (ou regard direct) provoqueront chez l'observateur plus d'émotion et seront plus imités que les sourires accompagnés du regard dirigé qui ne permet pas le contact visuel. Les participants de l'Étude 1 (**Chapitre 2.2**) ont évalué l'impact émotionnel des portraits de différentes époques, choisis pour représenter différentes intensités de sourire et différentes orientations du regard. Les portraits montrant les personnes souriantes avec un regard direct, qui donnait l'illusion du contact visuel, ont suscité plus d'impact émotionnel que les portraits des personnes souriantes dont le regard était dirigé à gauche ou à droite. Dans l'Étude 2 (**Chapitre 2.3**), nous avons manipulé le contact visuel. Les participants évaluaient la positivité et l'authenticité des sourires présentées sur les photographies. Le regard des modèles était direct, de sorte que le contact visuel soit possible, ou bien dirigé à droite ou à gauche de sorte que ce contact ne soit pas possible. L'analyse des résultats a révélé que les mêmes sourires des mêmes modèles ont été jugés comme plus positifs et plus authentiques lorsqu'ils étaient accompagnés du contact visuel, plutôt que d'un regard dirigé. L'Étude 3 (**Chapitre 2.4**) a employé un autre indicateur de simulation incarnée – le mimétisme facial, opérationnalisé par l'activité du muscle grand zygomatique. La contraction de ce muscle étire les commissures de la bouche et produit un sourire. Nous avons enregistré l'électromyogramme (EMG) du muscle lorsque les participants observaient les photographies des sourires identiques à celles utilisées dans l'Étude 2 et évaluaient la positivité des sourires en question. Encore une fois, les sourires accompagnés du contact visuel ont été évalués comme étant plus positifs que les sourires accompagnés du

regard dirigé. Ils suscitaient aussi plus de mimétisme facial. L'activité du muscle zygomatique des participants a donc été significativement plus élevée lorsqu'ils observaient les sourires en pouvant échanger le regard avec les modèles. Les résultats de ces trois études supportent donc les prédictions du modèle SIMS et soulignent l'importance du contact visuel dans l'interprétation des expressions faciales, en tant que déclencheur potentiel de la simulation incarnée et du mimétisme facial.

Cela étant dit, le rôle du mimétisme dans la perception et le jugement des sourires – et d'autres expressions – n'a pas encore été pleinement expliqué (Hess & Fischer, 2013; Hess & Fischer, 2014). Les études existantes suggèrent que l'inhibition de l'activité faciale par des moyens mécaniques, tel que l'instruction de tenir un stylo horizontalement dans la bouche, détériore la reconnaissance et le traitement des expressions faciales (Niedenthal et al., 2001 ; Oberman et al., 2007; Ponari et al., 2012). En particulier, les expériences de Maringer et collègues (2011) ont montré que l'inhibition du mimétisme facial des participants à l'aide d'un stylo les rendait incapables de distinguer les vrais sourires des faux. Ce jugement a pourtant été possible pour les participants qui ont pu imiter les sourires observés. Le but d'une deuxième série d'études (**Chapitre 3.1**) a été de répliquer les résultats obtenus par Maringer et al. (2011) en bloquant le mimétisme facial avec une méthode différente, et en utilisant les conditions contrôles permettant des conclusions plus fermes. Contrairement à la recherche de Maringer et ses collègues, nous avons utilisé comme stimuli les enregistrements réalistes des sourires humains plutôt que les animations représentant les sourires des agents animés. L'Expérience 1 (**Chapitre 3.1.2**) a testé si un protège-dents de sport permet une inhibition efficace du mimétisme des sourires. Nous avons enregistré l'EMG du muscle zygomatique des participants lorsqu'ils regardaient les vidéos des sourires, avec ou sans protège-dents dans leur bouche. L'analyse des résultats a révélé que les observateurs imitaient plus les sourires vrais que les sourires faux. Cette différence n'était pourtant plus significative lorsque le

mimétisme facial était bloqué avec le protège-dents. Ensuite, nous avons comparé l'activité zygomatique des participants aux mouvements faciaux des sourires observés. Ceci a été possible grâce au logiciel CERT (Computer Expression Recognition Toolbox, Littlewort et al., 2011) permettant un codage automatique des mouvements faciaux. Lorsque les participants ne portaient pas de protège-dents, leur activité zygomatique était corrélée avec les mesures des mouvements faciaux dans les sourires présentés. En revanche, quand les participants utilisaient un protège-dents, leurs mouvements faciaux n'étaient plus similaires à ceux présents dans les vidéos. Dans les Expériences 2 et 3 (**Chapitre 3.1.3 et 3.1.4**), nous avons employé cette technique afin de tester les conséquences d'inhibition du mimétisme facial. Les participants ont été aléatoirement assignés à des conditions expérimentales dans lesquelles ils portaient un protège-dents, ou dans lesquelles ils pouvaient imiter les sourires observés – soit sans rien faire, soit en serrant une balle anti-stress, soit avec un capteur de fréquence cardiaque attaché à leur doigt. Contrairement à d'autres conditions, l'inhibition du mimétisme facial avec le protège-dents a perturbé les jugements d'authenticité des sourires, en diminuant la différence entre vrais et faux sourires. Les trois études contribuent à un corps de recherche qui met en évidence le lien entre l'activité faciale et le traitement de l'information émotionnelle. Plus précisément, le fait d'occuper les muscles du visage par des procédures expérimentales peut réduire la capacité de juger correctement les émotions des autres.

La question qui s'impose est de savoir si les conséquences négatives de l'inhibition du mimétisme peuvent être observées dans des contextes plus réalistes. L'usage de la tétine chez les bébés constitue un cas très intéressant de modification des réponses faciales en dehors du laboratoire. Premièrement, le fait de sucer la tétine engage des muscles faciaux de manière très similaire à certaines manipulations de laboratoire (Strack et al., 1988; Oberman et al., 2007). Deuxièmement, l'altération des réponses faciales des bébés peut être prolongée et

répétée. Finalement, la tétine est utilisée à l'âge où les bébés apprennent à comprendre et imiter les expressions faciales, à interagir avec les autres et à réguler leurs propres émotions (Campos, Thein, & Owen, 2003; Fonagy, Gergely, Jurist, & Target, 2002; Jones, 2006; Lavallée, 2008). Il est donc possible que l'inhibition du mimétisme empêche les enfants de pleinement profiter de leurs premiers échanges sociaux et de développer les compétences nécessaires pour décoder les expressions émotionnelles. De plus, les enfants ayant utilisé la tétine pendant de longues périodes peuvent par la suite restreindre leurs réactions faciales de manière permanente. Étant donné l'implication du mimétisme dans le traitement de l'information émotionnelle, l'utilisation prolongée de la tétine par les bébés devrait avoir des effets délétères sur le développement de leurs compétences sociales.

Trois études ont testé ces prédictions (**Chapitre 3.2**). Dans l'Étude 1 (**Chapitre 3.2.2**), nous avons enregistré les visages des enfants lorsqu'ils regardaient des vidéos représentant les expressions faciales allant de la tristesse à la joie, et de la joie à la tristesse. L'analyse des résultats a montré que plus les enfants avaient utilisé la tétine dans le passé, moins ils imitaient les visages qu'ils voyaient. Cet effet fût néanmoins observé seulement chez les garçons. Les Études 2 et 3 (**Chapitre 3.2.3** et **3.2.4**) ont exploré des effets de la tétine à long terme. Nous avons examiné les niveaux d'empathie, d'intelligence émotionnelle et de l'anxiété-trait de jeunes adultes. La durée d'utilisation de la tétine était associée à une réduction des compétences émotionnelles. Encore une fois, cet effet était significatif chez les hommes mais pas chez les femmes. Ces différences peuvent être dues à la socialisation des enfants aux rôles de genre. Autrement dit, les filles – censées être plus émotionnelles et plus expressives que les garçons (Fischer, 2000) – sont plus encouragées à exprimer leurs émotions et à développer les compétences sociales. Il est possible que cette « éducation sentimentale » permette de réparer les effets néfastes de la tétine. D'autres recherches sont néanmoins nécessaires pour mieux comprendre ces différences ainsi que pour tester si l'usage

de la tétine influence le comportement d'adultes envers les bébés. En conclusion, même si ces études sont de nature corrélationnelle, la consistance de leurs résultats suggère une réelle implication de la tétine dans le développement du mimétisme et de l'intelligence émotionnelle. Dans l'ensemble, les expériences présentées dans le **Chapitre 3** mettent donc en évidence le rôle des réactions faciales dans l'interprétation des expressions émotionnelles et dans la formation des compétences sociales. Ce rôle peut être particulièrement important lorsque les expressions sont nuancées et non-prototypiques, comme dans le cas des sourires.

A ce stade, il est important de noter que le mimétisme facial est un phénomène très complexe. Les recherches sur ce sujet produites dans les dernières années fournissent au moins autant de questions que de réponses (pour revue voir Hess & Fischer, 2013 et Hess & Fischer, 2014). Les principaux défis sont liés à la définition exacte du mimétisme, les manières de le mesurer et à la spécification de ce qui est imité – toutes les expressions faciales ou seulement celles à caractère positif ou prosocial. Une étude systématique des sourires peut s'avérer particulièrement utile pour répondre à ces questions. Il s'agit en effet d'expressions faciales fréquentes (Ekman, 1992) et souvent imitées (Hinsz & Tomhave, 1991). Leur production et leur imitation sont associées à une activité musculaire intense et facile à détecter (Oberman et al., 2007). Enfin, comme nous l'avons déjà mentionné, les sourires sont uniques dans leur capacité à transmettre des messages positifs et négatifs. Cette richesse de significations des différents sourires, ainsi que les nombreuses différences dans leur perception et leur production à travers les cultures, permettraient de générer des prédictions spécifiques sur le rôle du mimétisme facial et les conditions dans lesquelles il sera observé. Toutefois, pour cela, il est nécessaire de définir les différents types des sourires et les messages qu'ils communiquent. La distinction classique entre les sourires vrais et faux utilisée jusqu'à maintenant dans les études du mimétisme facial, ne reflète pas toute la complexité de ces expressions faciales, et peut s'avérer insuffisante pour une telle description.

Selon le modèle SIMS (2010), les sourires peuvent être divisés en trois grandes catégories basées sur leur fonction sociale. La première catégorie, *sourires de joie*, regroupe les expressions qui communiquent les émotions positives, comme le plaisir ou le bonheur. En voyant un sourire de ce type, l'observateur devrait ressentir du plaisir et penser que l'autre est content ou heureux. Les *sourires d'affiliation* manifesteraient les tendances prosociales, comme l'intention d'être poli ou de montrer la sympathie. Leur fonction est de créer et maintenir les liens sociaux. Enfin, les *sourires de domination* servent à communiquer le statut hiérarchique et la supériorité.

Les études présentées dans le **Chapitre 4** ont porté sur cette nouvelle typologie. Dans les deux premières études (**Chapitre 4.1**), nous nous sommes intéressés aux raisons qui sous-tendent l'expression des sourires et aux règles d'expression des émotions dans différents pays. Une des prédictions du modèle SIMS (Niedenthal et al., 2010) est que la culture peut influencer les processus de base qui déterminent la perception et la production des expressions faciales. Dans l'étude présentée ici, nous avons examiné plusieurs dimensions écologiques et culturelles afin d'expliquer les différences dans la communication non-verbale et dans la signification des sourires à travers le monde. En particulier, notre but était de tester le rôle de l'homogénéité historique, définie comme la stabilité démographique d'un pays pendant les 500 dernières années. Cette dimension a été décrite et quantifiée par Putterman et Weil (2010) sous forme d'une matrice détaillant, pour chaque pays, la proportion d'habitants dont les ancêtres vivaient sur le même territoire en l'an 1500. Ainsi, les pays homogènes, comme le Japon, la Norvège ou la Pologne sont principalement peuplés par les descendants d'habitants de ces pays en l'an 1500. En revanche, les populations des pays hétérogènes, tels que l'Argentine, la Nouvelle Zélande ou les États-Unis sont largement originaires de grands flux migratoires. Le concept d'homogénéité historique est particulièrement intéressant parce que, dans les populations hétérogènes, la cohabitation et la coopération en l'absence d'une

langue commune et de normes sociales partagées, pourraient favoriser l'expression directe des émotions ainsi que la communication des intentions prosociales. En effet, l'Étude 1 (**Chapitre 4.1.2**) a montré que dans un échantillon de 31 pays, l'hétérogénéité historique était associée à des normes sociales qui autorisent l'expression directe des émotions. Cet effet a été observé en contrôlant d'autres dimensions comme le collectivisme-individualisme (Hofstede, 1980; Markus & Kitayama, 1991; Triandis, 1995), la mobilité résidentielle (Oishi, Lun, & Sherman, 2007) et l'homogénéité de la population (Alesina, Devleeschauwer, Kurlat, & Wacziarg, 2003). Dans l'Étude 2 (**Chapitre 4.1.3**), les participants de neuf pays ont rempli un questionnaire examinant combien les différentes émotions et intentions constituent une bonne raison pour sourire. Leurs réponses quantitatives ont pu être réduites à trois dimensions compatibles avec les fonctions des sourires proposées dans le modèle SIMS. Le partitionnement des données par l'analyse de type « cluster » a divisé les participants en deux catégories. Dans la première catégorie, les scores des participants étaient plus élevés pour les motivations de joie et d'affiliation, et moins élevés pour les motivations de supériorité et de manipulation. Au niveau des pays, les proportions des participants dans ces catégories ont été fortement corrélées avec les mesures d'homogénéité historique, et ce même en contrôlant d'autres dimensions culturelles. Les émotions de joie et les intentions d'affiliation ont donc été des meilleures raisons pour sourire dans les pays historiquement hétérogènes que dans des pays homogènes. L'inverse s'est avéré vrai pour les motivations de supériorité et de manipulation, préférées dans les pays homogènes. Les résultats de ces deux études corroborent les prédictions du modèle SIMS et montrent que l'étude du passé démographique des pays peut constituer une approche fructueuse pour expliquer et prédire les différences culturelles dans l'usage des expressions faciales. Les réponses des participants de l'Étude 2 (**Chapitre 4.1.3**) suggèrent également que les raisons qui sous-tendent l'expression d'un sourire peuvent en effet être regroupées en trois catégories, correspondant aux sourires de

joie, d'affiliation et de dominance décrits par Niedenthal et collègues (2010). Ces résultats préliminaires nous ont permis de poursuivre l'investigation en se focalisant sur ces trois sourires fonctionnels afin d'explorer leur morphologies respectives.

Les études présentées dans le **Chapitre 4.2** ont employé une nouvelle procédure (Yu, Garrod, & Schyns, 2012) pour modéliser les mouvements faciaux associés à des sourires de joie, d'affiliation et de domination. Les participants ont regardé un grand nombre de vidéos représentant les expressions faciales des agents animés. Le muscle zygomatique (le muscle du sourire) était actif dans toutes les vidéos, d'autres mouvements faciaux ont été aléatoirement choisis par le logiciel et pouvaient varier d'une vidéo à l'autre. Spécifiquement, au cours de cet exercice, chaque participant devait visionner 2400 vidéos, et après chaque présentation, devait choisir le type de sourire présenté (i.e. « joie », « affiliation », « domination » et « autre ») et évaluer son intensité. L'analyse des réponses a permis de trouver les configurations des mouvements faciaux caractéristiques pour chacun des sourires. A partir de ces résultats, nous avons pu reconstruire les modèles de trois sourires, que d'autres participants ont correctement associées à la joie, à l'affiliation et à la domination.

Ces modèles peuvent ne pas correspondre à des sourires réels, mais ils nous informent sur les mouvements faciaux potentiellement révélateurs de différents sourires et, par conséquent, permettent une étude systématique des sourires de joie, d'affiliation et de domination observés dans la vie réelle.

En conclusion, le présent travail de thèse a exploré les mécanismes de production et de perception des expressions faciales sur l'exemple du sourire. Un total de neuf études corrélationnelles, comportementales et psychophysiologiques ont été réalisées et ont permis de mettre en évidence le rôle du contact visuel et du mimétisme facial dans la reconnaissance et l'interprétation des sourires et autres expressions. Plus précisément (**Chapitre 2**), les sourires accompagnés du contact visuel produisent un impact émotionnel plus important, sont

évalués comme plus positifs et provoquent des réactions faciales plus intenses que les sourires accompagnés du regard dirigé. Le fait que le contact visuel influence le mimétisme facial, ainsi que l'émotion ressentie et perçue, supporte nos prédictions et suggère que le contact visuel peut être suffisant pour déclencher la simulation incarnée. Il faut toutefois noter que d'autres études, mesurant précisément le contact visuel et utilisant d'autres indicateurs de simulation incarnée seront nécessaires pour étayer davantage ces conclusions et en générer d'autres potentiellement plus robustes.

De telles conclusions sont pourtant possibles dans l'interprétation des résultats des études que nous avons réalisées examinant le rôle du mimétisme facial dans l'interprétation des expressions émotionnelles (**Chapitre 3.1**) et le développement des compétences sociales (**Chapitre 3.2**). Premièrement, nous avons répliqué les expériences de Maringer et al., (2011) en montrant que l'inhibition du mimétisme facial a pour conséquence l'incapacité de distinguer les sourires vrais des faux. Nos trois études ont employé une nouvelle procédure – le port du protège-dents – pour inhiber les réactions faciales. De plus, nous avons opérationnalisé le mimétisme en tant que similarité entre les mouvements faciaux produits et perçus par les participants. L'activité zygomatique visible dans les stimuli a été extraite avec un logiciel d'analyse automatique des expressions faciales (CERT, Littlewort et al., 2011). Finalement, les conditions contrôles ont permis d'éliminer les explications alternatives et de confirmer que les difficultés à juger les sourires sont dues à l'inhibition du mimétisme plutôt qu'au manque de ressources attentionnelles chez les participants. Nous avons également testé les rôles du mimétisme facial en dehors du laboratoire, en examinant les effets d'utilisation de la tétine sur les réactions faciales des enfants et les compétences émotionnelles des adultes. La similarité des résultats de nos 3 études sur ce sujet suggère fortement que le fait de sucer la tétine par l'enfant occupe ses muscles faciaux de manière similaire à des manipulations de laboratoire, et a des conséquences beaucoup plus sérieuses, notamment pour les garçons.

Si le lien entre l'activité faciale et le traitement des expressions faciales est bien établi, il reste compliqué de déterminer quand le mimétisme facial est nécessaire pour juger ces expressions. Selon les prédictions du modèle SIMS (2010), la simulation incarnée et le mimétisme facial peuvent être particulièrement utiles dans l'interprétation des expressions nuancées qui sont importantes pour l'observateur. Le sourire et ses fonctions dans différentes cultures se prêtent particulièrement bien à ce type de questions de recherche. Dans la présente thèse (**Chapitre 4**), nous avons montré que les raisons pour sourire dans différentes cultures peuvent être regroupées en trois groupes correspondants aux sourires de joie, d'affiliation et de domination décrits dans le modèle SIMS. De plus, grâce à l'emploi d'une nouvelle technique (Yu et al., 2012), nous avons pu identifier les mouvements faciaux qui caractérisent ces trois sourires. Ce n'est qu'un début. Les descriptions de ces mouvements nous permettront d'explorer la morphologie et les paramètres dynamiques des sourires de joie, d'affiliation et de domination observés dans la vie réelle. L'utilisation de ces sourires en tant que stimuli permettrait de mieux définir les mécanismes et le rôle du mimétisme facial. Il s'agit de problèmes complexes, étant donné que le traitement des expressions émotionnelles dépend largement du contexte social et de la culture. Précisément, notre travail de thèse (**Chapitre 4.1**) montre que, dans les pays historiquement hétérogènes, les normes sociales autorisent une expression directe des émotions. Aussi, dans ces mêmes pays, les gens sourient plus pour communiquer l'affiliation ou la joie que dans les pays homogènes. Ces effets sont compatibles avec le modèle SIMS et suggèrent que l'hétérogénéité historique peut favoriser la simulation et l'imitation des expressions faciales. Une explication plausible est que, dans le passé, les habitants de pays hétérogènes ont dû apprendre à décoder les expressions faciales ambiguës et importantes, qui dans certains contextes étaient le seul moyen de communiquer. En somme, le présent travail de thèse montre l'importance du mimétisme et de la simulation incarnée dans le traitement des expressions faciales et dans le développement des

compétences émotionnelles. Il montre aussi que l'étude du sourire, l'expression la plus complexe, peut s'avérer particulièrement fructueuse pour mieux comprendre ces mécanismes à la base de l'interaction sociale.

LIST OF FIGURES

Chapter 1.....	27
Introduction	27
Figure 1.1. The SIMS model.....	30
Chapter 2.....	37
Triggering Embodied Simulation: The Role of Eye Contact	37
Figure 2.1. Variations in degree of smile	41
Figure 2.2. Smile with achieved eye contact and gaze averted to the left/right.	45
Figure 2.3. Change of zygomatic activity as a function of facial expression and gaze.	48
Chapter 3.....	52
Why Do We Mimic? Implications of Facial Mimicry for Smile Judgments and the Development of Social Competences	52
Figure 3.1.1. Genuineness ratings of true and false smiles in the free, blocked and muscle-control (squeeze ball) condition of Experiment 2..	66
Figure 3.1.2. Genuineness ratings of true and false smiles in the free (finger cuff), blocked and muscle-control (squeeze ball) condition of Experiment 3.....	68
Figure 3.2.1. Mimicry as a function of participant gender and length of pacifier use in Study 1.....	Erreur ! Signet non défini.
Figure 3.2.2. Perspective taking as a function of participant sex and pacifier use (coded yes/no) in Study 2.....	Erreur ! Signet non défini.
Figure 3.2.3. Emotional intelligence as a function of participant sex and length of pacifier use in Study 3.	Erreur ! Signet non défini.
Chapter 4.....	76
Beyond Authenticity: Functional Smiles and Their Endorsement Across Cultures	76
Figure 4.1.1. Respondents in Cluster 1 and Cluster 2 by country. Percentages are computed by averaging the TwoStep and K-means cluster solution.	Erreur ! Signet non défini.
Figure 4.1.2. Cluster centers – TwoStep algorithm.....	Erreur ! Signet non défini.
Figure 4.1.3. Endorsement of the reward, bonding and hierarchy motives as a function of historical homogeneity.	Erreur ! Signet non défini.
Figure 4.2.1. Modelling dynamic smiles.....	Erreur ! Signet non défini.
Figure 4.2.2. Reconstructions of the functional smiles based on the observers' ratings..	Erreur ! Signet non défini.

LIST OF TABLES

Chapter 3	52
Why Do We Mimic? Implications of Facial Mimicry for Smile Judgments and the Development of Social Competences	52
Table 3.1.1. Responses of Zygomaticus Major as a Function of Mimicry (free, blocked) and Smile Type (true, false) in Experiment 1.	61
Chapter 4	76
Beyond Authenticity: Functional Smiles and Their Endorsement Across Cultures	76
Table 4.1.1. Emotional expressivity and socioecological variables for 31 countries (based on Matsumoto et al., 2008).....	Erreur ! Signet non défini.
Table 4.1.2. Correlation matrix for emotional expressivity, historical homogeneity, and other cultural dimensions	Erreur ! Signet non défini.
Table 4.1.3. Cultural and socioecological variables : Study 2 ...	Erreur ! Signet non défini.
Table 4.2.1. Confusion matrices for the smile detection task. The rows correspond to smile types presented, and the columns to observers' responses.....	Erreur ! Signet non défini.
Appendix A	109
Table A. Final cluster centers for the three smile indexes (K-Means clustering).	111

CHAPTER 1

INTRODUCTION

*Your face, my thane, is as a book where men
May read strange matters.
- Shakespeare -*

In the social world, few things affect us to the same extent as faces and their expressions. We are deeply touched by smiles, furrows, and grimaces, especially when those whom we love display them. This is because facial movements directly inform us about others' feelings and intentions, and thereby influence our own emotions and behaviors. Our daily interactions thus depend on efficient perception and interpretation of these expressions. These processes are quick and largely unconscious. Some facial expressions, however, are more complex than others. This is certainly true for smiles. As stated Ekman, smiles are frequently displayed and easily produced (Ekman, 1992; Ekman et Friesen, 1982). They elicit positive impressions (Hess et al., 2002) such that smiling individuals are perceived to be warm (Bayes, 1972), attractive (McGinley et al., 1978), competent (Reis et al., 1990) and polite (Mueser, Grau, Sussman, & Rosen, 1984). These positive effects are not surprising given that the pleasure of seeing a smile might act as a powerful social reward (Shore & Heerey, 2011). Yet there is more to smiles than meets the eye.

1.1 So easy, yet so difficult: smiles and their multiple meanings

Admittedly, the main function of a smile is signaling happiness (Ekman, 1992, 1994). The association between smiles and positive emotions or traits is widely shared across cultures (Ekman, 1989; Ekman & Friesen, 1971; Frank & Stennett, 2001; Izard, 1971; Lau,

1982; Matsumoto & Kudoh, 1993; Otta et al., 1996) such that people consistently use the words “happiness” or “joy” to label the feelings underlying a smile, and associate smiling faces with joyful vignettes. Despite the stability of this association, smiles still confuse observers within and across cultures. Firstly, the display rules governing their expression may vary considerably from one country to another. For example, in Eastern countries, social norms restrict overt smiles to a greater extent than in Western countries (Matsumoto et al., 2008). In Japan, display rules prescribe smiling as a strategy to mask negative feelings (Matsumoto & Kudoh, 1993). Consequently, people who smile too much might be judged as dishonest or manipulative. In the same way, cheerfulness and smiling are highly valued among Americans but often perceived as superficial and fake in many other countries (Kotchemidova, 2005).

A second complication stems from the fact that, even within one culture, smiles are displayed in a wide variety of contexts. People smile to express joy, to encourage, and to signal affiliation or sympathy. Smiles also appear in negative situations such as sexual harassment (Woodzicka & LaFrance, 2001), being in pain (Kunz, Prkachin, & Lautenbacher, 2013) or seeing a decapitated rat (Landis, 1924). Indeed, Ekman (2001) identified 18 types of smiles and suggested that their total number might reach 50. All these different smiles vary in their facial morphology (Frank & Ekman, 1993), as well as in their behavioral and neural correlates (Ekman, Davidson, & Friesen, 1990; Fox & Davidson, 1988; Hess et al., 2002).

In addition, the meaning of a smile depends on the individual expressing the smile and on this individual’s characteristics; such as gender, race, age, and social group. Expectations and beliefs related to social status of this person and his/her group membership (Kirouac & Hess, 1999; Niedenthal, 2008) can influence early stages of facial expression processing, particularly when the meaning of smile is unclear (e.g., Halberstadt & Niedenthal 2001; Halberstadt et al., 2009). Smiles are thus misleading, and one can ask how – despite all the

complexities detailed above – observers still correctly decode the subtle meanings of smiles. This is a challenging question; hence studying the smile can be an interesting starting point for a better understanding of the production and perception of facial expressions.

1.2 Simulation of Smiles Model and routes to decode facial affect

The Simulation of Smiles Model (SIMS, Niedenthal et al., 2010), a theory of smiles and their processing, proposes specific predictions about how perceivers interpret smiles. According to the model, multiple processes may guide the observer's decoding of facial expressions. These processes are not mutually exclusive, and their recruitment depends on the task demands (Adolphs, 2002; Atkinson, 2007; Kirouac & Hess, 1999).

Observers can undoubtedly classify facial expressions on the basis of low-level perceptual cues (Smith et al., 2005), such as the shape of the mouth, the visibility of teeth, or the presence of crow's feet. The features of the perceived expression are integrated and then compared with the observer's prototypical representation of what the smile should look like. This pattern-matching strategy might be especially useful for simple categorization tasks, when observers are judging prototypical or intense facial expressions (Buck 1984). However, when the task is more challenging and involves the decoding of more realistic expressions, interpretation is likely to rely on non-visual information derived from stereotyped knowledge and expectations about the expresser and the social situation. For example, an ambiguous facial expression displayed by a female might be identified as a smile because of the social norm encouraging affiliative behaviors in women (Hess et al., 2005).

Finally, decoding the emotion underlying smiles can also rely on the embodied simulation processes (Decety & Chaminade, 2003; Gallese, 2005; Goldman & Sripada, 2005; Keysers & Gazzola, 2007). In this case, as shown in Figure 1.1, seeing a facial expression triggers an active representation – or simulation – of this expression in the motor, somatosensory, affective, and reward systems of the observer. Such representation then

guides the decoding of the expression's meaning. In other words, simulating an emotional facial expression produces bodily and affective states similar to those experienced by the person who displays the expression. Embodied simulation processes are likely to be recruited when the observed facial expression is important for the observer and ambiguous in its meaning.

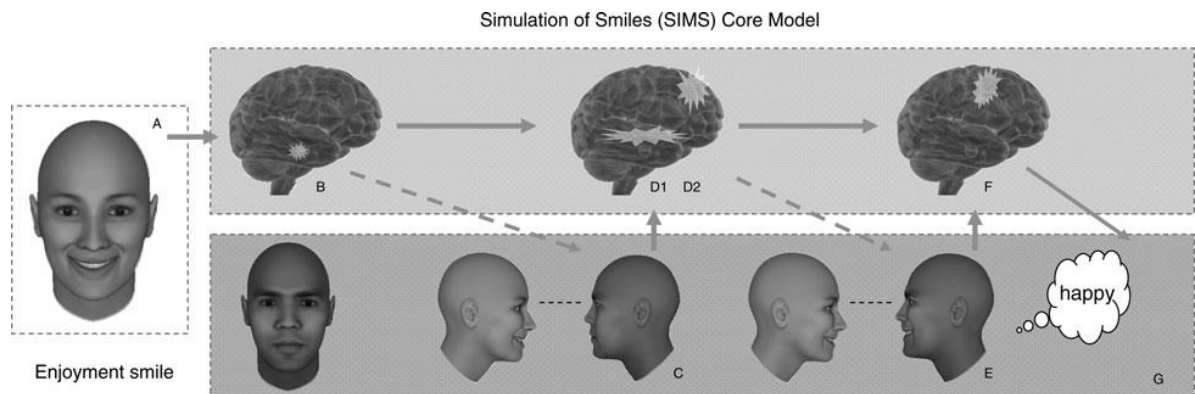


Figure 1.1. The SIMS model: the case of the embodied simulation of a smile A) presented such that the meaning is initially uncertain. The perception of the smile is accompanied by activation in the amygdala (B) which might enhance the probability of eye contact with the smiling person (C). Eye contact (proposed to be a trigger for embodied simulation) increases activation in the reward centers of the basal ganglia (D1) and in motor regions (Schilbach, Eickhoff, Mojzisch, & Vogeley, 2008) that support motor mimicry (E). These processes then produce bodily sensations in somatosensory cortex (F). On the basis of these neural activations and behaviors, the smile is judged as communicating enjoyment (G). Adapted from “The Simulation of Smiles (SIMS) model: Embodied simulation and the meaning of facial expression,” by P. M. Niedenthal, M. Mermillod, M. Maringer, and U. Hess, 2010, *Behavioral and Brain Sciences*, 33, p. 428. Copyright 2010 by Cambridge University Press. Adapted with permission.

1.3 The role of facial mimicry and eye contact

The SIMS model identifies two social behaviors important for embodied simulation (see Figure 1.1 for details). One of them is facial mimicry, defined as overt or covert facial responses of the perceiver that imitate the communicator's expression (Dimberg & Thunberg, 1998, Mojzisch et al., 2006; Schilbach et al., 2008). Imitating the perceived facial expressions is held to provide proprioceptive input necessary to simulate perceived facial expressions (McIntosh, 1996). An increasing body of research highlights the role of facial responses in emotional experience (Hennenlotter et al., 2009; Havas et al., 2010; Lewis & Bowler, 2009;

Sato, Fujimura, Kochiyama, & Suzuki, 2013) and in the processing of facial expression (Maringer et al., 2011 ; Niedenthal et al., 2001 ; Oberman et al., 2007 ; Ponari et al., 2012 ; Stel & Knippenberg, 2008 ; Strack et al., 1988). In particular, Maringer and colleagues (2011) found that participants whose mimicry was blocked with a pen-in-mouth procedure were unable to distinguish genuine from false smiles, whereas the same judgment was easy for participants who could freely mimic the perceived smiles.

The other important behavior involved in facial expression processing is eye contact, or the direction of one's gaze at another's eyes. The SIMS model holds that achieving eye contact automatically triggers embodied simulation and facial mimicry. This prediction is motivated by an extensive body of results linking eye contact to arousal and attention (Frischen, Bayliss, & Tipper, 2007; George & Conty, 2008), social closeness (Iizuka, 1992; Russo, 1975, Walsh & Hewitt, 1985), joint action (Sato & Itakura, 2013), and imitation (Wang, Newport, & Hamilton, 2011; Wang, Ramsey & Hamilton, 2011). Findings by Bavelas, Black, Lemery and Mullett (1986) showed a clear connection between eye contact and embodied simulation by demonstrating that mimicry of facial expressions of pain increased when participants could see the eyes of the suffering person. In a more recent study conducted by Schrammel et al. (2009), participants showed higher levels of mimicry and stronger affective reactions in response to facial expressions presented under conditions of eye contact than to facial expressions presented in the no-eye contact conditions.

1.4 Culture and the use of nonverbal behavior

According to the SIMS model, the use of specific routes to decode facial expressions also depends on the demands of the task. Specifically, whereas pattern-matching strategies should be effective in simple lower demand tasks, recruiting embodied simulation processes might be necessary during judgments of subtle or ambiguous facial expressions, especially if accurate interpretation of an expression is important for the observer. People might also rely

on conceptual emotion knowledge, based on beliefs and stereotypes about the meaning of a facial expression in a given situation. If the social context influences the processes used to judge facial expressions, it is reasonable to expect that different types of societal organization will promote specific routes to emotion recognition. Namely, for reasons related to immigration flow, some countries are composed of inhabitants coming from many different places. In these countries, the necessity of interacting with other people without a common language or shared customs and norms, might shape a social context in which facial expressions are crucial cues. They are indeed the main source of information for understanding other people's intentions and emotions. Given their critical social value, facial expressions might thus require deep, embodied processing in order to fully understand what the expresser feels.

On the other hand, when the same people inhabit the same territory over the centuries, they are used to imitating each other from birth. As a consequence, their facial expressions might become more similar, facilitating the judgments based on pattern-matching processes. Moreover, shared social norms and hierarchies provide information about others, making judgments of facial expressions less crucial. As a consequence, such societal stability should encourage use of either the conceptual knowledge-based route or the pattern-matching strategy. A careful examination of ecological and demographic variables that describe populations of different countries – such as ethnic homogeneity (Alesina et al., 2003), historical homogeneity (Putterman & Weil, 2010), or residential mobility (Oishi, 2010) – and a comparison of these variables to the measures of emotional expressivity might shed more light on the predictions described above.

1.5 A social functional classification of smiles

As suggested above, smiles are especially interesting for examining questions about embodied simulation, facial mimicry, and their possible triggers. These facial expressions are

frequently mimicked (Hinsz & Tomhave, 1991), and their mimicry elicits strong, easily measurable facial activity (Oberman et al., 2007). Most importantly, however, smiles are unique because they can express a wide range of messages. In order to further advance our knowledge on processing of smiles, we need to know what is mimicked or triggered, and create a systematic description of the existing smile types. To date, studies examining facial mimicry of smiles operationalized them as a single class (Oberman et al., 2007; Ponari et al., 2012), or used the distinction between true (spontaneous) and false (deliberate) smiles (Maringer et al., 2011). This distinction, extensively documented in the literature, is mostly based on the amount of eye constriction (the so-called Duchenne marker, Duchenne, 1862; Frank, Ekman, Friesen, 1993) or the time course of the smile (Krumhuber & Kappas, 2005). True and false smiles are therefore well described and easy to operationalize by controlling the presence of the Duchenne marker or by manipulating temporal parameters of a given smile. We believe, nonetheless, that classifying smiles on the sole basis of their genuineness fails to account for the complexity of these facial expressions. Consequently, the true-false distinction of smiles might be insufficient to explore questions related to embodied simulation and facial mimicry.

According to the SIMS model, smiles communicate emotions (Ekman, 1972) along with social motives and behavioral intentions (Fridlund, 1994; Jakobs, Manstead, & Fischer, 1999). On this basis, they can be classified into three large categories: pleasure, affiliative, and dominance smiles. Pleasure smiles correspond to the smiles described in the literature as true or genuine (Duchenne, 1862; Frank et al., 1993; Krumhuber & Manstead, 2009). This relatively homogeneous and well-defined class of expressions (Frank et al., 1993) communicates positive internal states generated by social or sensory experience. The function of affiliative smiles is to build and maintain social bonds (Cashdan, 2004; Fridlund, 1991; 2002). This second category may include several subclasses, such as greeting (Eibl-Eibesfeld,

1972), embarrassed (Keltner, 1995; Hess et al., 2002), and reassurance smiles (Fischer, Becker, & Veenstra, 2012; Kunz et al., 2013), as well as other displays conveying appeasement and prosocial intentions. Finally, dominance smiles communicate one's superior or secure status in a given hierarchy. Unlike the two previous categories, dominance smiles may elicit withdrawal and a negative affect (Davidson, Ekman, Saron, Senulis, & Friesen, 1990). Displays of contempt (Ekman & Friesen, 1986), derision (Carranza, Prentice, Larsen, 2009), pride (Tracy & Robins, 2008) and all types of derisive or sardonic smiles (Darwin, 1872) are possible candidates for this category. It is worth noting that the three categories of smiles described in the SIMS model (2010) are neither completely distinct nor definitive. The validity of the typology needs to be assessed in future studies. It should also be possible to construct a visual description of facial movements involved in pleasure, affiliative and dominance smiles, allowing further examination of the social functions of these smiles.

1.6 Goals of the dissertation

To summarize, the SIMS model offers a theoretical framework that details the mechanisms underlying production and perception of facial expressions with regard to smiles. In particular, the model describes three types of processes recruited by the observers to decode facial expressions, and links their use to specific social situations. Niedenthal and colleagues (2010); nevertheless, focused on one process in particular, namely, on the embodied simulation. As defined above, this simulation is a “representation” of a perceived expression in the body's periphery as well as central motor, somatosensory, affective and reward system. This process allows the perceiver to experience the bodily feeling and the affective state of the other. Compared to the other routes to decode facial affect, embodied simulation would allow an accurate interpretation of ambiguous expressions such as smiles. As we have suggested, this deep, motivated processing might be mediated by two social behaviors: eye contact and facial mimicry. While eye contact is described as a sufficient

(although not necessary) trigger of embodied simulation, facial mimicry is likely to provide bodily input into the simulated representation and to help accurate judgments of smiles. In addition, the occurrence of these two behaviors – and of the related processes of embodied simulation – depends largely on task demands and social context. A novel typology of functional smiles described by Niedenthal and colleagues (2010) provides a paradigm for testing these influences which is arguably more useful than the classic distinction between true and false smiles. This is because all three functional smiles are held to be caused by both internal states and social motivations. For example, the affiliative smiles combine the motivation to communicate positive feelings with specific contexts (e.g. Fischer et al., 2012) and cannot be dismissed as false.

To conclude, this dissertation is composed of five manuscripts published in or submitted to peer-reviewed journals, and contains 12 studies that aimed to test four main predictions of the SIMS model: (1) Achieved eye contact triggers embodied simulation and facial mimicry (**Chapter 2**), (2) Facial mimicry supports the accurate decoding of smiles and other facial expressions (**Chapter 3**), (3) Culture moderates the basic processes proposed in SIMS (**Chapter 4**), (4) There are three functionally discrete types of smiles which convey pleasure, affiliation and dominance (**Chapter 4**).

Chapter 2 included therefore 3 experiments testing the hypothesis that eye contact – displayed in paintings or in photographs – is sufficient to trigger embodied simulation and facial mimicry of smiles. These two processes were measured with self-reports (ratings of emotional impact, positivity, and genuineness) and psychophysiological indicators, i.e., electromyographic (EMG) recordings of the zygomaticus major muscle.

Based on our results (**Chapter 2**), and the extensive literature linking mimicry with emotional expression and experience, **Chapter 3** presents our hypotheses according to which motor imitation is necessary for generating the felt meaning of a specific facial display.

Chapter 3 thus describes 6 different studies. Especially, **Chapter 3.1** reports three experiments testing the role of facial mimicry in the judgments of smiles. Three other studies presented in **Chapter 3.2** examine the consequences of blocking mimicry during the stages of development that are critical for the emergence of social skills.

According to the SIMS model (2010), the recruitment of facial mimicry to decode emotional expressions varies as a function of the social context and the facial expression itself. **Chapter 4** thus reports 2 studies that attempted to identify cultural and ecological dimensions relevant to emotional expressivity and smile behavior. Moreover, they examine the validity of a novel social-functional typology of smiles with a cross-cultural survey assessing people's beliefs about valid reasons for smiling. Finally, the goal of the third and final study described in **Chapter 4** was to describe the facial movements involved in each of the three functional smiles described in the SIMS model (Niedenthal et al., 2010).

CHAPTER 2

TRIGGERING EMBODIED SIMULATION: THE ROLE OF EYE CONTACT

There is a road from the eye to the heart that does not go through the intellect.

- G. K. Chesterton -

2.1 Introduction

Understanding the subtle meaning of facial expression is a daily challenge, and the smile might be the most challenging of expressions. While it is true that prototypical smiles are universally recognized as signs of joy (Ekman, 1994; Frank & Stennett, 2001; Izard, 1971), suggesting that this expression is easily interpreted, other research (Abe, Beetham, & Izard, 2002; Ekman & Friesen, 1982) attests to its complexity.

How do people understand a smile? This question is addressed in the Simulation of Smiles (SIMS) Model, recently proposed by Niedenthal et al. (2010). The present research was conducted in order to test a specific hypothesis generated by the SIMS, namely that eye contact is a sufficient trigger for embodied simulation of smiles.

2.1.1 The Simulation of Smiles (SIMS) Model

The SIMS model integrates social psychological research with recent findings in neuroscience in order to propose how the specific meaning of a smile is arrived at. According to the SIMS, three operations can be used to process smiles: perceptual analysis (matching the smile to representations of prototypical smiles), top-down application of beliefs and stereotypes, and embodied simulation.

Embodied simulation refers to partial *reenacting* of a corresponding state in the motor, somatosensory, affective and reward systems. This reenacting represents the meaning of the expression to the perceiver (Gallese, 2003; Decety & Sommerville, 2003; Niedenthal, 2007) *as if* she was in the place of the smiling person. The perception of a smile is therefore accompanied by the bodily and affective states associated with the production of this facial expression. In addition to the affective state, an important part of the embodied simulation of a smile is facial mimicry. We define facial mimicry as the visible or non-visible use of facial musculature by an observer to imitate another person's facial expression (Niedenthal et al., 2010).

The important role of the facial mimicry was suggested by the findings of Stel and van Knippenberg (2008). They showed that inhibiting facial mimicry decreased the speed of judging facial displays as expressing positive or negative emotion. In another study, Maringer et al. (2011) showed that inhibition of facial mimicry impaired the distinction between genuine and nongenuine smiles. A recent study by Neal and Chartrand (2011) further bolsters this conclusion, showing that amplifying facial mimicry improves one's ability to read others' facial emotions.

Although parts of embodied simulation, such as facial mimicry, appear to be helpful in forming an accurate understanding of facial expression, what is less clear are the conditions under which embodied simulation occurs. According to the SIMS model, a sufficient though not necessary trigger for embodied simulation is the achievement of eye contact with the individual displaying the expression.

2.1.2 Eye contact as a trigger to simulation

Both developmental research (Farroni, Csibra, Simion, & Johnson, 2002; Hains & Muir, 1996; Lohaus, Keller, & Voelker, 2001) and work on intimacy (Iizuka, 1992; Russo, 1975) provide hints of the role of eye contact in embodied simulation of emotion. This role is more

explicitly indicated by the findings of Bavelas, Black, Lemery, and Mullett (1986) on the perception of pain expressions. There, a confederate faked the experience of pain and expressed the pain facially. Further, he made eye contact with some of the participants but not others. Eye contact significantly affected participants' reactions: they mimicked the confederate's expressions most clearly when eye contact with the confederate was made. Relatedly, Schrammel and colleagues (2009) showed that participants' zygomatic major muscle activity was stronger when viewing happy faces than neutral faces, and, most importantly, facial expression had an effect only under conditions of eye contact. These results suggest a close link between eye contact and facial mimicry.

In the present three studies, our aim was to test the SIMS model's specific hypothesis that eye contact is a trigger of embodied simulation of the smile. The first study relied on existing portraiture paintings. We selected portraits of subjects who achieved different degrees of eye contact with the viewer, and who expressed smiles. Participants saw each portrait twice. On one exposure the participant viewed the full portrait; on the other exposure the eyes of the portrait subject were obscured. The indicator of embodied simulation was the participant's rating of the emotional impact of the painting. Since embodied simulation is related to affective change, the more a smile is embodied in the self, the more the viewer should report an emotional response to the portrait. If the eye-contact-as-trigger hypothesis is correct, then the emotional impact of the portrait should be significantly greater when the eyes are unmasked versus masked, and this should be particularly true if the viewer achieves eye contact with the portrait on the unmasked trial. In contrast, if participants were using a perceptual analysis for decoding the smile, then seeing the eyes per se would be important, but level of eye contact would be irrelevant to personal feelings of emotion.

2.2 Study 1

2.2.1 Method

Participants. Undergraduates (101 female, 13 male) from two medium-size universities participated in exchange for course credit. Data from 6 participants were discarded because they were incomplete or because they failed to follow instructions.

Stimuli. Paintings were selected from art archive internet sites by a research assistant who was blind to the hypotheses. Criteria that guided the selection of potential target portraits included that the portrait showed a frontal and not profile view, and that the eyes were clearly visible. Neither portraits of celebrities nor very famous portraits were included in the final set. The 16 target portraits were selected based on a pilot study involving 39 undergraduate students (27 female, 12 male) from a medium-sized university. Participants saw 32 smiling portraits and rated the extent to which they were certain that the subject of the portrait was actually smiling. Responses were made on scales from 0 (not at all sure) to 100 (very sure). The 16 portraits selected as targets were those for which the average ratings of certainty that the displayed expression was a smile were the highest ($M = 73.22$, $SD = 13.07$). Among the 16 targets, the level of eye contact varied substantially (see examples in Figure 2.1).

72 paintings from the 16th through 20th centuries, 56 distractors and 16 target portraits, constituted the final stimulus set¹. The distractors (portraits, landscapes, and still life works) were included to minimize demand characteristics.

A mask (pattern: small checkerboard, colors: 98, 92, 56 and 181, 188, 146 RGB) obscured the eyes for one presentation of all 32 portraits (i.e., both target and distractor portraits, see Figure 2.1, bottom panel). Four mask sizes (128 by 22 pixels, 158 by 22 pixels, 189 by 45 pixels and 242 by 60 pixels) were used, depending on the face area proportions.

¹ Stimuli are available on-line at : <https://www.dropbox.com/s/q48il7ti6cse7ui/Study%201.zip>

Masks did not systematically cover any particular portion of the eye area but always obscured eye gaze, and they were applied randomly to the landscape and still life paintings.



Figure 2.1. Variations in degree of smile, for unmasked (top row) and masked (bottom row) conditions.

Procedure. Participants were tested in pairs, but worked independently at individual computer stations. They were seated approximately 0.5 m from the screen (20", display resolution: 1280 x 768). The experiment was programmed in E-Prime Version 1.2 (1996-2006 Psychology Software Tools).

Each of the 72 paintings was presented twice (once masked and once unmasked) in a random order, with the constraint that one exposure occurred in the first, and the other in the second half of the trials. Stimuli were displayed on a black background. The inter-trial interval was 800 ms, during which participants saw a black screen.

For masked and unmasked presentations, target portraits were accompanied by the question, presented simultaneously at the bottom of the screen, "How emotional is the impact of the painting?" Participants responded by positioning a cursor on a bar ranging from 0 (no

emotion) to 100 (a lot of emotion). Positive emotion was not mentioned in the question in order to minimize demand characteristics. For half of the distractors, a filler question appeared and the other half was presented without a question.

In the second part of the experiment, participants saw the 16 target portraits again. This time they rated the amount of perceived eye contact (“How much eye contact does the subject establish with you as the viewer?”) using the scale described above (cursor bar ranging from 0, no eye contact to 100, a lot of eye contact). At the end of the session the experimenter debriefed the participants and probed for suspicion.

2.2.2 Results

We first divided the target portraits into two groups, based on a median split of the eye contact ratings averaged across subjects: portraits achieving eye contact and portraits not achieving eye contact.

Ratings of emotional impact were then submitted to a 2 (mask: masked vs. unmasked) x 2 (eye contact: achieved or not achieved) repeated-measures ANOVA. Unsurprisingly, there was a main effect of mask, $F(1,107) = 92.05, p < .001$, such that emotional impact was higher for unmasked ($M = 54.02, SD = 16.83$) than for masked portraits ($M = 42.97, SD = 15.64, d = 0.93$). Emotional impact also varied as a function of eye contact, $F(1,107) = 117.80, p < .001$, such that portraits that achieved eye contact had more emotional impact on the observer than portraits that did not achieve eye contact ($M = 53.63, SD = 15.84, M = 43.36, SD = 15.93, d = 1.04$). However, as predicted, mask interacted with eye contact, $F(1,107) = 17.76, p < .001$, such that the difference between the emotional impact of masked and unmasked trials was higher for portraits achieving eye contact ($M = 13.09, SD = 12.57$) than for smiles that did not achieve eye contact ($M = 9.00, SD = 13.39, d = 0.41$).

The dichotomization of continuous variables is a controversial practice, which decreases the statistical power (Brauer, 2002). We therefore reanalyzed the data using eye contact as a

continuous variable. Since participants rated the emotional impact of each of the 16 target portraits twice, impact ratings could not be considered independent. Therefore, we used hierarchical modeling (HLM software, version 6.06, Raudenbush, Bryk, Cheong, & Congdon, 2004) with portraits as the level-1 units and participants as level-2 units. There were a total of 1728 observations. The intercept was allowed to vary randomly. Mask and eye contact were specified as predictors.

Analysis of the main effects revealed the expected effect of mask, $t(107) = 9.93$, $p < .001$, such that the emotional impact of unmasked portraits was higher than the impact of masked portraits. Also, emotional impact significantly increased with eye contact, $t(1726) = 11.18$, $p < .001$. Most importantly, mask interacted with eye contact, $t(1726) = 4.43$, $p < .001$, such that the difference between masked and unmasked trials was greatest for portraits achieving high levels of eye contact.

2.2.3 Discussion

Our results are consistent with the hypothesis that eye contact triggers embodied simulation of smiles, estimated by the reported emotional impact of portraiture painting. This impact was greater when the subject's eyes were visible, versus when masked. More importantly, the difference was significantly greater when eye contact was achieved. Facial mimicry and the production of a corresponding emotional state are two components of embodied simulation. Our finding complements other results in the literature that demonstrate eye contact is associated with greater facial mimicry (Bavelas et al., 1986; Schrammel et al., 2009).

A limitation of Study 1 was that although we experimentally manipulated whether or not the eyes were visible, we did not manipulate eye contact. Further, we used one indicator of simulation – emotional impact. In Study 2 we tried to address these limitations by manipulating eye contact and using a different measure of embodied simulation, namely,

ratings of positivity and genuineness of smiles. We were inspired by past research showing that smiles judged as genuine are related to greater facial mimicry and positive feelings in the perceiver (Ekman & Davidson, 1993; Soussignan, 2002). If eye contact is a trigger of embodied simulation, ratings of positivity and genuineness of smiles should be higher under conditions of achieved eye contact.

2.3 Study 2

2.3.1 Method

Participants. 41 undergraduates (40 females, 1 male) from a medium-sized university took part in exchange for course credit. Data from 4 participants were discarded from further analyses due to their failure to follow instructions.

Materials. 72 photographs of smiles were developed for the study. 12 models (6 female, 6 male) were photographed by a professional photographer in the presence of an expert on facial expression of emotion. The expert used standard instructions (Ekman & Davidson, 1993) for eliciting Duchenne and non-Duchenne smiles. Each model was photographed smiling with three levels of eye contact: direct gaze (high eye contact), left averted and right averted gaze (see Figure 2.2).

Procedure. Participants were tested in pairs, but worked independently. They were exposed to each of the 72 photographs² (screen size: 20", display resolution: 1280 x 768, picture size: 380 by 475 pixels) for 1500 msec. Their task was to rate the degree to which they perceived the smile to be genuine on a scale ranging from 0 (*not genuine at all*) to 100 (*very genuine*), and the degree to which they perceived the smile to be positive on a scale ranging from 0 (*not at all positive*) to 100 (*very positive*).

² Stimuli are available on-line at : <https://www.dropbox.com/s/wvoead207bhljc9/Study%202.zip>



Figure 2.2. Smile with achieved eye contact and gaze averted to the left/right.

2.3.2 Results

Two one-way ANOVAs were conducted with gaze (eye contact or averted) as the independent variable, and genuineness and positivity as the dependent variables. There was a main effect of gaze on ratings of genuineness such that smiles with eye contact were judged as more genuine ($M = 60.99$, $SD = 11.21$) than smiles with averted gaze ($M = 58.93$, $SD = 10.08$), $t(36) = 2.47$, $p = .018$, $d = 0.42$. This was also true for positivity: smiles that achieved eye contact were rated as significantly more positive ($M = 64.29$, $SD = 11.68$) than smiles with averted gaze ($M = 60.54$, $SD = 10.31$), $t(36) = 4.76$, $p < .001$, $d = 0.81$. Mediation analyses indicated that the effect of eye contact on genuineness disappeared when controlling for positivity, $F(1,34) = 1.73$, $p > .1$. However, the effect of eye contact on positivity was still significant over and above the differences in ratings of genuineness, $F(1,34) = 16.19$, $p < .001$. This is consistent with complete mediation, such that the increased perceived genuineness of smiles that make eye contact was largely determined by the increased feelings of positive emotion generated by such smiles.

2.3.3 Discussion

The present study used an experimental manipulation of eye contact and found that eye contact was related to higher ratings of both positivity and genuineness, for both Duchenne and non-Duchenne smiles. In light of past findings on the extent to which “genuine” smiles

produce physiological, bodily, and experiential signs of positive affect, we suggest that the present positivity ratings can be one valid indicator of emotional simulation. In our experiment ratings of positivity fully mediated the relationship between eye contact and perceived genuineness. This result suggests that judgments of the genuineness of smiles may not be based only on perceptual features of the smile, but also on the affective experience of the perceiver.

A limitation of these two studies is that only self-reported indicators of embodied simulation - emotional impact and ratings of positivity - were used. The aim of Study 3 was to address this limitation by adding a measure of facial mimicry. Participants' EMG activity was recorded while they were observing smiles in which eye contact was manipulated. If eye contact is a sufficient trigger of embodied simulation, smiles should be mimicked more when eye contact is achieved than when it is not.

2.4 Study 3

2.4.1 Method

Participants. A total of 27 female undergraduate students from a medium-size university participated in the experiment. They were recruited on campus and received 10 € compensation.

Materials. Experimental stimuli were prepared according to the parameters described in Study 2. This time, participants saw photographs of 6 models (3 female, 3 male) displaying facial expressions (neutral or smiling) and two levels of eye contact (eye contact achieved, and averted gaze – no eye contact) for a total of 24 facial stimuli³.

Procedure. Participants were tested individually. Facial stimuli were presented on a computer screen (screen size: 17", display resolution: 1024 x 768, picture size: 760 by 950 pixels) for 8 s. Each stimulus appeared three times in a random order, with the constraint that

³ Stimuli are available on-line at : <https://www.dropbox.com/s/he3m6el1mv5lyfe/Study%203.zip>

two photographs of the same face never occurred in succession. The inter-trial interval was 500 ms. Presentations began with a screen prompting participants to press the space bar when ready. Participants were told to imagine real interactions with models of the photographs.

Activity of the zygomatic major (ZM) muscle was recorded on the left side of the face, according to the established guidelines (Fridlund & Cacioppo, 1986) and using bipolar 10 mm Ag/AgCl surface-electrodes filled with SignaGel (Parker Laboratories Inc.). As a pretext for the placement of electrodes used to record ZM activity, participants were told that their brain waves would be recorded - and a dummy electrode was also placed in the center of the forehead.

The EMG raw signal was measured with the 16 Channel Bio Amp amplifier (ADInstruments, Inc.), digitized by a 16 bit analogue-to-digital converter (PowerLab 16/30, ADInstruments, Inc.), and stored with a sampling rate of 1000 Hz. Data were filtered with a 10-Hz high-pass filter, a 400-Hz low-pass filter, and a 50-Hz notch filter.

Next, participants saw the 24 photographs once again and rated the degree to which they perceived the facial expression to be positive on a scale ranging from 0 (*not at all positive*) to 100 (*very positive*), identical to the procedure used in Study 2. At the end of the session participants completed a questionnaire that tested their understanding of the task and probed for suspicion. These post-experiment responses indicated that the cover story was persuasive.

2.4.2 Results

EMG activity. The scores of interest were expressed as a difference in the mean activity during the last 500 ms before stimulus onset and the mean activity in the time window 500-1500 ms after stimulus onset. EMG data were subjected to 2 (facial expression: neutral, smile) x 2 (gaze: direct vs. averted) analyses of variance (ANOVA), with both expression and gaze as within subject factors.

Analysis of the main effects showed a significant main effect of expression such that ZM activity was higher for smiles than for neutral expression, $F(1,26) = 11.89, p = .002$. The interaction between expression and gaze was not significant $F(1,26) = 2.32, p > .1$, but post-hoc comparisons showed that smiling photographs achieving eye contact elicited higher ZM activity ($M = 49.89$ mV, $SD = 64.78$) than photographs with averted gaze ($M = 32.11$ mV, $SD = 52.50$), $t(1,26) = 2.54, p = .017, d = 0.52$, see Figure 2.3. This difference was not significant for neutral photographs ($M_{EC} = 6.04$ mV, $SD = 33.28$, $M_{Averted} = 3.63$ mV, $SD = 42.46$), $t(1,26) = 0.47, p > .5, d = 0.10$.

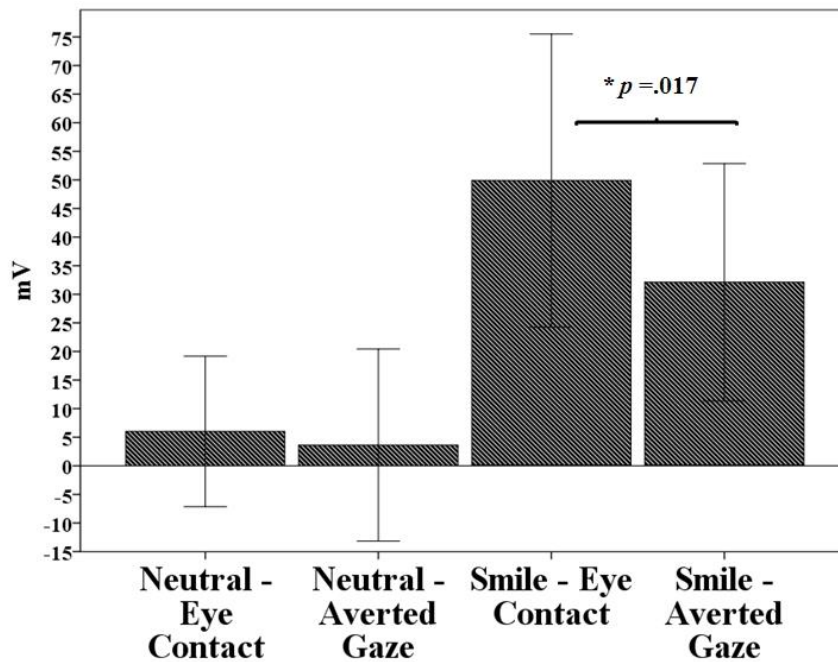


Figure 2.3. Mean change of zygomatic activity as a function of facial expression and gaze.

Ratings of positivity. Positivity scores were subjected to 2 x 2 analyses of variance with facial expression and gaze as within subject factors. A significant main effect of facial expression was found, $F(1,26) = 547.47, p < .001$. Not surprisingly, smiles ($M = 83.43, SD = 9.30$) were rated as significantly more positive than neutral facial expressions ($M = 24.61, SD = 12.84$), $t(26) = 23.40, p < .001, d = 4.62$. Again, the expression-gaze interaction was not significant, $F(1,26) = 0.36, p > .5$, but post-hoc comparisons showed that ratings of positivity

were significantly higher for smiling photographs achieving eye contact ($M = 84.93$, $SD = 8.48$) than for smiling photographs with averted gaze ($M = 81.93$, $SD = 11.03$), $p = .020$, $d = 0.51$. This difference was not significant for neutral photographs ($M_{EC} = 25.52$, $SD = 12.80$, $M_{Averted} = 23.70$, $SD = 13.76$), $t(1,26) = 1.38$, $p > .1$, $d = 0.27$.

2.4.3 Discussion

This study used a psychophysiological indicator of embodied simulation to supplement the self-reported measures used in Study 1 and 2. We found that smiles provoked greater zygomatic major activity under conditions of eye contact compared to averted gaze. These results are in line with the findings of Bavelas et al. (1986), where facial expressions of pain elicited greater mimicry in condition of eye contact than when eye contact was not achieved. Also, Schrammel et al. (2009) showed that smiles of animated virtual characters had an effect on participants' zygomatic activity only if the character directly turned towards the observer (and thus, when eye contact was achieved). At first pass these results seem contradictory to these obtained by Mojzisch et al. (2006), where participants smiled both in response to characters who made eye contact and those who were turned away. Note however that in this study mean zygomatic activity was (not significantly) higher for conditions where virtual characters gazed directly at participants, compared to when characters were turned away. It should be also mentioned that only males participated in the research of Mojzisch et al. (2006), whereas earlier EMG findings (Dimberg & Lundqvist, 1990) suggest that females show more a pronounced facial mimicry effect than males.

In Study 3, the main effect of gaze was *not* qualified by an interaction with facial expression, as was found by Schrammel et al. (2009). This may be due to the type of stimuli used in the two studies. Note that Schrammel and colleagues used dynamic sequences presenting virtual characters, while in our study participants observed photographs of real persons. Moreover, we specifically manipulated eye contact, while Schrammel et al. (2009)

varied the character's body orientation. The lack of significant interaction may be also due to an insufficient statistical power. The impact of eye contact on facial mimicry and possible moderations should be investigated in further studies involving more participants.

2.5 General discussion

The present studies were motivated by a prediction (Niedenthal et al., 2010), that eye contact is a sufficient trigger of embodied simulation of smiles. We used two types of stimuli – portraiture paintings and portrait photography – and three measures of embodied simulation: emotional impact, smile positivity and facial EMG. In the first study, achieved eye contact elicited more emotion than non-achieved eye contact. The second study showed that eye contact increased the perceived positivity and genuineness of smiles. Finally, the third study demonstrated eye contact is associated with greater imitation of smiles than averted gaze. Although our dependent measures are only parts of a complex phenomenon of embodied simulation, findings from these three studies support our prediction and highlight the importance of eye contact in the judgment of smiles. Moreover, these effects of mutual gaze can extend to other facial and bodily expressions (Wang et al., 2011).

Achieved eye contact is a powerful social signal. When perceiving direct gaze, people allocate their attentional resources to the interaction and engage in intensive processing of their interaction partners' faces (George & Conty, 2008). Eye contact has also been proposed to be a signal of approach motivation. For example, Adams and Kleck (2003; 2005) found that eye contact increased the recognition accuracy and perceived intensity of so-called approach-oriented emotions (i.e., anger and happiness). Such findings are neither completely consistent with, nor contradictory to the present account. We argue, however, that the effects of eye contact extend beyond mere attention and information, and involve emotional experience along with imitation of the interaction partner. Findings of the present studies are consistent with such a view. Moreover, the association between increased facial mimicry and

higher ratings of the positivity of smiles suggests a link between facial imitation and emotional experience. Motivated by these findings and by other recent research results (e.g., Maringer et al., 2011), in the subsequent chapter we explore the consequences of blocking facial mimicry in children and adults.

CHAPTER 3

WHY DO WE MIMIC? IMPLICATIONS OF FACIAL MIMICRY FOR SMILE JUDGMENTS AND THE DEVELOPMENT OF SOCIAL COMPETENCES

Stripped of the facial expression, the emotion just dies there, unshared.

- K. Bogart -

Along with eye contact, facial mimicry is another social behavior relevant for embodied simulation and emotion resonance. Embodied cognition theories claim that the afferent feedback generated by facial mimicry is integrated into a larger representation and used by the observers to decode the perceived facial expressions. Based on the substantial body of research implicating facial mimicry in emotion processing (e.g., Hennenlotter et al., 2009) and facial expression recognition (e.g., Neal & Chartrand, 2011), we hypothesized that blocking facial mimicry, both in the laboratory and in daily life, will negatively impact the decoding of subtle meanings of facial expressions and the development of emotional competences.

3.1. Blocking mimicry makes true and false smiles look the same

3.1.1 Introduction

Accurate judgment of other people's facial expressions is critical in everyday social interactions. Recent theories suggest that such judgments are sometimes subtended by automatic facial mimicry, defined as overt or covert imitation of perceived expression (Niedenthal et al., 2001; Niedenthal et al., 2010; Oberman et al., 2007). The claim is that automatic facial mimicry helps a perceiver internally simulate and re-experience an emotion

that corresponds to the perceived expression, thereby aiding in processes of recognition and interpretation (Niedenthal, 2007; Niedenthal, et al., 2010; Pitcher et al., 2008). This “embodiment” hypothesis derives from theories that hold that perception and action are tightly coupled, such that simulating a perceived action enables its perceptual encoding (Miellet, Hoogenboom, & Kessler, 2012; Proffitt, 2006; Vernon, 2008). The hypothesis has been supported by a handful of studies on the decoding of facial expression. For example, Oberman and colleagues (2007) blocked mimicry on the lower half of perceivers’ faces and observed poorer recognition of happiness and disgust expressions, but no difference for sadness or fear. Ponari, Conson, D’Amico, Grossi, and Trojano (2012, Study 1) replicated the findings for happiness and disgust, and further demonstrated that blocking mimicry of the upper face resulted in poorer recognition of anger. These results are impressive because participants of the experiments viewed and classified facial expressions that were prototypic, and thus easily categorized. In theory, people may be most served by embodied simulation when they are both highly motivated to understand the perceived expression and when the expression itself is non-prototypic or conveys nuanced meanings (Niedenthal et al., 2010; see also Hess & Fischer, 2013).

A smile is a good example of a nuanced facial expression. Human smiles can communicate not only happiness (Ekman, 1972, 1973), but also other emotions and motivations (see LaFrance, 2011 for review). An accurate judgment of these motives may therefore be more dependent on facial mimicry, making smiles ideal expressions for studying this phenomenon. Spontaneous smiles that reflect feelings of enjoyment – so-called *true* smiles – are a particularly well-defined class (Frank et al., 1993). Such smiles elicit pleasure in the perceiver and thereby can act as powerful social rewards (Shore & Heerey, 2011), triggering positive emotion (Surakka & Hietanen, 1998) and cooperative behavior (Krumhuber, Manstead, Cosker, Marshall, Rosin, & Kappas, 2007a). *False* or *polite* smiles

are less rewarding and are displayed when people want to mask unpleasant feelings or show positive affect they do not actually feel (Ekman et al., 1990). The distinction between true and false smiles involves not only the action of certain facial muscles (such as the *cheek raiser*, action unit (AU) 6, in Facial Action Coding System, FACS, Ekman, Friesen, & Hager, 2002) but also subtle dynamic properties such as the synchrony of different facial actions (Messinger, Cassel, Acosta, Ambadar, & Cohn, 2008; Frank & Ekman, 1993); the time course of the expression's onset, apex, and offset (Krumhuber & Kappas, 2005); and the amount of eye constriction (Ekman et al., 1990; Johnston, Miles, & Macrae, 2009). Judging smile genuineness is a complex task that requires simultaneous integration of these features. Consequently, it is likely to be supported by embodied responses such as facial mimicry. It is also worth noting that facial expressions of happiness are especially appropriate for studying facial mimicry because their imitation elicits high levels of muscle activity and is easy to detect (Oberman et al., 2007).

The goal of the present research was to provide a critical test of the role facial mimicry plays in the judgments of smile authenticity. In the first experiment reported here, we introduce and test a novel mimicry inhibition technique. We then employ the technique in the two following experiments to clarify the role that mimicry plays in distinguishing between true and false smiles.

Our experiments improve on and extend initial evidence for the role of mimicry in decoding true and false smiles reported by Maringer et al. (2011). In that work, Maringer and colleagues showed videos of animated agents expressing empirically validated “true” and “false” dynamic smiles (Krumhuber, Manstead, & Kappas, 2007) to their participants. Half of the participants were able to freely mimic the smiles, whereas the remaining half held pens in their mouth such that facial mimicry was functionally blocked. Participants' task was to rate the genuineness of each smile. Findings revealed that participants in the mimicry condition

judged true smiles as more genuine than false smiles, consistent with validation studies. However, in the mimicry-blocked condition, participants' judgments of genuineness did not vary by smile type. Instead, all smiles were rated as equally genuine. This result was consistent with the hypothesis that the ability to mimic smiles is essential for distinguishing among their subtle meanings.

The study by Maringer and colleagues (2011) represented the first step in demonstrating how facial mimicry supports perceivers' detection of subtle differences between smiles, but it was not without its limitations. The stimuli used were synthetic faces expressing "true" and "false" smiles, with true smiles defined as having a slower onset and a briefer apex compared to the false smiles (Krumhuber et al., 2007 b). While such stimuli are valuable because they have been precisely constructed and controlled, they do lack external validity and cannot represent a situation in which motivations to express true and false smiles are present. Whenever possible, it is important that research compares the mechanisms involved in the decoding of synthetic and real human facial expressions.

Another potential limitation of the study by Maringer et al. (2011) is the lack of control conditions to support a strong causal conclusion about the role of facial mimicry in decoding smiles. As mentioned, half of the participants completed the experimental task without any interfering activity (free mimicry condition) and the other half held a pen sideways between their lips and teeth, exerting only slight pressure (mimicry-blocked condition). Because holding the pen in the mouth requires some sustained attention, it is possible that the findings of the study, specifically that blocking mimicry compromised decoding accuracy, were due to distraction caused by the method for blocking mimicry. Perhaps the participants with the pen were simply sloppier in their judgments of genuineness.

Finally, Maringer and colleagues did not measure the effects of the pen-in-the-mouth manipulation on facial mimicry. Their manipulation elicits less interference with mimicry

than a similar paradigm that has also been described in the literature (i.e., holding a pen between the teeth, without touching it with the lips; Oberman et al., 2007; Ponari et al., 2012; Strack et al., 1988). Since Maringer and colleagues (2011) did not report empirical evidence for the effectiveness of their manipulation of facial mimicry, it is impossible to draw strong conclusions from their findings about the role of mimicry in the decoding of smiles. Finally, the between-subject design employed by the researchers does not allow taking into account important individual differences in both participants' tendency to mimic and the effectiveness of mimicry-blocking manipulation.

In order to address these shortcomings found in previous work, the present research employed a number of strategies in order to ground stronger conclusions about the role of facial mimicry in decoding smiles. First, we used rich, naturalistic stimuli representing spontaneous true and posed false smiles. Specifically, participants saw video recordings of real human participants smiling in response to real, amusing (versus neutral) stimuli.

Second, in order to control for the possibility that blocking facial mimicry distracts participants resulting in poor decoding of smiles, in Experiment 2, in addition to free mimicry and mimicry-blocked conditions, we added a control condition in which participants held a squeeze ball ("stress ball") in their non-dominant hand as they performed the smile decoding task. Participants in this latter condition were free to mimic the stimuli, but, like participants in the mimicry-blocked condition, they had an additional, potentially distracting task to perform. In Experiment 3 we implemented further control by adding distraction to the free mimicry condition itself. In that condition, participants wore a finger-cuff heart rate monitor such that they experienced the same amount of experimental involvement as participants in the other conditions. If the mimicry-blocked participants in the Maringer et al. study were less accurate in decoding true and false smiles because they were distracted by the pen-in-the-

mouth manipulation, then the participants holding a squeeze ball or wearing a finger cuff in the present studies should also be less accurate in decoding smiles.

Finally, in this research we introduce and validate (Experiment 1) a new procedure for inhibiting mimicry, namely the wearing of a plastic mouthguard. This device is then used in Experiments 2 and 3. Mouthguards are used in contact sports, such as football and boxing, in order to prevent injury to the teeth, jaw, and mouth (Knapik et al., 2007). They are made of thermo-plastic materials and are individually shaped to the mouth so that they fit closely around the wearer's teeth. When inserted, the mouthguard slightly stretches the mouth and cheeks, keeps the mouth in a stable position, and reduces facial movements without requiring the active attention of the wearer. Thus, mouthguards should effectively inhibit or at least disrupt the dynamics of facial mimicry. Anecdotal evidence corroborates this claim: athletes report that they strategically remove the guard when mobilizing emotional behavior. In Experiment 1 we measured facial muscle activity with and without a mouthguard in order to test the effectiveness of this technique for blocking facial mimicry.

To summarize, in the three experiments reported here we introduce and test the efficacy of a mouthguard technique for blocking facial mimicry (Experiment 1), and then use the procedure in two experiments that test the role of facial mimicry in decoding true and false smiles. Participants in Experiments 2 and 3 saw dynamic human true and false smiles and rated them on scales of genuineness. Compared to participants in several control conditions, all of whom were able to freely mimic the smile stimuli, we expected participants in mimicry-blocked conditions to show poorer accuracy in discriminating between the two types of smiles. Taken together, the three experiments presented here provide strong evidence in support of the prediction that facial mimicry plays a functional role in the processing of smile meaning.

3.1.2 Experiment 1

In order to investigate the efficacy of mouthguards as mimicry inhibitors, in Experiment 1 we compared the facial muscle activity of participants with and without “boil and bite” mouthguards as they viewed videos of true and false smiles.

3.1.2.1 Method

Participants and design. Forty-two students (5 men, 37 women, age $M = 19.12$ years, $SD = 1.47$) at Blaise Pascal University, France, took part in the experiment and were paid €10. All participants were at least 18 years old. Eight participants (7 female) were not French and their responses were excluded from further analyses because of the possibility that facial behavior varies across cultures (Elfenbein, Beaupré, Lévesque, & Hess, 2007). We also dropped data from one female participant because of the large number of trials preceded by intense facial activity⁴. Participants watched 12 videos of true and false smiles while wearing a mouthguard and under conditions of free mimicry. Thus, the experiment followed a 2 (Smile Type: true, false) by 2 (Mimicry Condition: free, blocked) within-subject design, where mimicry conditions were counterbalanced across participants. This and all other experiments reported in the present article were conducted according to the appropriate ethical guidelines and approved by the Conseil Restreint, a department-wide ethics committee at Blaise Pascal University.

Stimuli. We used six videos of true smiles and six videos of false smiles, selected from stimuli developed and described in Krumhuber and Manstead (2009). Films started and ended with a neutral expression and were extracted from recordings of participants (4 males and 2 females) performing an experimental task (Krumhuber & Manstead, 2009, Study 1). True smiles were spontaneous reactions to amusing stimuli accompanied by self-reported high positive emotions (i.e., pleasure, amusement, and happiness ratings of 3 or higher on a 7-

⁴ It is worth noting that removing those participants did not have a significant impact on the observed patterns of results.

point scale ranging from 1-*not at all* to 7-*extremely*), whereas false smiles represented deliberate actions of participants asked to look as if they felt amused (and were accompanied by reported low or no positive emotions, i.e., pleasure, amusement, and happiness ratings of 2 or lower). All smiles were of moderate intensity. Facial activity in every video was scored by two FACS-trained coders. True smiles ($M = 3.50$ s, $SD = 1.05$) included both AU 12 (lip corner puller) and AU 6 (cheek raiser), whereas false smiles ($M = 2.50$ s, $SD = 0.55$) included only AU 12. False smiles were also coded as more asymmetric compared to true smiles. Perceivers' ratings (Krumhuber & Manstead, 2009, Study 2) were consistent with these objective differences: observers judged false smiles as significantly less amused and less genuine than true smiles. All smiles were displayed as movie clips (1368 x 1026 pixels, 25 frames/s) in E-Prime Version 2.0 (Psychology Software Tools) and shown in random order.

Procedure. Participants first provided written informed consent to take part in the study. They were tested individually, seated in front of a 14'' screen connected to a PC. As they viewed videos of true and false smiles, we recorded the EMG activity of participants' zygomaticus major, the main muscle involved in smiling. Videos were displayed on a black screen, separated by self-paced pauses (no less than 500 ms). Given that the technique of EMG requires multiple repetitions of the same stimulus (Kamen & Gabriel, 2009; Konrad, 2005), each of the 12 sequences was presented three times, for a total of 72 trials presented in two randomized blocks (36 in the free mimicry and 36 in the blocked mimicry condition). The order of conditions was counterbalanced across participants. Before fitting and inserting the mouthguard, participants were told that our goal was to stabilize their facial muscles because their activity could interfere with the experimental task. Then, each participant received a new, transparent "boil and bite" mouthguard, still in the unopened box. We provided hot and cold water, along with the instructions on how to properly mold the mouthguard using tongue and biting pressure.

Electrical activity of the zygomaticus major was recorded on the left side of the face, consistent with established guidelines (Fridlund & Cacioppo, 1986), using bipolar 10 mm Ag/AgCL surface electrodes. We measured the EMG raw signal with a 16 Channel Bio Amp amplifier (ADInstruments, Inc.). The signal was then digitized by a 16 bit analogue-to-digital converter (PowerLab 16/30, ADInstruments, Inc.), and stored with a sampling rate of 1000 Hz.

Data preprocessing. EMG recordings were preprocessed using LabChart 7 (ADInstruments, Inc.). Recordings were filtered with a 10-Hz high-pass filter, a 400-Hz low-pass filter, and a 50-Hz notch filter, and segmented from 500 ms before to 2 seconds after the video onset, given that the most distinct facial reactions occur during the first second after stimulus onset (Dimberg, 1997; Dimberg & Thunberg, 1998). In order to control for random facial movements prior to the stimulus onset, we excluded from further analysis trials on which the z-scores of mean amplitude of the baseline (500 ms before the stimulus onset) were higher than 3 (on average 1 out of 72 trials per participant, never more than 3). The remaining data were then expressed as percentages of the baseline and averaged per condition in 20 time bins of 100 ms, in order to reflect how the EMG signal evolved after the onset of true and false smile videos.

3.1.2.2 Results

Statistical analyses were performed using PASW Statistics 18 (SPSS, Inc., Chicago, IL) and RStudio (version 0.96.331, RStudio, Inc.).

Overall effect of condition on EMG responses. Given that the mouthguard stretches the mouth and the cheeks, we did not expect it to completely inhibit facial movements but rather to induce irrelevant muscle activity that would interfere with participants' mimicry. To test this hypothesis, we examined how average responses of zygomaticus major in the first 2 seconds after the video onset varied as a function of smile type (true, false) and mimicry

condition (free, blocked). Data screening and Shapiro-Wilk tests revealed that the dataset violated normality assumptions (see Table 3.1.1 for details). A Wilcoxon Signed-ranks test indicated that when participants could freely mimic the video stimuli, they imitated true smiles to a greater extent ($M = 1.336$, $SD = 1.476$) than false smiles ($M = 1.08$, $SD = .27$), $Z = -2.64$, $p = .008$, consistent with previous research (Surakka & Hietanen, 1998; Krumhuber, Likowski, & Weyers, 2014). This difference disappeared when participants were wearing a mouthguard (respectively, $M = 1.08$, $SD = .16$, $M = 1.06$, $SD = .14$), $Z = 0.12$, $p = .908$.

Table 3.1.1. *Responses of Zygomaticus Major as a Function of Mimicry (free, blocked) and Smile Type (true, false) in Experiment 1.*

Mimicry	Free		Blocked	
Smile Type	True	False	True	False
M	1.336	1.085	1.081	1.062
SD	1.476	.267	.159	.143
$S-W (df = 33)$.261	.681	.783	.927
Skewness	5.604	2.560	2.559	.807
Kurtosis	31.876	6.989	10.220	.409
p	.000	.000	.000	.029

Note. EMG scores are expressed as percentages of baseline (500 ms before the stimulus onset).

Mapping EMG data on stimuli's facial activity. In order to assess the time course of participants' zygomaticus major activity in both conditions, we compared their EMG responses to the smile dynamics of the stimuli videos, extracted with the Computer Expression Recognition Toolbox (CERT, Littlewort et al., 2011).

The Computer Expression Recognition Toolbox. CERT is a software tool for automatic facial expression recognition, trained to code 19 FACS action units as well as

prototypic facial expressions, facial features, and head orientation. It is a useful alternative to human FACS coding because it allows for quick frame-by-frame coding of videos of facial expressions. More precisely, CERT outputs can describe a given facial expression as series of numbers corresponding to the intensity of each facial action unit for each video frame. Intensities are described as distances between the values of each facial unit detected in the source video and the support vector machines classifying this particular facial unit (see Littlewort et al., 2011). Preliminary empirical evidence suggests that CERT outputs are correlated with the EMG activity of the muscles supporting the corresponding action units (Littlewort et al., 2011; Pierce et al., 2009). CERT is especially useful for research on smiles, because it not only detects AU 12 (lip corner puller), but is also equipped with a separate smile detector that significantly correlates with human judgments of smile intensity (Whitehill, Littlewort, Fasel, Bartlett, & Movellan, 2009).

We used CERT to explore patterns of participants' mimicry of true and false smiles in the conditions of free and blocked mimicry. We defined facial mimicry in terms of positive correlations between the intensities of smiles detected by CERT in the video stimuli and the EMG recordings of participants' zygomaticus major. If wearing a mouthguard interferes with facial mimicry, positive correlations between the CERT output and EMG recordings should not be observed.

Analyses. To test these predictions, we compared CERT outputs for smile detection and AU 12 during the first 2000 ms after stimulus onset with participants' zygomatic activity recorded for the same time period under the conditions of free and blocked mimicry. CERT distances and EMG activations were expressed as z-scores and correlated using the nonparametric Spearman's rank order correlation coefficient (i.e., Spearman's rho).

In the condition of free mimicry, Spearman's rho revealed large (Cohen, 1992) positive relationships between AU 12 detected in the video stimuli and the participants' zygomaticus

activity. The correlations were significant for true and false smiles, respectively, $r_s(18) = .67$, $p = .001$; $r_s(18) = .79$, $p < .001$, suggesting that both types of stimuli elicited facial mimicry. We observed a similar pattern when zygomaticus activity in reaction to true and false smiles was correlated with the outputs of the smile detector, respectively $r_s(18) = .57$, $p = .009$; $r_s(18) = .81$, $p < .001$. Using the standard Fisher's z-transformation and subsequent comparison of Spearman coefficients (Myers & Sirois, 2006) did not reveal significant differences in the degree of participant-target synchrony for genuine and false smiles ($z = -0.75$, $p = .23$ for AU 12; $z = -1.38$, $p = .084$ for the smile detector).

Importantly, when participants were wearing a mouthguard, their facial responses did not correlate with the CERT codings of the smile stimuli, suggesting that participants imitated neither the true ($r_s(18) = .22$, $p = .346$ for AU 12; $r_s(18) = .11$, $p = .654$ for smile detector) nor the false smiles ($r_s(18) = -.23$, $p = .336$ for AU 12; $r_s(18) = -.23$, $p = .326$ for smile detector).

In summary, results of the two analyses reported show that participants imitated smiles that they viewed when they were allowed to mimic freely. More importantly, we also show that wearing a mouthguard decreases both the amount of mimicry and the degree to which participants' facial expressions corresponded to those in the videos, compared to the condition without mouthguard. We can thus conclude that using this device is a valid procedure for interfering with facial mimicry.

3.1.3 Experiment 2

The goal of Experiment 2 was to test whether mouthguards alter participants' ratings of the genuineness of smiles used in Experiment 1. Support for this prediction would suggest that the ability to mimic smiles moderates processing of subtle differences in the meaning of facial expression. Furthermore, in order to rule out potential alternative interpretations of the

effect of the mouthguard on participants' ratings, we included an appropriate control condition.

3.1.3.1 Method

Participants and design. Seventy-eight undergraduate students (10 men, 68 women, age $M = 20.09$ years, $SD = 2.45$) at Blaise Pascal University, France, participated in exchange for course credit. All participants were at least 18 years old. They were randomly assigned to the conditions of a 2 (Smile Type: true, false) by 3 (Mimicry Condition: free, blocked, muscle-control) factorial design, where the first factor varied within subjects and the second varied between subjects. Each participant was tested individually.

Procedure. As in Maringer et al. (2011), the pretext for the research was the development of a collaborative system in which people could attend meetings and conferences online. After providing their written consent, participants were told that our goal was to evaluate features of sample facial expressions that would be displayed on the computer screen. Participants were then randomly assigned to one of the three mimicry conditions, and given specific instructions to rate each face according to how genuine the expressed smile was on 5-point scales, where 1 meant that the smile was *not at all genuine* and 5 meant that the smile was *very genuine*. Each participant saw all 12 videos from Experiment 1 one time each.

In the *free* mimicry condition no additional information was provided. Participants in the *blocked* mimicry condition were informed that past research had shown that individuals' extraneous bodily movements interfered with the performance of the task, and that it was important that some of their muscles be otherwise occupied. Similarly to Experiment 1, subjects were told that their face muscles would be stabilized throughout the experiment by a sports mouthguard. A new transparent mouthguard was then offered to each participant, along with hot and cold water and instructions on how to mold the mouthguard to fit the mouth and teeth snugly.

Participants in the *muscle-control* condition heard the same information about extraneous bodily movements, but they received a small “stress ball” about 7 cm in diameter, which they were instructed to hold firmly in their non-dominant hand throughout the experiment. This condition thus controlled for the potential distracting aspects of the mouthguard used in the blocked mimicry condition.

Upon completion of the task, participants were debriefed. Participants in the blocked condition were given the mouthguard to keep.

3.1.3.2 Results

Average genuineness ratings were submitted to an ANOVA with one within-subjects factor (Smile Type: true, false) and one between-subjects factor (Mimicry: free, blocked, control). Data for one participant were not properly recorded and were thus eliminated from final analyses.

A main effect of Smile Type was observed, $F(1,74) = 185.86, p < .001, \eta^2 = 0.72$ with true smiles rated as more genuine ($M = 3.31; SD = .56$) than false smiles ($M = 2.31; SD = .64$), see Figure 3.1.1 for details. More importantly, we also observed a significant interaction between Smile Type and Mimicry, $F(2, 74) = 5.98, p = .004, \eta^2 = 0.14$, showing that participants assigned to the free-mimicry and the muscle-control conditions distinguished more between true and false smiles in their ratings of genuineness than did participants in the blocked-mimicry condition. Specific comparisons revealed that the difference between the free mimicry and muscle-control condition was not significant, $F(1, 49) < 1$, while the differences between free and blocked, and muscle-control and blocked conditions were significant $F(1, 49) = 5.60, p < .022, \eta^2 = 0.10$, and $F(1, 50) = 10.34, p = .002, \eta^2 = 0.17$, respectively.

Thus, Experiment 2 supported the prediction that participants allowed to mimic freely, with or without a distracting task, would differentiate more in their genuineness ratings of true and false smiles compared to participants whose mimicry was blocked with a mouthguard.

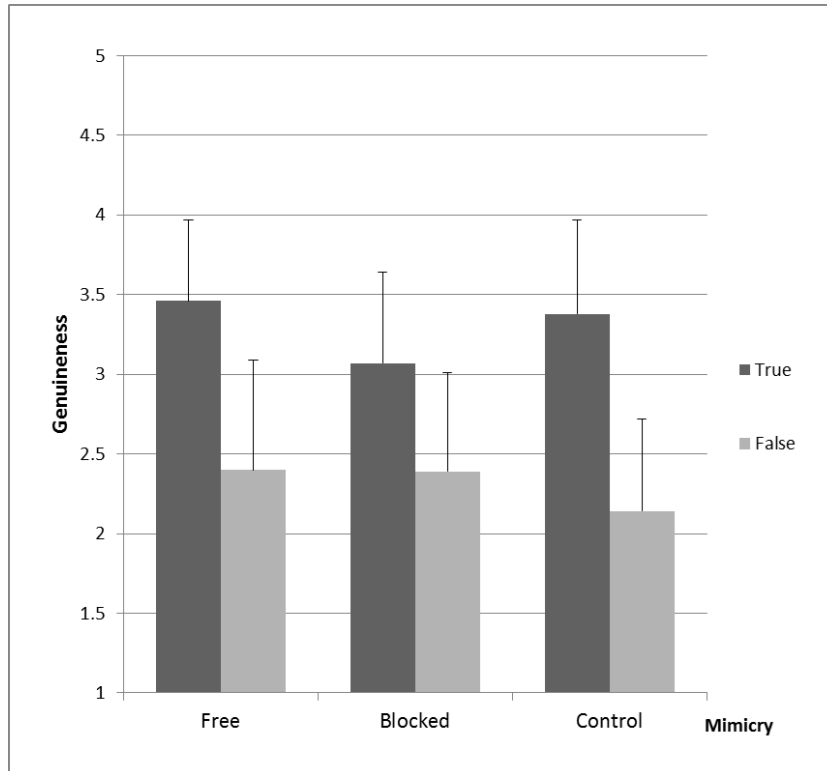


Figure 3.1.1. Genuineness ratings of true and false smiles in the free, blocked and muscle-control (squeeze ball) condition of Experiment 2. Error bars represent standard errors.

3.1.4 Experiment 3

This study was conducted in order to replicate Experiment 2 and to further refine the comparison between the free mimicry and muscle-control conditions. We wanted to ensure that the reduced discrimination between true and false smiles in the mouthguard condition was truly due to a reduction in facial mimicry, and not because the mouthguard was distracting or heightened self-consciousness. Therefore in Experiment 3 we modified the free mimicry condition to involve specific instructions and additional materials so that it better matched the procedures in the “stress ball” and mouthguard conditions and was equally distracting for participants. Participants in this new “free mimicry” condition were fitted with a finger heart rate monitor and informed that their heart rate would be measured during the

task. The heart rate monitor is comparable to the mouthguard as it requires initial fitting, makes participants similarly aware of their bodies, and presumably has a similar effect on attention throughout the task.

3.1.4.1 Method

Participants and design. Sixty-six undergraduate students (9 men, 57 women, age $M = 20.46$ years, $SD = 6.31$) at Blaise Pascal University, France participated in exchange for course credit. All of them were at least 18 years old. None of them had participated in Experiment 2. Participants were randomly assigned to the conditions of a 2 (Smile Type: true, false) by 3 (Mimicry: free, blocked, and muscle-control) factorial design as in Experiment 2.

Stimuli and procedure. All participants provided written informed consent to take part in the study. The stimuli and procedure largely replicated Experiment 2, with the exception of several small changes made to the instructions and materials used in the free mimicry condition. For this condition participants were informed that past research had shown that some physiological responses were related to the performance of this task, and so, it was important for us to measure their heart rate. A heart rate monitor was then secured to the index finger of their non-dominant hand for the duration of the experiment. The monitor did not record any data and was only used to control for participants' potential distraction.

3.1.4.2 Results

As before, genuineness ratings were submitted to an ANOVA with one within-subjects factor (Smile Type: true, false) and one between-subjects factor (Mimicry: free, blocked and muscle-control). A main effect of Smile Type was observed, $F(1, 63) = 338.61$, $p < .001$, $\eta^2 = 0.84$, with true smiles rated as more genuine ($M = 3.73$; $SD = .56$) than false smiles ($M = 2.34$; $SD = .65$), see Figure 3.1.2 for details. More importantly, we also found a significant Mimicry by Smile Type interaction, $F(2, 63) = 17.24$, $p < .001$, $\eta^2 = 0.35$, such that participants assigned to free mimicry and muscle-control conditions discriminated more in their ratings of

genuineness between true and false smiles. The differences between free mimicry and muscle-control conditions were not significant, $F(1, 43) < 1$, while differences between the free mimicry and blocked mimicry conditions, and between the muscle-control and blocked mimicry conditions were highly significant $F(1, 42) = 24.59, p < .001, \eta^2 = 0.40$, and $F(1, 41) = 30.40, p < .001, \eta^2 = 0.43$, respectively. Experiment 3 thus constituted a successful replication of the second experiment. It also better controlled for potential confounds in the mimicry and control conditions, showing that being able to freely mimic the perceived smiles supported participants' accuracy in judgments of authenticity, even when the participants were potentially distracted by other manipulations.

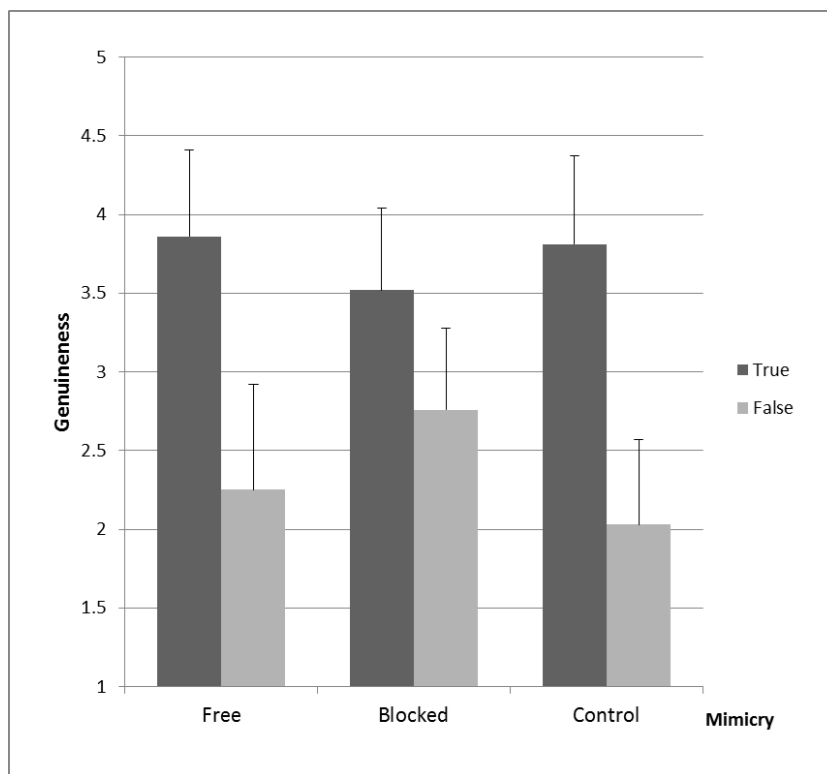


Figure 3.1.2. Genuineness ratings of true and false smiles in the free (finger cuff), blocked and muscle-control (squeeze ball) condition of Experiment 3. Error bars represent standard errors.

3.1.5 Discussion

The present research was conducted in order to provide a careful test of the role of facial mimicry in the decoding of smiles. The first study validated the use of a mouthguard as an effective inhibitor of facial mimicry. Having participants wear a mouthguard was shown, in Experiment 1, to disrupt the mimicry response to the perceived smiles, such that participants' EMG activity did not reflect the amount of smiling in the video stimuli. In Experiments 2 and 3 we tested the hypothesis that inhibiting facial mimicry with the mouthguard resulted in poorer decoding of true and false smiles. Unlike previous tests of this hypothesis (Maringer et al., 2011), we were able to exclude the possibility that participants in blocked mimicry conditions were simply distracted by the mouthguard and did not have the attentional resources necessary to see small differences between smiles. The results of our two experiments provide support for the hypothesis that facial mimicry is used to decode the differences between true and false smiles.

While the previous studies (e.g., Maringer et al., 2011; Niedenthal et al., 2001; Oberman et al., 2007; Ponari et al., 2012), preferentially used pen-in-the-mouth procedures, we asked participants to wear mouthguards in order to limit their facial responses. Our interpretation of the findings is that altered facial mimicry reduces participants' ability to distinguish true and false smiles. Alternatively, however, the use of mouthguard or pen-in-mouth manipulations could prevent participants from generating verbal labels when identifying smiles. Such a disruption of inner speech – rather than blocked facial mimicry – could then be reflected in impaired judgments of smile authenticity. We believe that such an alternative explanation, although consistent with findings from neuroscience linking inner speech with imitation and emotion processing (George et al., 1993; Meister, Wu, Deblieck, & Iacoboni, 2012; Pulvermüller, & Fadiga, 2010), is unlikely in the case of the current studies. First, it is difficult to predict what exactly participants would subvocalize - especially when

observing genuine and false smiles – and thus, to anticipate the exact nature and timing of the effects. Secondly, it is possible that the mouthguard and pen do not prevent inner speech because these procedures do not necessarily interfere with inner voice and inner ear (phonological store), critical for subvocalization (Smith, Wilson, & Reisberg, 1995). Finally and most importantly, if subvocalization underlies emotion recognition, preventing it should disrupt the processing of all facial expressions equally. This is, however, not the case in previous studies that block mimicry: techniques altering the muscles of mouth impair recognition of happiness and disgust, which heavily involve the mouth, but not recognition of fear and anger (Oberman et al., 2007; Ponari et al., 2012). Such findings suggest that being able to use facial muscles relevant for a given facial expression may be more essential for recognition than subvocally naming the expression.

Our findings replicate and strengthen the results of Maringer and colleagues (2011). They are also consistent with other evidence implicating embodiment and mimicry in judging the meaning of facial expressions. Namely, Oberman et al. (2007) altered facial responses using a variant of the pen-in-the-mouth procedure. Holding the pen with the teeth without touching it with the lips significantly decreased participants' performance, especially when recognizing facial expressions of happiness. Oberman and colleagues' study used static, prototypical expressions of happiness, edited to decrease their intensity. Recognizing such expressions is an arguably difficult task that should recruit embodied simulation processes. However, the forced-choice paradigm asked participants to distinguish between categorically different expressions, such as happiness and disgust (happiness being the only positive emotion), while the current study demonstrated the importance of facial mimicry in making more subtle judgments *within* the category of smiles. This suggests that mimicry does not simply promote emotion category labeling, but also facilitates the detection of fine-grained differences in expression meaning.

More recently, Manera, Grandi, and Colle (2013) provided interesting insight into the “embodiment” hypothesis and recognition of subtle facial expressions. The researchers tested participants’ accuracy in judging photographs as instances of true and false smiles. Performance varied significantly as a function of participants’ tendency to experience emotional contagion (Doherty, 1997). Susceptibility to emotional contagion for *negative emotions*, such as fear, anger, and sadness, predicted more accurate judgments of smile genuineness. But higher levels of susceptibility to emotional contagion for *positive emotions* (happiness, love) predicted lower recognition performance, because such participants categorized most false smiles as sincere. Manera and colleagues (2013) did not directly assess or manipulate the facial reactions of the participants. Still, when combined with the current study’s demonstration of the role mimicry plays in smile genuineness judgments, it is entirely possible that individual tendencies to simulate the perceived emotion and to produce overt or covert facial mimicry might have been the mechanism underlying differences in participants’ judgments. The relationship between emotional contagion and mimicry of non-prototypic facial expressions needs to be explored in further studies

Despite the growing body of research implicating mimicry in the discrimination between genuine and false smiles, other recent findings suggest that this evidence, although promising, is far from being conclusive. For example, the exact conditions under which spontaneous mimicry improves the recognition of facial expression in general and smile type in particular still need to be examined (Hess & Fischer, 2013). Consistently, Korb, With, Niedenthal, Kaiser and Grandjean (2013) presented participants with different types of precisely-manipulated smiles and recorded participants’ facial EMG while collecting ratings of smile genuineness. Both smile intensity and participants’ facial mimicry predicted judgments of authenticity. Still, Korb and colleagues did not find significant mediation – that is, statistically controlling for participants’ facial mimicry did not significantly influence their

ratings of smile genuineness. Similarly, a recent study by Slessor, Bailey, Rendell, Huffmann, Henry, and Miles (in press) showed that the time course of facial reactions to enjoyment and non-enjoyment smiles differs in young and older adults. More importantly, such differences in facial mimicry did not predict participants' ratings of smile authenticity.

This somewhat complicated literature highlights the need for a better understanding of the effect different types of stimuli, such as static, dynamic, and synthetic, play in judgments of genuineness. Furthermore, a clearer operationalization of smiles would be useful in unraveling these problems. Because the debate about the actual features of "true" and "false" smiles is unresolved, a potential solution is not to create experimental stimuli having these features, but rather to use videos of spontaneously-produced, naturalistic smiles, as we did in the current experiments.

It is also worth noting that in the two EMG studies just described (i.e., Korb et al., 2013; Slessor et al., in press), participants judged authenticity with the electrodes attached to their faces, while in Maringer et al. (2011) and in the experiments reported here genuineness ratings were collected without any invasive measure of mimicry. Moreover, in Maringer's studies and in the present Experiments 2 and 3, facial mimicry was experimentally altered, and not measured at its spontaneously occurring levels. On the other hand, studies of Korb et al. (2013) and Slessor and colleagues (in press) examined such spontaneous facial mimicry. These and other methodological differences, including the nature of the stimuli used, the action units manipulated, and the experimental design employed do not allow a conclusive explanation of such inconsistent findings. Future studies will need to address the causes of observed discrepancies and attempt to precisely define the conditions under which facial reactions are crucial for correct smile interpretation. Such questions can be explored in constructive replications of existing findings, using different types of smile stimuli, varying experimental designs, and with appropriate control conditions.

Another possible improvement in the investigation of the role of mimicry of smiles is to go beyond the classic distinction of “true” and “false”. Smiles convey a much wider variety of messages, often unrelated to enjoyment per se. Thus, using different types of socially functional smiles and asking participants to judge the extent to which these smiles communicate trustworthiness, embarrassment, or superiority may be more relevant to the situations that participants experience in their daily lives, and offer more possibilities for studying facial mimicry. Future studies in our laboratory will also test new procedures for blocking mimicry of the entire face, including the use of clay or paraffin masks. Another line of research aims to investigate how chronic impairments of facial mimicry in facial palsy patients affect the perception and recognition of facial expressions. A focus of future research will be to investigate whether “mimicry” needs to be observable, involve all of the relevant muscles, and/or be time-locked in order to have functional effects on face processing (cf. Jabbi & Keysers, 2008). Answering such questions has the potential to advance our understanding of how modulations of facial mimicry shape social interactions and group dynamics.

In sum, the present research relied on the strategy of preventing or moderating a supposedly causal mechanism in order to measure predicted changes in performance (e.g., Pitcher et al., 2008) such as smile discrimination. An important question that the present studies cannot answer is related to the neural mechanisms underlying blocking imitation. Consistently with previous findings from neuroscience, pre-engaging facial musculature with a pen or a mouthguard may alter feedback from face muscles and skin and reduce the subsequent activations of the amygdala as well as the shared representation network involving premotor cortex, inferior frontal gyrus pars opercularis (mirror neuron system), somatosensory cortex, and left anterior insula (Hennenlotter et al., 2005, Hennenlotter et al., 2009, Cross, Torrisi, Reynolds Losin, & Iacoboni, 2013). The exact alterations in motor

outflow induced by mimicry-inhibiting manipulations need to be assessed in further studies. Recent results suggest, however, that these experimental procedures may inhibit the influence of the shared representation network on the motor system (Cross, 2013; Wang et al., 2011). Such preparatory suppression might constitute the mechanism controlling the automatic tendency to imitate.

In the experiments reported here, inhibiting this tendency was related to poorer discrimination of true and false smiles. Our studies not only relate facial mimicry to understanding the meaning of smiles, but they also test novel techniques for manipulating and measuring mimicry. For instance, Experiment 1 in the current paper employs a combination of automatic facial recognition software and EMG recording to correlate the synchrony between the facial expressions of the target and the perceiver. As we develop better tools for manipulating and operationalizing facial mimicry, we will come closer to answering the questions of whether, when, and how mimicry plays a fundamental role in emotion processing. Another promising way to explore these questions might be to study the consequences of blocking mimicry in real-world situations.

3.2. Consequences of blocking mimicry on the development of emotional competence

Chapter 3.2 is an article published and available upon request: Niedenthal, P.M., Augustinova, M., Rychlowska, M., Droit-Volet, S., Zinner, L., Knafo, A. & Brauer, M. (2012). Negative relations between pacifier use and emotional competence. *Basic and Applied Social Psychology*, 34, 387-394. PMN, SDV, MA, LZ, MB conceived and designed the experiments. PMN, SDV and MR collected the data. MB and MR analyzed the data. PMN, MA, SDV, LZ, AK wrote the paper.

Taken together, findings of studies reported in the present chapter are in line with the embodied view of emotion processing. Blocking facial mimicry, one of the key substrates of embodied simulation, impaired smile judgments and was associated with reduced emotional competence. Given that observers may use multiple processes to interpret facial expressions, recognition accuracy and affect sharing are not always supported by simulation and facial mimicry (e.g. Blairy, Herrera, & Hess, 1999; Fischer et al., 2012). Studies reported here suggest that embodied processes are critical for the interpretation of subtle facial expressions, such as smiles, and in early stages of life, when perceived expressions are especially relevant for the observer. In addition to adding evidence supporting the role of facial mimicry in emotion recognition processes, the present studies provide insights about the social contexts favoring the use of such processes. These contexts are discussed in detail in the next chapter.

CHAPTER 4

BEYOND AUTHENTICITY: FUNCTIONAL SMILES AND THEIR ENDORSEMENT ACROSS CULTURES

The Cat only grinned when it saw Alice. It looked good-natured, she thought: still it had very long claws and a great many teeth, so she felt that it ought to be treated with respect.

- L. Carroll -

[The American] smile signifies only the need to smile. It is a bit like the Cheshire Cat's grin: it continues to float on the faces long after all emotion has disappeared ... The smile of immunity, the smile of advertising... Smile to show how transparent, how candid you are. Smile if you have nothing to say.

- J. Baudrillard -

A smile that floats in the air might be puzzling, especially if it belongs to a cat. Still, the quote from Jean Baudrillard reveals that even ordinary human smiles can be as disconcerting and as ambiguous as the famous grin of The Cheshire Cat. What exactly makes American smiles so false in the eyes of many observers? We predict that social functions of smiles and norms governing expressive behavior differ across countries, and that both socioecological and cultural variables can meaningfully account for these variations. Studies reported in the present chapter aim to test this hypothesis and to systematically explore a novel social-functional typology of smiles.

4.1 Emotional expression and smiling across cultures

Chapter 4.1 is a manuscript submitted for publication and available upon request: Niedenthal, P.M., Rychlowska, M., Miyamoto, Y., Matsumoto, D., Hess, U., Gilboa-Schechtman, E., Kamble, S., Muluk, H., Masuda, T. (2014). *Historical homogeneity, emotional expressiveness and the social functions of smiles*. PMN, YM, UH, EGS, MR conceived and designed the experiments. PMN, YM, DM, EGS, SK, HM, TM, MR collected the data. DM contributed materials. MR analyzed the data. PMN, MR, YM wrote the paper.

4.2 What's in a smile? Specific facial actions combine with *zygomaticus major* in expressions of pleasure, affiliation and dominance

Chapter 4.2 is a manuscript submitted for publication and available upon request: Rychlowska, M., Jack, R. E., Garrod, O.G.B., Schyns, P.G., & Niedenthal, P. (2014). *What's in a smile? Specific facial actions combine with *zygomaticus major* in expressions of pleasure, affiliation and dominance*. PGS, OGB, RJ, PMN, MR conceived and designed the experiments. MR collected the data. PGS, OGB, RJ contributed materials. RJ and MR analyzed the data. MR, RJ, PGS, PMN wrote the paper.

CHAPTER 5

INTEGRATION OF RESULTS AND FUTURE DIRECTIONS

An extensive literature links embodied processes, including facial mimicry, to the recognition and interpretation of facial expression (e.g., Goldman & Sripada, 2005; Havas et al., 2010; Hennenlotter et al., 2009; Keysers & Gazzola, 2007; Lipps, 1907; Neal & Chartrand, 2011). More precisely, embodied simulation is asserted to recreate in the perceiver the bodily feeling and the affective state of the observed facial expression, thus helping the perceiver to understand the message conveyed by the other's facial expression. Despite the substantial empirical evidence linking embodied processes to the decoding of facial expression, the exact circumstances under which embodiment is necessary remain poorly understood (see Hess & Fischer, 2013 for a review). It is for example unclear whether and when facial mimicry – rather than perceptual cues or conceptual knowledge – is necessary for facial expression processing (Bogart & Matsumoto, 2010; Blairy et al., 1999; Fischer et al., 2012; Slessor et al., in press).

The present work attempts to shed more light on the mechanisms underlying production and perception of emotional facial expressions, with the human smile as a case study. We used the SIMS model (Niedenthal et al., 2010) as a theoretical framework allowing us to generate specific predictions about the possible triggers of embodied simulation, about the role of mimicry and culture in facial expression processing, and about the types of smiles

produced. In addition to specific findings discussed in previous chapters, several broader conclusions can be drawn from the work reported in this dissertation.

5.1 Eye contact as a trigger for embodied simulation

Three experiments reported in **Chapter 2** reveal that smiles accompanied by eye contact elicit more facial mimicry, have higher emotional impact, and are perceived as more positive than smiles displayed with an averted gaze that prevents eye contact. The observed associations among eye contact, mimicry and ratings of smile positivity are consistent with the view that looking in the eyes of another person is sufficient to trigger embodied processes. We should note, however, that embodied simulation involves a complex pattern of neural, bodily and emotional responses (Decety & Chaminade 2003; 2005; Gallese 2003; 2005; Goldman & Sripada, 2005). Given the distributed nature of these processes, other studies involving multiple measures are necessary for conclusive evidence that eye contact triggers embodied simulation. Finally, several studies have shown that eye contact elicits stronger reactions to approach-oriented facial emotions, such as happiness or anger. The opposite is true for avoidance-oriented emotions, like fear, which are more recognizable and elicit higher mimicry under conditions of an averted gaze (Hess et al., 2007; Schrammel et al., 2009; Soussignan et al., 2012). In this view, speed of recognition and facial mimicry of certain expressions may be due to their self-relevance rather than to embodied processes. In the three studies reported here, we used an approach-oriented expression, namely the smile. Our experimental procedures manipulated the eye gaze displayed on paintings and on photographs, but not the participants' gaze. Consequently, we cannot be confident whether increased facial mimicry and high ratings of smile positivity observed under conditions of eye contact are due to the embodied processes or to the self-relevance of smile. Future research will need to address this limitation by manipulating or measuring the observer's gaze.

5.2 Facial mimicry and its importance for smile interpretation

Studies described in **Chapter 3** focus on facial mimicry and examine its role in facial expression processing, as well as in the development of emotional competence. Recent theories (Hess & Fischer, 2013; Niedenthal et al., 2010) hold that embodied simulation and facial mimicry are most likely to occur when observers are judging subtle, ambiguous facial expressions, and when they are especially motivated to correctly decode these expressions. Consequently, the present studies examined how the blocking of mimicry impacts judgments of smiles, the most complex facial expressions. We also tested the consequences of blocking mimicry in a situation when facial expressions are especially relevant for the observer, namely when children learn to interact with adults and mirror their displays (Fonagy et al., 2002; Jones, 2006).

First, we conducted conceptual replications of the experiments of Maringer and colleagues (2011) and demonstrated that inhibiting facial reactions impairs participants' ability to distinguish true smiles from false ones (**Chapter 3.1**). In our experiment, however, we used a novel paradigm for blocking facial mimicry – namely, the use of a sports mouthguard, and included additional control conditions allowing firm causal conclusions. We also employed videos of real human smiles instead of computer-generated expressions of animated agents. Study 1 (**Chapter 3.1.2**) tested if wearing a sports mouthguard allows an efficient inhibition of smile mimicry. We recorded EMG activity over the participants' zygomatic major muscle while they watched videos of genuine and false smiles, with and without the mouthguard. Findings revealed that false smiles elicited lower levels of facial mimicry than genuine smiles. Importantly, this difference was no more significant when participants used the mouthguard. In order to better assess the disruptions of facial mimicry caused by the mouthguard, we used CERT, a software tool for automatic facial expression recognition (Littlewort et al., 2011) to quantify the smiles visible in the videos. These scores

were then compared to participants' EMG recordings, in order to assess how closely participants' facial reactions matched the presented stimuli. When participants didn't wear mouthguards, their zygomaticus activity was strongly correlated with the quantitative descriptions of smile videos. Wearing a mouthguard disrupted this similarity such that the participants' EMG signal was unrelated to the amount of smiling visible in the stimuli. Experiments 2 and 3 (**Chapter 3.1.3 and 3.1.4**) inhibited facial mimicry using this new mouthguard technique. Other participants, randomly assigned to the control conditions, did nothing, squeezed a stress ball in their hands, or had a heart rate monitor attached to their fingers. Unlike these control conditions, blocking mimicry with a mouthguard disrupted the judgments of smile genuineness. Together, our three experiments constitute additional evidence linking motor mimicry to emotional expression processing, and suggest that altering facial responses negatively affects the ability to correctly interpret other people's emotions.

5.3 Pacifier use and emotion processing

One can ask whether and how blocking mimicry with a pen or a mouthguard is applicable to real-life situations. The use of a pacifier by babies provides a perfect opportunity to answer such a question. This is because use of a pacifier disrupts facial responding similarly to pen-in-the-mouth procedures used to block mimicry in the laboratory (Strack et al., 1988; Oberman et al., 2007). Moreover, during the pacifier use, mimicry blocking occurs on a regular basis, for extended periods of time, and often during face-to-face interaction (including with the mother). Finally and most importantly, the age when babies use pacifiers corresponds to a critical stage in emotional development, when children begin to understand facial expressions, learn to engage in social interactions and to communicate their own emotions (Campos et al., 2003; Fonagy et al., 2002 ; Jones, 2006 ; Lavallée, 2008). We hypothesized that early and systematic alteration of facial responses with a pacifier prevents babies from learning emotional information during their interactions with adults. Moreover,

long-term pacifier use may induce in babies a habit to permanently restrain their facial mimicry. Given the well-documented importance of facial reactions for emotional processing, long-term pacifier use can eventually lead to reduced emotional competence and social skills.

Three studies tested this prediction (**Chapter 3.2**). In Study 1 (**Chapter 3.2.2**), we recorded infants' faces while they watched videos of morphed facial expressions changing from happiness to sadness, and from sadness to happiness. Our analyses revealed that the length of pacifier use was negatively associated with the amount of facial mimicry displayed by the child. This effect, however, was only significant for boys. Studies 2 and 3 (**Chapter 3.2.3** and **Chapter 3.2.4**) explored the long-term effects of the pacifier use. Namely, we assessed the levels of empathy, emotional intelligence and trait anxiety in young adults. The length of pacifier use was associated with a decrease in emotional competence and, again, our results revealed that this effect was only significant for men. The gender differences might be due to differences in early socialization of girls and boys. Specifically, given that social norms dictate that women should be emotional "experts" (Fischer, 2000), girls are likely to be more strongly encouraged to express emotion and develop social skills. Such "emotional education" might alleviate or even prevent the disruptive effects of early pacifier use. In sum, the remarkable consistence in the results of the three studies strongly suggests that pacifier use negatively impacts the development of automatic facial mimicry and emotional competence.

Together, the studies presented in **Chapter 3** highlight the role of bodily experience in the judgments of facial expressions and the development of social skills. To our knowledge, they also represent the first systematic study of the link between pacifier use and social skills. One important limitation of these findings is their correlational nature. To draw stronger conclusions about the effects of pacifier use, it would be useful to manipulate the pacifier use, and to conduct laboratory experiments employing pacifiers as a technique to block mimicry. Similar studies will help identifying the muscles and the processes that the pacifier use

disrupts. For example, more recent research (Rychlowska et al., 2013) examined adults' facial and emotional reactions to faces of babies using a pacifier and showed that the presence of a pacifier disrupts facial mimicry of the expressions that largely involve the lower half of the face. Specifically, when infants had pacifiers, perceivers showed reduced EMG activity in response to infants' smiles. Smiles of babies using a pacifier were also rated as less happy than smiles depicted without a pacifier. The same pattern was observed for facial expressions of distress such that adults rated infants presented with pacifiers as less sad than infants presented without pacifiers. These findings suggest that potentially deleterious effects of pacifier use might involve not only infants but also adults who interact with them and mirror their expressions. For example, an infant sucking on a pacifier might elicit less interest and receive less stimulation from adults than a baby who smiles and whose facial movements are fully visible. Along with the facial muscles disrupted by pacifiers, it is also important to understand why babies use pacifiers for long periods of time. We are currently conducting a large survey study assessing parent and infant characteristics, as well as adults' attitudes about pacifiers, in order to identify potential predictors of pacifier use.

The studies reported in **Chapter 3** contribute to embodied theories of facial expression decoding in a number of ways. In particular, we introduced and validated the use of a mouthguard for disrupting facial responding. We also used a more precise operationalization of facial mimicry. In this work, such mimicry was defined as the similarity between participants' facial reactions and the activity present in the stimuli, coded with a software tool for automatic facial expression recognition. Finally, we examined effects of blocking mimicry in the real world, by studying consequences of pacifier use on emotion processing and emotional development. We believe that investigating facial expressions processing in ecological contexts has the potential to improve our understanding of when and how mimicry underlies emotion processing.

5.4 Historical homogeneity as a predictor of nonverbal expressiveness

According to the SIMS model (Niedenthal et al., 2010), the use of mimicry rather than other processes to decode facial expressions of emotion depends on social context and on culture. The goals of studies presented in **Chapter 4** were twofold. Firstly, we examined the usefulness of a new construct, historical homogeneity, as a predictor of emotional expressivity and functions of smiles in different countries. Secondly, we attempted to assess the endorsement of smile functions described by Niedenthal and colleagues (2010) and to create a visual description of the corresponding smiles.

In the first two studies (**Chapter 4.1**), we reanalyzed an existing data set on display rules that govern the expression of emotion in 31 countries (**Chapter 4.1.1**), and assessed the endorsement of the smile functions of reward, bonding and hierarchy negotiation in 9 countries (**Chapter 4.1.2**). We then related these measures to several cultural and socioecological dimensions, including historical homogeneity (Putterman & Weil, 2010), individualismcollectivism (Hofstede, 1980; Markus & Kitayama, 1991; Triandis, 1995), residential mobility (Oishi et al., 2007) and present homogeneity (Alesina et al., 2003). The findings revealed that historical homogeneity, defined as demographic stability of a given country over the last 500 years, is a powerful predictor of emotional expressiveness and functions of smiles over and above the variance explained by other constructs. Namely, historically heterogeneous countries originating from large migration flows endorse open expression of emotions, and the use of pleasure and affiliative smiles, to a greater extent than historically homogeneous countries. On the other hand, concealing emotional expressions and smiling to negotiate social hierarchies are preferred in homogeneous cultures. Our findings suggest that a systematic study of the demographic past of different nations is a promising approach to account meaningfully for the differences in expressive behavior across cultures. Given that populations of historically heterogeneous countries originate from large migration

flows, their societal practices emerged from interactions of people with different cultural, linguistic, and religious traditions. It is thus reasonable to assume that in heterogeneous countries communication largely relies on facial expressions, and that the accurate judgment of these expressions is more important than in historically homogeneous countries. In the latter, the existence of shared social norms, display rules and contextual knowledge reduces the need to use or understand strong, basic communicative signals (Giddings, 1906). As a consequence, facial expression processing in homogeneous societies is likely to be guided by low-level perceptual cues or contextual knowledge, while heterogeneous societies may encourage the use of eye contact and embodied simulation to decode facial expressions of emotions. Studies reported here represent just a first step in understanding how historical homogeneity influences the use of facial expression. More specific predictions about the use of facial mimicry and of eye contact in homogeneous and heterogeneous cultures need to be assessed in laboratory studies. All in all, the predictive value of historical homogeneity revealed in the present research (**Chapter 4.1**) highlights the importance of the cultural evolution and history of different ethnic groups in explaining not only variations in facial expression processing but also possible sources of more general societal dimensions, such as individualism-collectivism (Kitayama, 2002).

5.5 Pleasure, affiliative and dominance smiles: their functions and morphology

In addition to shedding more light on the cultural correlates of facial expressivity, studies described in **Chapter 4** provide initial evidence in favor of the social-functional typology of smiles proposed by Niedenthal and colleagues (2010). Our findings suggest that psychological states and motives for smiling assessed in 9 countries can be classified into three categories corresponding to pleasure, affiliative and dominance smiles. Moreover, participants in historically heterogeneous countries endorsed pleasure and affiliative motives to a greater extent than participants in homogeneous cultures. The reverse was true for

hierarchy negotiation (dominance) motives, preferred in homogeneous countries. This finding suggest that at least some misunderstandings related to smile interpretation across cultures may be due to differences in the production of affiliative and dominance smiles. Specifically, homogeneous cultures endorse hierarchy management functions of smiles to a greater extent than heterogeneous cultures, and people from homogeneous countries value affiliative reasons for smiling less than inhabitants of heterogeneous countries. Consequently, a visitor from Poland (homogeneity ratio: 0.95) coming to the United States (homogeneity ratio: 0.03) might be puzzled by the amount of smiles displayed in situations unrelated to joy or happiness. These ambiguous grins are likely to be interpreted as superficial and phony, especially in the absence of eye contact or face mimicry.

Based on our preliminary findings consistent with the social-functional typology of smiles proposed by the SIMS model (Niedenthal et al., 2010), we could attempt to identify facial movements conveying the motivations of reward, affiliation and dominance. Studies reported in **Chapter 4.2** employed a random generator of photo-realistic facial movements (Yu et al., 2012) to model, in a data-driven manner, specific facial actions that combine with the zygomaticus major – the main muscle involved in smiling – in facial expressions of pleasure, affiliation and dominance. Based on the responses of each participant who categorized a large number of random facial expressions, we could generate dynamic prototypes of the three functional smiles and identify the facial movements most characteristic of each category. This first systematic description of the three functional smiles enables a meaningful exploration of real-world displays of pleasure, affiliation and dominance. Prototypes of smiles generated in the present research are currently used in our laboratory to analyze spontaneous smiles of derision (Carranza et al., 2012) and smiles displayed by the candidates during the 2012 Presidential and Vice-Presidential Debates.

5.6 Conclusions

Taken together, the studies reported in this dissertation explore facial expression processing by using the smile as a case study. Our findings highlight the importance of eye contact and facial mimicry for the accurate judgment of facial expressions. We also provide compelling evidence linking pacifier use – analogous to certain mimicry-blocking manipulations – to reduced emotional competence. Finally, results of this work support the social-functional typology of smiles proposed by the SIMS model (Niedenthal et al., 2010) and suggest that the historical homogeneity of populations can meaningfully account for cross-cultural differences in facial expressivity and the endorsement of smile functions. Future studies in our research laboratory will build on the results of the present research. Specifically, the complex relationships among eye contact, mimicry, and embodied simulation need to be assessed in more ecological paradigms, or in the experiments controlling participants' eye gaze. Also, in order to shed more light on misunderstanding and misattributions with regard to out-group emotions (Chambers, Baron, & Inman, 2006; Elfenbein & Ambady, 2002), new studies on facial mimicry will examine facial responses in intergroup contexts. Studying facial expression processing in ecological contexts or in clinical populations such as facial palsy patients is another promising avenue for research on the role of facial mimicry. Finally, descriptions of the prototypical movements involved in pleasure, affiliative, and dominance smiles, described in Niedenthal et al. (2010) will guide the exploration of real-world instances of these smiles. Such studies can not only inform research on emotion and facial expression, but also provide important insights for developing theory in clinical psychology (especially concerning autism, facial paralysis, and other impairments of social-emotional behavior), social robotics, and game studies.

REFERENCES

- Abdi, H. (2007). Signal detection theory. In N.J. Salkind (Ed.): *Encyclopedia of Measurement and Statistics*. Thousand Oaks (CA): Sage. pp. 886-889.
- Abe, J. A., Beetham, M., & Izard, C. (2002). What do smiles mean? An analysis in terms of differential emotions theory. In M. H. Abel, *An empirical reflection on the smile* (pp. 83-110). Lewiston, NY: Edwin Mellen Press.
- Abel, M. H. (2002). The elusive nature of smiling. In M.H. Abel (Ed.), *An empirical reflection on the smile* (pp. 1-13). Lewiston, NY: Edwin Mellen Press.
- Abu-Lughod, L. (1986). *Veiled sentiments: Honor and poetry in a Bedouin society*. Berkeley: University of California Press.
- Adam, E. K. (2004). Beyond quality: Parental and residential stability and children's adjustment. *Current Directions in Psychological Sciences*, 13, 210–213. DOI: 10.1111/j.0963-7214.2004.00310.x
- Adams, R., & Kleck, R. E. (2003). Perceived gaze direction and the processing of facial displays of emotion. *Psychological Science*, 14, 644-647. DOI: 10.1046/j.0956-7976.2003.psci_1479.x
- Adams, R., & Kleck, R. E. (2005). The effects of direct and averted gaze on the perception of facially communicated emotion. *Emotion*, 5, 3-11. DOI: 10.1037/1528-3542.5.1.3
- Adams, S., Kuebli, J., Boyle, P., & Fivush, R. (1995). Gender differences in parent-child conversations about past emotions: A longitudinal investigation. *Sex Roles*, 33, 309–323. DOI: 10.1007/BF01954572
- Adolphs, R. (2002). Recognizing emotion from facial expressions: Psychological and neurological mechanisms. *Behavioral and Cognitive Neuroscience Reviews*, 1(1), 21–62. DOI: 10.1.1.135.9369
- Adolphs, R., Damasio, H., Tranel, D., Cooper, G., & Damasio, A. R. (2000). A role for somatosensory cortices in the visual recognition of emotion as revealed by 3-D lesion mapping. *Journal of Neuroscience*, 20, 2683-2690. DOI: 10.1.1.132.43
- Ahumada, A. & Lovell, J. (1971). Stimulus features in signal detection. *Journal of the Acoustical Society of America*, 49, 1751-1756. DOI: 10.1121/1.1912577
- Alesina A., Baqir, R., & Easterly, W. (1999), Public goods and ethnic divisions. *Quarterly Journal of Economics*, 114, 1243-1284. DOI: 10.1162/003355399556269

- Alesina, A., Devleeschauwer, A., Easterly, W., Kurlat, S., & Wacziarg, R. (2003). Fractionalization. *Journal of Economic Growth*, 8(2), 155-194, DOI:10.1023/A:1024471506938
- Ambadar, Z., Cohn, J. F., & Reed, L. I. (2009). All smiles are not created equal: Morphology and timing of smiles perceived as amused, polite, and embarrassed/nervous. *Journal of Nonverbal Behavior*, 33, 17-34. DOI: 10.1.1.173.1641
- Atkinson, A. P. (2007). Face processing and empathy. *Empathy in Mental Illness*, 360-385. Cambridge University Press.
- Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, 68(3), 255-278. DOI: 10.1016/j.jml.2012.11.001
- Baumeister, R. F. (1987). How the self became a problem: A psychological review of historical research. *Journal of Personality and Social Psychology*, 52(1), 163-176, DOI: 10.1037//0022-3514.52.1.163
- Bavelas, J. B., Black, A., Lemery, C. R., & Mullett, J. (1986). "I show how you feel": Motor mimicry as a communicative act. *Journal of Personality and Social Psychology*, 50, 322-329. DOI: 1986-14425-001
- Bayes, M. A. (1972). Behavioral cues of interpersonal warmth. *Journal of Consulting and Clinical Psychology; Journal of Consulting and Clinical Psychology*, 39(2), 333, DOI: 10.1037/h0033367
- Beaupré, M. G., & Hess, U. (2003). In my mind, we all smile: A case of in-group favoritism. *Journal of Experimental Social Psychology*, 39(4), 371-377, DOI: 10.1016/S0022-1031(03)00012-X
- Berry, J. W. (1976). *Human ecology and cognitive style*. New York: John Wiley.
- Blairy, S., Herrera, P., & Hess, U. (1999). Mimicry and the judgment of emotional facial expressions. *Journal of Nonverbal Behavior*, 23, 5-41. DOI: 10.1023/A:1021370825283
- Blanz, V., Vetter, T. A morphable model for the synthesis of 3D faces. Proceedings of the ACM SIGGRAPH; 1999, *ACM Digital Library*. DOI: 10.1145/311535.311556
- Blasius, J., & Greenacre, M. (Eds.). (1997). *Visualization of categorical data*. San Diego, CA: Academic Press.
- Boas, F. (1896). The limitations of the comparative method of anthropology. *Science*, 4, 901-908. DOI: 10.1126/science.4.103.901
- Bogart, K. R., & Matsumoto, D. (2010). Facial mimicry is not necessary to recognize emotion: Facial expression recognition by people with Moebius syndrome. *Social Neuroscience*, 5(2), 241-251. DOI: 10.1080/17470910903395692
- Boone, R. T., & Buck, R. (2003). Emotional expressivity and trustworthiness: The role of nonverbal behavior in the evolution of cooperation. *Journal of Nonverbal Behavior*, 27(3), 163-182, DOI: 10.1023/A:1025341931128

- Brauer, M. (2002). L'analyse des variables indépendantes continues et catégorielles: alternatives à la dichotomisation. *L'Année Psychologique*, 102, 449-484.
- Brewer, P., & Venaik, S. (2011). Individualism–Collectivism in Hofstede and GLOBE. *Journal of International Business Studies*, 42, 436-445. DOI: 10.1057/jibs.2010.62
- Briggs, J. L. (1970). *Never in anger; portrait of an Eskimo family*. Cambridge: Harvard University Press.
- Brody, L. R. (2000). The socialization of emotion: Display rules, infant temperament, and differentiation. In A. Fischer (Ed.), *Gender and emotion* (pp. 24–47). Cambridge, England: Cambridge University Press.
- Brown, W. M., Palameta, B., & Moore, C. (2003). Are there nonverbal cues to commitment? An exploratory study using the zero-acquaintance video presentation paradigm. *Evolutionary Psychology*, 1, 42–69.
- Buck, R. (1979). Measuring individual differences in the nonverbal communication of affect: The slide-viewing paradigm. *Human Communication Research*, 6, 47-57. DOI: 10.1111/j.1468-2958.1979.tb00290.x
- Buck, R. (1984). *The communication of emotion*. Guilford Press.
- Campos, J., Thein, S., & Owen, D. (2003). A Darwinian legacy to understanding human infancy. *Annual NY Academy of Science*, 1000, 110–134. DOI: 10.1196/annals.1280.040
- Camras, L. A., Oster, H., Campos, J., Campos, R., Ujiie, T., Miyake, K., ... & Meng, Z. (1998). Production of emotional facial expressions in European American, Japanese, and Chinese infants. *Developmental Psychology*, 34(4), 616, DOI: 10.1037/0012-1649.34.4.616
- Carranza, E., Prentice, D. A., Larsen, J. T (2009). *Derisive response to dominance and deviance*. Manuscript in preparation, Department of Psychology, Princeton University, Princeton, USA.
- Cashdan, E. (2004). Smiles, speech, and body posture: How women and men display sociometric status and power. *Journal of Nonverbal Behavior*, 22, 209-228. DOI: 10.1023/A:1022967721884
- Chambers, J. R., Baron, R. S., & Inman, M. L. (2006). Misperceptions in intergroup conflict: Disagreeing about what we disagree about. *Psychological Science*, 17, 38–45. DOI:10.1111/j.1467-9280.2005.01662.x
- Cohen, J. (1992). A power primer. *Psychological Bulletin*, 112, 155-159. DOI: 10.1037/0033-2909.112.1.155
- Cross, K. (2013). *Neural systems for preparatory and reactive imitation control*. (Doctoral dissertation). Retrieved from eScholarship (<http://www.escholarship.org/uc/item/4cj0x4pk>)

- Cross, K. A., Torrisi, S., Reynolds Losin, E. A., & Iacoboni, M. (2013). Controlling automatic imitative tendencies: Interactions between mirror neuron and cognitive control systems. *NeuroImage*, 83, 493-504. DOI: 10.1016/j.neuroimage.2013.06.060
- Dailey, M. N., Cottrell, G. W., Padgett, C., & Adolphs, R. (2002). EMPATH: A neural network that categorizes facial expressions. *Journal of cognitive neuroscience*, 14, 1158–1173. DOI: 10.1.1.152.8946
- Darwin, C. (1872/1998). *The expression of the emotions in man and animals*. New York/Oxford: Oxford University Press.
- Davidson, R. J., Ekman, P., Saron, C. D., Senulis, J. A., & Friesen, W. V. (1990). Approach-Withdrawal and Cerebral Asymmetry: Emotional Expression and Brain Physiology I. *Journal of Personality and Social Psychology*, 2, 330-341. DOI: 1990-14037-001
- Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology*, 44, 113–126. DOI: 10.1037/0022-3514.44.1.113
- D’Andrade, R. (2001). A cognitivist’s view of the units debate in cultural anthropology. *Cross-Cultural Research*, 35, 242–257. DOI: 10.1177/106939710103500208
- Decety, J., & Chaminade, T. (2003). Neural correlates of feeling sympathy. *Neuropsychologia*, 41, 127-138. DOI: 10.1016/S0028-3932(02)00143-4
- Decety, J., & Chaminade, T. (2005). The neurophysiology of imitation and intersubjectivity. *Perspectives on imitation: From neuroscience to social science: Vol. 1: Mechanisms of imitation and imitation in animals* (pp. 119-140). Cambridge, MA US: MIT Press.
- Decety, J., & Grezes, J. (2006). The power of simulation: Imagining one’s own and other’s behavior. *Brain Research*, 1079, 4–14. DOI: 10.1016/j.brainres.-2005.12.115
- Decety, J., & Sommerville, J. A. (2003). Shared representations between self and other: A social cognitive neuroscience view. *Trends in Cognitive Sciences*, 7(12), 527-533. DOI: 10.1016/j.tics.2003.10.004
- Dimberg, U. (1997). Facial reactions: Rapidly evoked emotional responses. *Journal of Psychophysiology*, 11, 115–123. DOI: 1997-43304-002
- Dimberg, U., & Lundqvist, L.-O. (1990). Gender differences in facial reactions to facial expressions. *Biological Psychology*, 30, 151–159. DOI: 10.1016/0301-0511(90)90024-Q
- Dimberg, U., & Thunberg, M. (1998). Rapid facial reactions to emotional facial expressions. *Scandinavian Journal of Psychology*, 39, 39-45, DOI: 10.1111/1467-9450.00054
- Doherty, R. W. (1997). The Emotional Contagion Scale: A measure of individual differences. *Journal of Nonverbal Behavior*, 21, 131-154. DOI: 10.1023/A:1024956003661
- Duchenne de Boulogne, C.-B. (1990). *The mechanism of human facial expression*. Cambridge: Cambridge University Press. (Original work published 1862)

- Eibl-Eibesfeldt, I. (1972). Similarities and differences between cultures in expressive movements. In R.A. Hinde (Ed.), *Non-verbal communication*. Cambridge: Cambridge University Press.
- Ekman, P. (1972). Universals and cultural differences in facial expressions of emotion. In J. Cole (Ed.), *Nebraska Symposium on Motivation*, 1971 (Vol. 19, pp. 207–283). Lincoln: University of Nebraska Press.
- Ekman, P. (1973). Cross-cultural studies of emotion. In P. Ekman (Ed.), *Darwin and facial expression: A century of research in review* (pp. 169-222). New York: Academic Press.
- Ekman, P. (1989). The argument and evidence about universals in facial expressions of emotion. In H. Wagner & A. Manstead (Eds.), *Handbook of Psychophysiology: The Biological Psychology of the Emotions and Social Processes* (pp. 143-164). London: John Wiley Ltd.
- Ekman, P. (1992). An argument for basic emotions. *Cognition & Emotion*, 6(3-4), 169-200. DOI:10.1080/02699939208411068
- Ekman, P. (1994). Strong evidence for universals in facial expression: A reply to Russell's mistaken critique. *Psychological Bulletin*, 115, 268 – 287. DOI: 10.1037/0033-2909.115.2.268
- Ekman, P. (2001) *Telling Lies: Clues to deceit in the marketplace, politics, and marriage*. New York, NY: WW Norton & Company.
- Ekman, P., & Davidson, R. (1993). Voluntary smiling changes regional brain activity. *Psychological Science*, 4, 342-345. DOI: 10.1111/j.1467-9280.1993.tb00576.x
- Ekman, P., Davidson, R. J., & Friesen, W.V. (1990). The Duchenne smile: Emotional expression and brain physiology II, *Journal of Personality and Social Psychology*, 58, 342-353, DOI: 10.1037/0022-3514.58.2.342
- Ekman, P., & Friesen, W. V. (1969). The repertoire of non-verbal behavior: Categories, origins, usage, and coding. *Semiotica*, 1, 49-98.
- Ekman, P., & Friesen, W. V. (1971). Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology*, 17(2), 124-129. DOI:10.1037/h0030377
- Ekman, P., & Friesen, W. V. (1975). *Unmasking the face: A guide to recognizing emotions from facial expressions*. Englewood Cliffs, N.J.: Prentice-Hall.
- Ekman, P., & Friesen, W. V. (1982). Felt, false and miserable smiles. *Journal of Nonverbal Behavior*, 6, 238-252. DOI: 10.1007/BF00987191
- Ekman, P., & Friesen, W. V. (1986). A new pan-cultural facial expression of emotion. *Motivation and Emotion*, 10(2), 159-168. DOI: 10.1007/BF00992253
- Ekman, P., Friesen, W. V., & Hager, J. C. (Eds.). (2002). *Facial Action Coding System* [E-book]. Salt Lake City, UT: Research Nexus.

- Elfenbein, H. A., & Ambady, N. (2002). On the universality and cultural specificity of emotion recognition: a meta-analysis. *Psychological Bulletin*, 128(2), 203. DOI: 10.1037//0033-2909.128.2.203
- Elfenbein, H. A., Beaupré, M., Lévesque, M., & Hess, U. (2007). Toward a dialect theory : Cultural differences in the expression and recognition of posed facial expressions. *Emotion*, 7, 131-146, DOI: 10.1037/1528-3542.7.1.131
- Er-rafiy, A., & Brauer, M. (2013). Modifying perceived variability: four laboratory and field experiments show the effectiveness of a ready-to-be-used prejudice intervention. *Journal of Applied Social Psychology*, 43, 840-853. DOI: 10.1111/jasp.12010
- Farroni T, Csibra G, Simion, F., & Johnson, M. H. (2002). Eye contact detection in humans from birth. *Proceedings of the National Academy of Sciences of the United States of America*, 99, 9602-9605. DOI: 10.1073/pnas.152159999
- Fincher, C. L., Thornhill, R., Murray, D. R., Schaller, M. (2008). Pathogen prevalence predicts human cross-cultural variability in individualism/collectivism. *Proceedings of the Royal Society B: Biological Sciences*, 275(1640), 1279-1285, DOI: 10.1098/rspb.2008.0094
- Fischer, A. H. (Ed.). (2000). *Gender and emotion: Social psychological perspectives* (pp. 71–94). London, England: Cambridge University Press.
- Fischer, A. H., Becker, D., & Veenstra, L. (2012). Emotional mimicry in social context: The case of disgust and pride. *Frontiers in Psychology*, 3, DOI: 10.3389/fpsyg.2012.00475
- Fiske, A. P. (1992). The four elementary forms of sociality: framework for a unified theory of social relations. *Psychological review*, 99(4), 689. DOI: 1993-05502-001
- Fiske, A. P., Kitayama, S., Markus, H. R., & Nisbett, R. E. (1998). The cultural matrix of social psychology. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *The handbook of social psychology*. Boston: McGraw-Hill.
- Fivush, R., Brotman, M. A., Buckner, J. P., & Goodman, S. H. (2000). Gender differences in parent–child emotion narratives. *Sex Roles*, 42, 233–253. DOI: 10.1023/A:100709-1207068
- Fogel, A., Toda, S., & Kawai, M. (1988). Mother-infant face-to-face interaction in Japan and the United States: A laboratory comparison using 3-month-old infants. *Developmental Psychology*, 24(3), 398. DOI: 10.1037/0012-1649.24.3.398
- Fonagy, P., Gergely, G., Jurist, E., & Target, M. (2002). *Affect regulation, mentalization, and the development of self*. H. Karnac (Books) Ltd.
- Fox, N. A., & Davidson, R. J. (1988). Patterns of brain electrical activity during facial signs of emotion in 10-month old infants. *Developmental Psychology*, 24, 230-236.
- Fraley, R. C., Niedenthal, P. M., Marks, M., Brumbaugh, C., & Vicary, A. (2006). Adult attachment and the perception of emotional expression: Probing the hyperactivating strategies underlying anxious attachment. *Journal of Personality*, 74, 1163–1190. DOI: 10.1111/j.1467-6494.2006.00406.x

- Frank, M. G., & Ekman, P. (1993). Not all smiles are created equal: the differences between enjoyment and nonenjoyment smiles. *Humor*, 6, 9-26. DOI:10.1515/humr.1993.6.1.9
- Frank, M. G., Ekman, P., & Friesen, W. V. (1993). Behavioral markers and recognizability of the smile of enjoyment. *Journal of Personality and Social Psychology*, 64, 83-93, DOI:10.1037/0022-3514.64.1.83
- Frank, M., & Stennett, J. (2001). The forced-choice paradigm and the perception of facial expression of emotion. *Journal of Personality and Social Psychology*, 80, 75-85. DOI: 10.1037/0022-3514.80.1.75
- Fridlund, A. J., & Cacioppo, J. T. (1986). Guidelines for human electromyographic research. *Psychophysiology*, 23, 567-89. DOI: 10.1111/j.1469-8986.1986.tb00676.x
- Fridlund, A. J. (1991). The sociality of solitary smiling: Potentiation by an implicit audience. *Journal of Personality and Social Psychology*, 60, 229-40. DOI: 1991-18314-001
- Fridlund, A. J. (1994). *Human facial expression: An evolutionary view*. New York: Academic Press.
- Fridlund, A. J. (2002). The behavioral ecology view of smiling and other facial expressions. In M.H. Abel (Eds.), *An empirical reflection on the smile*. Ewin Mellen Press.
- Frischen, A., Bayliss, A. P., & Tipper, S. P. (2007). Gaze cueing of attention: Visual attention, social cognition, and individual differences. *Psychological Bulletin*, 133(4), 694–724. DOI:10.1037/0033-2909.133.4.694
- Gallese, V. (2003). The roots of empathy: The shared manifold hypothesis and the neural basis of intersubjectivity. *Psychopathology*, 36, 171-180. DOI: 10.1159/000072786
- Gallese, V. (2005). 'Being like me': Self-other identity, mirror neurons, and empathy. In S. Hurley, & N. Chater (Eds.), *Perspectives on imitation: From neuroscience to social science: Vol. 1: Mechanisms of imitation and imitation in animals* (pp. 101-118). Cambridge, MA: MIT Press.
- Gauthier, J., & Bouchard, S. (1993). Adaptation canadienne-française de la forme révisée du State-Trait Anxiety Inventory de Spielberger [A French-Canadian adaptation of the revised version of Spielberger's State-Trait Anxiety Inventory]. *Canadian Journal of Behavioral Science*, 25, 559–578.
- George, M. S., Ketter, T. A., Gill, D. S., Haxby, J. V., Ungerleider, L. G., Herscovitch, P., & Post, R. M. (1993). Brain regions involved in recognizing facial emotion or identity: An oxygen-15 PET study. *The Journal of Neuropsychiatry and Clinical Neurosciences*, 5, 384-394.
- George, N., & Conty, L. (2008). Facing the gaze of others. *Neurophysiologie Clinique/Clinical Neurophysiology*, 38(3), 197-207. DOI: 10.1016/j.neucli.2008.-03.001.
- Giddens, A. (1984). *The constitution of society*. Oxford, England: Polity Press.

- Giddings, F. H. (1906). *Readings in descriptive and historical sociology*. New York: Macmillan.
- Goldman, A., & Sripada, C. (2005). Simulationist models of face-based emotion recognition. *Cognition*, 94, 193-213. DOI: 10.1016/j.cognition.2004.01.005
- Guéguen, N., Fischer-Lokou, J., Lefebvre, L., & Lamy, L. (2008). Women's eye contact and men's later interest: Two field experiments. *Perceptual and Motor Skills*, 106, 63-66.
- Gunnar, M., & Donahue, M. (1980). Sex differences in social responsiveness between six months and twelve months. *Child Development*, 51, 262-265. DOI:10.1111/j.1467-8624.1980.tb02538.x
- Hains, S. M., & Muir, D. W. (1996). Infant sensitivity to adult eye direction. *Child Development*, 67(5), 1940. DOI: 10.2307/1131602
- Halberstadt, J., & Niedenthal, P. M. (2001). Effects of emotion concepts on perceptual memory for emotional expressions. *Journal of Personality and Social Psychology*, 81, 587-598. DOI:10.1037//0022-3514.81.4.587
- Halberstadt, J., Winkielman, P., Niedenthal, P. M., & Dalle, N. (2009). Emotional conception: How embodied emotion concepts guide perception and facial action. *Psychological Science*, 20, 1254-1261. DOI : 10.1111/j.1467-9280.2009.02432.x
- Hauck, F. R., Omojokun, O. O., & Siadaty, M. S. (2005). Do pacifiers reduce the risk of sudden infant death syndrome? A meta-analysis. *Pediatrics*, 116, 716-723. DOI: 10.1542/peds.2004-2631
- Havas, D., Glenberg, A., Gutowski, K., Lucarelli, M., & Davidson, R. (2010). Cosmetic use of botulinum toxin-A affects processing of emotional language. *Psychological Science*, 21, 895-900. DOI: 10.1177/0956797610374742
- Hayes, J. (1974). The Hong Kong region: Its place in traditional Chinese historiography and principal events since the establishment of Hsin-an County in 1573, *Journal of the Royal Asiatic Society Hong Kong Branch*, 14, 108-135.
- Hazard, P. (2013). *The crisis of the European mind: 1680-1715*. New York: New York Review Books.
- Heine, S. J., Lehman, D. R., Markus, H. R., & Kitayama, S. (1999). Is there a universal need for positive self-regard? *Psychological Review*, 106(4), 766, DOI: 10.1037/0033-295X.106.4.766
- Hennenlotter, A., Dresel, C., Castrop, F., Ceballos-Baumann, A. O., Wohlschlager, A. M., & Haslinger, B. (2009). The link between facial feedback and neural activity within central circuitries of emotion--new insights from botulinum toxin-induced denervation of frown muscles. *Cerebral Cortex*, 19, 537-542, DOI: 10.1093/cercor/bhn104
- Hennenlotter, A., Schroeder, U., Erhard, P., Castrop, F., Haslinger, B., Stoecker, D., ... Ceballosbaumann, A. (2005). A common neural basis for receptive and expressive communication of pleasant facial affect. *NeuroImage*, 26, 581-591, DOI: 10.1016/j.neuroimage.2005.01.057

- Hess, U., Beaupré, M. & Cheung, N. (2002). Who to whom and why – Cultural differences and similarities in the function of smiles. In M. Abel (Eds.), *An empirical reflection on the smile*, (pp. 187-216). Edwin Mellen Press.
- Hess, U. & Fischer, A. H. (2013). Emotional mimicry as social regulation. *Personality and Social Psychology Review*, 17, 142-157, DOI: 10.1177/1088868312472607
- Hess, U. & Fischer, A. H. (2014). Emotional mimicry: Why and when we mimic emotions. *Social and Personality Psychology Compass*, 2, 45-57, DOI: 10.1111/spc3.12083
- Hess, U., Adams, R. B., Jr., & Kleck, R. E. (2005). Who may frown and who should smile? Dominance, affiliation, and the display of happiness and anger. *Cognition and Emotion*, 19, 515–36. DOI:10.1080/02699930441000364
- Hess, U., & Thibault, P. (2009). Darwin and emotion expression. *American Psychologist*, 64, 120-128. DOI: 2009-01602-003
- Hietanen, J. K., Leppanen, J. M., Peltola, M. J., Linna-aho, K., & Ruuhiala, H. J. (2008). Seeing direct and averted gaze activates the approach–avoidance motivational brain systems. *Neuropsychologia*, 46, 2423–2430. DOI: 10.1016/j.neuropsychologia.-2008.02.029
- Hinsz, V. B., & Tomhave, J. A. (1991). Smile and (half) the world smiles with you, frown and you frown alone. *Personality and Social Psychology Bulletin*, 17, 586-592. DOI: 10.1177/0146167291175014
- Hofstede, G. (1980). *Culture's consequences: International differences in work-related values*. Beverly Hills, CA: Sage.
- Hofstede, G. (2001). *Culture's consequences. Comparing values, behaviors, institutions, and organizations across nations*. 2nd ed. Thousand Oaks, CA: Sage Publications.
- Holtgraves, T. (1997). Styles of language use: Individual and cultural variability in conversational indirectness. *Journal of Personality and Social Psychology*, 73(3), 624-637. DOI: 10.1037//0022-3514.73.3.624
- House, R. J., Hanges, P. J., Javidan, M., Dorfman, P. W., & Gupta, V. (Eds.). (2004). *Culture, leadership, and organizations: The GLOBE study of 62 societies*. Thousand Oaks, CA: Sage Publications.
- Howard, C. R., Howard, F. M., Lanphear, B., Eberly, S., deBlieck, E. A., Oakes, D., & Lawrence, R. A. (2003). Randomized clinical trial of pacifier use and bottle-feeding or cupfeeding and their effect on breastfeeding. *Pediatrics*, 111, 511–518. DOI: 10.1542/peds.111.3.511
- Iizuka, Y. (1992). Eye contact in dating couples and unacquainted couples. *Perceptual and Motor Skills*, 75, 457-461. DOI: 10.2466/pms.1992.75.2.457
- Iwao S. (1993). *The Japanese Woman: Traditional Image and Changing Reality*. New York: Free Press.
- Izard, C. E. (1971). *The face of emotion*. East Norwalk, CT US: Appleton-Century-Crofts.

- Izard, C. E. (1994). Innate and universal facial expressions: Evidence from developmental and cross-cultural research. *Psychological Bulletin*, 115(2), 288-299, DOI: 10.1037//0033-2909.115.2.288
- Jabbi, M., & Keysers, C. (2008). Inferior frontal gyrus activity triggers anterior insula response to emotional facial expressions. *Emotion*, 8, 775-780, DOI: 10.1037/a0014194.
- Jack, R. E., Garrod, O. G., Yu, H., Caldara, R., & Schyns, P. G. (2012). Facial expressions of emotion are not culturally universal. *Proceedings of the National Academy of Sciences of the United States of America*, 109, 7241. DOI: 10.1073/pnas.1200155109
- Jakobs, E., Manstead, A. S. R., & Fischer, A. H. (2001). Social context effects on facial activity in a negative emotional setting. *Emotion*, 1, 51–69. DOI: 10.1037/1528-3542.1.1.51
- Johnston, L., Miles, L., & Macrae, C. N. (2010). Why are you smiling at me? Social functions of enjoyment and non-enjoyment smiles. *British Journal of Social Psychology*, 49, 107-127, DOI: 10.1348/014466609X412476
- Jones, S. S. (2006). Infants learn to imitate by being imitated. In C. Yu, L.B. Smith, & O. Sporns (Eds.), *Proceedings of the International Conference on Development and Learning: The Tenth International Conference on Development and Learning*. Bloomington, IN: Indiana University.
- Kagan, J., Kearley, R., & Zelazo, P. (1978). *Infancy: its place in human development*. Cambridge, MA: Harvard University Press.
- Kamen, G., & Gabriel, D.A. (2009). *Essentials of electromyography*. Champaign, IL: Human Kinetics.
- Kashima, E.S., Kashima, Y. (1998). Culture and language: The case of cultural dimensions and personal pronoun use. *Journal of Cross-Cultural Psychology*, 29, 461-486. DOI: 10.1177/0022022198293005
- Keltner, D. (1995). Signs of appeasement: Evidence for the distinct displays of embarrassment, amusement, and shame. *Journal of Personality and Social Psychology*, 66(3), 441-54. DOI: 10.1037/0022-3514.68.3.441
- Keltner, D. & Gross, J. J. (1999). Functional accounts of emotions. *Cognition & Emotion*, 13, 467-480. DOI: 10.1080/026999399379140
- Kennedy, L.W. (1984). Residential stability and social contact: Testing for saved versus liberated communities. *Journal of Community Psychology*, 12, 3–12. DOI: 10.1002/1520-6629(198401)12:1
- Keysers, C. & Gazzola, V. (2007). Integrating simulation and theory of mind: from self to social cognition. *Trends in Cognitive Science*, 11, 194-196. DOI: 10.1016/j.tics.2007.02.002
- Kimble, C., & Olszewski, D. (1980). Gaze and emotional expression: The effects of message positivity-negativity and emotional intensity. *Journal of Research in Personality*, 14, 60-69. DOI: 10.1016/0092-6566(80)90040-9

- Kirouac, G., & Hess, U. (1999). Group membership and the decoding of nonverbal behavior. In: *The social context of nonverbal behavior*, pp. 182–210. Cambridge University Press.
- Kiser, E. (2012). *Relationships between the past and present: A typology and analysis*. Paper presented at the Comparative-Historical Section conference “Comparing Past and Present” Berkeley, August 2012.
- Kitayama, S. (2002). Culture and basic psychological processes-Toward a system view of culture: Comment on Oyserman et al. (2002). *Psychological Bulletin*, 128(1), 89-96, DOI: 10.1037//0033-2909.128.1.89
- Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). New York, NY US: Guilford Press.
- Klineberg, O. (1940) *Social Psychology*. New York, NY: Holt.
- Kling, K.C., Ryff, C.D., & Essex, M.J. (1997). Adaptive changes in the self-concept during a life transition. *Personality and Social Psychology Bulletin*, 23, 981–990. DOI: 10.1177/0146167297239008
- Knapik, J.J., Marshall, S.W., Lee, R. B., Darakjy, S.S., Jones, S.B., Mitchener, T.A., DelaCruz, G.G., Jones, B.H. (2007). Mouthguards in sport activities: History, physical properties and injury prevention effectiveness. *Sports Medicine*, 37, 117-144, DOI: 10.1111/j.1600-9657.2008.00586
- Konrad, P. (2005). The ABC of EMG: A practical introduction to kinesiological electromyography. Version 1.0, Noraxon Inc. Retrieved from <http://demotu.org-/aulas/control/ABCOFEMG.pdf>
- Korb, S., With, S., Niedenthal, P., Kaiser, S., & Grandjean, D. (2013). *Mimicking smiles – the role of embodiment in judging smile authenticity*. Manuscript submitted for publication.
- Kotchemidova, C. (2005). From good cheer to "drive-by smiling": A social history of cheerfulness. *Journal of Social History*, 39(1), 5-37, 297. DOI: 10.1353/jsh.2005.0108
- Kraut, R.E., & Johnston, R.E. (1979). Social and emotional messages of smiling: an ethological approach. *Journal of Personality and Social Psychology*, 37, 1539-1553. DOI: 1981-01226-001
- Krumhuber, E.G., & Kappas, A. (2005). Moving smiles. The role of dynamic components for the perception of the genuineness of smiles. *Journal of Nonverbal Behavior*, 29, 3-24, DOI: 10.1007/s10919-004-0887-x.
- Krumhuber, E.G., Likowski, K.U., & Weyers, P. (2014). Facial mimicry of spontaneous and deliberate Duchenne and non-Duchenne smiles. *Journal of Nonverbal Behavior*, 38, 1-11, DOI: 10.1007/s10919-013-0167-8
- Krumhuber, E., Manstead, A. S. R., Cosker, D., Marshall, D., Rosin, P. L. & Kappas, A. (2007). Facial dynamics as indicators of trustworthiness and cooperative behavior. *Emotion*, 7(4), 730-35, DOI: 10.1037/1528-3542.7.4.730

- Krumhuber, E. G., & Manstead, A. S. R. (2009). Can Duchenne smiles be feigned? New evidence on felt and false smiles. *Emotion*, 9, 807-820, DOI: 10.1037/a0017844
- Krumhuber, E., Manstead A. S. R., & Kappas A. (2007b). Temporal aspects of facial displays in person and expression perception. The effects of smile dynamics, head-tilt and gender. *Journal of Nonverbal Behavior*. 31, 39-56, DOI: 10.1007/s10919-006-0019-x
- Kunz, M., Prkachin, K., & Lautenbacher, S. (2013). Smiling in pain: Explorations of its social motives. *Pain Research and Treatment*. DOI: 10.1155/2013/128093
- Landis, C. (1924). Studies of emotional reactions: II. General behavior and facial expression. *Journal of Comparative Psychology*, 4, 447-509.
- LaFrance, M. (2009). What's in a robot's smile? The many meanings of positive facial display. In L. Canamero & R. Aylett (Eds.), *Animating Expressive Characters for Social Interaction*. Amsterdam, The Netherlands: J. D. Benjamin.
- LaFrance, M. (2011). *Lip service: Smiles in life, death, trust, lies, work, memory, sex, and politics*. New York, NY: W. W. Norton & Company.
- LaFrance, M., Hecht, M. A., & Paluck, E. (2003). The contingent smile: A meta-analysis of sex differences in smiling. *Psychological Bulletin*, 129(2), 305-334, DOI:10.1037/0033-2909.129.2.305
- Lau, S. (1982). The effect of smiling on person perception. *Journal of Social Psychology*, 117, 63-67. DOI: 10.1080/00224545.1982.9713408
- Lavallée, M. C. (2008). *Réponses visuelles et réponses faciales des nourrissons aux expressions faciales de leur mère*. (Doctoral dissertation). Retrieved from Archipel UQUAM (<http://www.archipel.uqam.ca/988/1/D1631.pdf>)
- Lewis, M. B. and Bowler, P. J. (2009). Botulinum toxin cosmetic therapy correlates with a more positive mood. *Journal of Cosmetic Dermatology*, 8(1), 24-26. DOI: 10.1111/j.1473-2165.2009.00419.x
- Lipps, T. (1907). *Das Wissen von fremden Ichen [The knowledge of other selves]*. In T. Lipps (Ed.), *Psychologische Untersuchungen (Band 1)*. Leipzig, Germany: Engelmann.
- Littlewort, G., Whitehill, J., Wu, T., Fasel, I., Frank, M., Movellan, J., & Bartlett, M. (2011). The computer expression recognition toolbox (CERT). *2011 IEEE International Conference on Automatic Face & Gesture Recognition (FG 2011)*, 298–305.
- Lohaus, A., Keller, H., & Voelker, S. (2001). Relationships between eye contact, maternal sensitivity and infant crying. *International Journal of Behavioral Development*, 25, 542-548. DOI: 10.1080/01650250042000528
- Losin, E. R., Dapretto, M., & Iacoboni, M. (2010). Culture and neuroscience: Additive or synergistic? *Social Cognitive and Affective Neuroscience*, 5(2-3), 148-158, DOI: 10.1093/scan/nsp058

- Manera, V., Grandi, E., & Colle, L. (2013). Susceptibility to emotional contagion for negative emotions improves detection of smile authenticity. *Frontiers in Human Neuroscience*, 7, DOI: 10.3389/fnhum.2013.00006
- Manktelow, R. T., Tomat, L. R., Zuker, R. M., & Chang, M. (2006). Smile reconstruction in adults with free muscle transfer innervated by the masseter motor nerve: effectiveness and cerebral adaptation. *Plastic and Reconstructive Surgery*, 118, 885-899. DOI:10.1097/01.prs.0000232195.20293.bd
- Maringer, M., Krumhuber, E., Fischer, A. H., & Niedenthal, P. M. (2011). Beyond smile dynamics: Mimicry and beliefs in judgments of smiles. *Emotion*, 11, 181–187. DOI: 10.1037/a0022596.
- Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review*, 98(2), 224, DOI: 10.1177/1745691610375557
- Marter, A., & Agruss, J. C. (2007). Pacifiers: An update on use and misuse. *Journal for Specialists in Pediatric Nursing*, 12, 278–285. DOI:10.1111/j.1744-6155.2007.00126.x
- Matsumoto, D. (1989). Cultural influences on the perception of emotion. *Journal of Cross-Cultural Psychology*, 20(1), 92-105, DOI: 10.1177/0022022189201006
- Matsumoto, D. (1990). Cultural similarities and differences in display rules. *Motivation and Emotion*, 14(3), 195-214, DOI: 10.1007/BF00995569
- Matsumoto, D. (1993). Ethnic differences in affect intensity, emotion judgments, display rule attitudes, and self-reported emotional expression in an American sample. *Motivation and Emotion*, 17(2), 107-123, DOI: 10.1007/BF00995188
- Matsumoto, D., Kasri, F., & Kookan, K. (1999). American-Japanese cultural differences in judgements of expression intensity and subjective experience. *Cognition & Emotion*, 13(2), 201-218, DOI: 10.1080/026999399379339
- Matsumoto, D., & Kudoh, T. (1993). American-Japanese cultural differences in attributions of personality based on smiles. *Journal of Nonverbal Behavior*, 17(4), 231-243, DOI: 10.1007/BF00987239
- Matsumoto, D., Takeuchi, S., Andayani, S., Kouznetsova, N., & Krupp, D. (1998). The contribution of Individualism-collectivism to cross-national differences in display rules. *Asian Journal of Social Psychology*, 1, 147–165. DOI: 10.1111/1467-839X.00010
- Matsumoto, D., Yoo, S. H., Hiramaya, S., & Petrova, G. (2005). Validation of an individual-level measure of display rules: The Display Rule Assessment Inventory (DRAI). *Emotion*, 5(1), 23-40, DOI: 10.1037/1063-4269.5.1.23
- Matsumoto, D., Yoo, S., Fontaine, J., Anguas-Wong, A., Arriola, M., Ataca, B., & ... Grossi, E. (2008). Mapping expressive differences around the world: The relationship between emotional display rules and individualism versus collectivism. *Journal of cross-cultural psychology*, 39(1), 55-74, DOI: 10.1177/0022022107311854

- Mehu, M., & Dunbar, R. I. M. (2008). Naturalistic observations of smiling and laughter in human group interactions. *Behaviour*, 145, 1747–1780.
- Meister, I. G., Wu, A. D., Deblieck, C., & Iacoboni, M. (2012). Early semantic and phonological effects on temporal- and muscle-specific motor resonance. *European Journal of Neuroscience*, 36, 1-9, DOI: 10.1111/j.1460-9568.2012.08134.x
- Mermillod, M., Niedenthal, P., Rychlowska, M., Droit-Volet, S., Beffara, B., Vermeulen, N. (2013). *How good is a smile of a serial killer? Social information induces early modulation of neural and electromyographical responses to facial expressions*. Manuscript submitted for publication.
- Messinger, D. S., Cassel, T. D., Acosta, S. I., Ambadar, Z., & Cohn, J. F. (2008). Infant smiling dynamics and perceived positive emotion. *Journal of Nonverbal Behavior*, 32, 133–155, DOI: 10.1007/s10919-008-0048-8.
- Messinger, D. S., Fogel, A. & Dickson, K. L. (2001) All smiles are positive, but some smiles are more positive than others. *Developmental Psychology*, 37, 642–53. DOI: 10.1037//0012-1649.37.5.642
- Mesquita, B. & Ellsworth, P. (2001). The role of culture in appraisal. In K. Scherer, A. Schorr, & T. Johnstone, (Eds.), *Appraisal Processes in Emotion: Theory, Methods, Research* (pp. 233–48). New York: Oxford University Press.
- Mesquita, B., & Frijda, N.H. (1992). Cultural variations in emotions: a review. *Psychological Bulletin*, 112, 179-204. DOI: 1993-05618-001
- Mesquita, B., Frijda, N. H., & Scherer, K. R. (1997). Culture and emotion. In J. W. Berry, P. R. Dasen, & T. S. Saraswathi (Eds.), *Handbook of cross-cultural psychology: Vol. 2*. (pp. 255–297). Needham Heights, MA: Allyn & Bacon.
- McGinley, H., McGinley, P., & Nicholas, K. (1978). Smiling, body position, and interpersonal attraction. *Bulletin of the Psychonomic Society*, 12, 21-24. DOI: 10.3758/BF03329613
- McIntosh, D. (1996). Facial feedback hypotheses: Evidence, implications, and directions. *Motivation and Emotion*, 20, 121-147. DOI: 10.1007/BF02253868
- Miellet, S., Hoogenboom, N., & Kessler, K. (2012). Visual and embodied perception of others: The neural correlates of the "body gestalt" effect. *Journal of Vision*, 12, 824-824, DOI: 10.1167/12.9.824
- Mikolajczak, M., Luminet, O., Leroy, C., & Roy, E. (2007). Psychometric properties of the Trait Emotional Intelligence Questionnaire: Factor structure, reliability, construct, and incremental validity in a French-speaking population. *Journal of Personality Assessment*, 88, 338–353.
- Miles, L. & Johnston, L. (2007). Detecting happiness: Perceiver sensitivity to enjoyment and non-enjoyment smiles. *Journal of Nonverbal Behavior*, 31, 259-275, DOI: 10.1007/s10919-007-0036-4

- Mitchell, E. A., Blair, P. S., & L'Hoir, M. P. (2006). Should pacifiers be recommended to prevent sudden infant death syndrome? *Pediatrics*, 117, 1755–1758. DOI: 10.1542/peds.2005-1625
- Mojzisch, A., Schilbach, L., Helmert, J., Pannasch, S., Velichkovsky, B., & Vogeley, K. (2006). The effects of self-involvement on attention, arousal, and facial expression during social interaction with virtual others: A psychophysiological study. *Social Neuroscience*, 1, 184–195. DOI: 10.1080/17470910600985621
- Mueser, K. T., Grau, B. W., Sussman, S., & Rosen, A. J. (1984). You're only as pretty as you feel: Facial expression as a determinant of physical attractiveness. *Journal of Personality and Social Psychology*, 46(2), 469. DOI: 10.1037/0022-3514.46.2.469
- Myers, L., & Sirois, M. J. (2006). Spearman correlation coefficients, differences between. *Encyclopedia of Statistical Sciences*, DOI: 10.1002/0471667196.ess5050.pub
- Nakane, C. (1967). *Tate-shakai no ningen-kankei: Tanitsu shakai no riron (Human relations in a hierarchical society: a theory of homogeneous society)*. Tokyo: Kodansha.
- Neal, D. T., & Chartrand, T. (2011). Embodied emotion perception: Amplifying and dampening facial feedback modulates emotion perception accuracy. *Social Psychological and Personality Science*, 2, 673-678. DOI: 10.1177/1948550611406138
- Niedenthal, P. M. (2007). Embodying emotion. *Science*, 316, 1002–1005.
- Niedenthal, P. M. (2008). Emotion concepts. In M. Lewis, J. M. Haviland-Jones & L. F. Barrett (Eds.), *Handbook of emotion*. Guilford Press.
- Niedenthal, P., Brauer, M., Halberstadt, J., & Innes-Ker, A. (2001). When did her smile drop? Facial mimicry and the influence of emotional state on the detection of change in emotional expression. *Cognition and Emotion*, 15, 853-864. DOI: 10.1080/-02699930143000194
- Niedenthal, P. M., Mermillod, M., Maringer, M., & Hess, U. (2010). The simulation of smiles (SIMS) model: Embodied simulation and the meaning of facial expression. *Behavioral and Brain Sciences*, 33, 417-433. DOI: 10.1017/S0140525X10000865
- Nisbett, R. E., & Cohen, D. (1996). *Culture of honor*. Boulder, CO: Westview Press.
- Norusis, M. J. (2011). *IBM SPSS Statistics 19 Statistical Procedures Companion*. US: Pearson Press.
- O'Doherty, J., Winston, J., Critchley, H., Perrett, D., Burt, D., & Dolan, R. (2003). Beauty in a smile: The role of medial orbitofrontal cortex in facial attractiveness. *Neuropsychologia*, 41(2), 147-155. DOI: 10.1016/S0028-3932(02)00145-8
- Oberman, L., Winkielman, P., & Ramachandran, V. S. (2007). Face to face: Blocking facial mimicry can selectively impair recognition of emotional expressions. *Social Neuroscience*, 2, 167-178. DOI: 10.1080/17470910701391943

- Öhman A, Lundqvist D, Esteves F. (2001). The face in the crowd revisited: A threat advantage with schematic stimuli. *Journal of Personality and Social Psychology*, 80, 381-396. DOI: 10.1037/0022-3514.80.3.381
- Oishi, S. (2010). The psychology of residential mobility: Implications for the self, social relationships, and well-being. *Perspectives on Psychological Science*, 5, 5-21. DOI: 10.1177/1745691609356781
- Oishi, S., & Graham, J. (2010). Social ecology: Lost and found in psychological science. *Perspectives on Psychological Science*, 5(4), 356-377. DOI: 10.1177/1745691-610374588
- Oishi, S., Lun, J., & Sherman, G.D. (2007). Residential mobility, self-concept, and positive affect in social interactions. *Journal of Personality and Social Psychology*, 93, 131-141. DOI: 10.1037/0022-3514.93.1.131
- Oishi S., Miao, F. F., Koo, M., Kisling, J., & Ratliff, K. A. (2012). Residential mobility breeds familiarity-seeking. *Journal of Personality and Social Psychology*, 102, 149-162. DOI: 10.1037/a0024949
- Otta, E., Abrosio, F. F. E., & Hoshino, R. L. (1996). Reading a smiling face: Messages conveyed by various forms of smiling. *Perceptual and Motor Skills*, 82(3c), 1111-1121, DOI: 10.2466/pms.1996.82.3c.1111
- Oyserman, D., Coon, H., & Kemmelmeier, M. (2002). Rethinking individualism and collectivism: Evaluation of theoretical assumptions and meta-analyses. *Psychological Bulletin*, 128, 3-72. DOI: 10.1037/0033-2909.128.1.3
- Parr, L. A., & Waller, B. M. (2006). Understanding chimpanzee facial expression: insights into the evolution of communication. *Social Cognitive and Affective Neuroscience*, 1(3), 221-228, DOI: 10.1093/scan/nsl031
- Parr, L. A., Waller, B. M., & Vick, S. J. (2007). New developments in understanding emotional facial signals in chimpanzees. *Current Directions in Psychological Science*, 16, 117-122. DOI: 10.1111/j.1467-8721.2007.00487.x
- Pennebaker, J. W., Rimé, B., & Blankenship, V. E. (1996). Stereotypes of emotional expressiveness of Northerners and Southerners: A cross-cultural test of Montesquieu's hypotheses. *Journal of Personality and Social Psychology*, 70(2), 372-380, DOI: 10.1037/0022-3514.70.2.372
- Petrides, K. V., Sangareau, Y., Furnham, A., & Frederickson, N. (2006). Trait emotional intelligence and children's peer relations at school. *Social Development*, 15, 537-547. DOI: 10.1111/j.1467-9507.2006.00355.x
- Pierce, M., Cockburn, J., Gordon, I., Butler, S., Dison, L., & Tanaka, J. (2009). In *All Hands Meeting of the Temporal Dynamics of Learning Center*, UCSD.
- Pitcher, D., Garrido, L., Walsh, V., & Duchaine, B. C. (2008). Transcranial magnetic stimulation disrupts the perception and embodiment of facial expressions. *The Journal of Neuroscience*, 28, 8929-8933, DOI: 10.1523/j.neurosci.1450-08.2008

- Ponari, M., Conson, M., D'Amico, N. P., Grossi, D., & Trojano, L. (2012). Mapping correspondence between facial mimicry and emotion recognition in healthy subjects. *Emotion, 12*, 1398-1403, DOI: 10.1037/a0028588
- Proffitt, D. R. (2006). Embodied perception and the economy of action. *Perspectives on Psychological Science, 1*, 110-122, DOI: 10.1111/j.1745-6916.2006.00008.x
- Pulvermüller, F., & Fadiga, L. (2010). Active perception: Sensorimotor circuits as a cortical basis for language. *Nature Reviews Neuroscience, 11*, 351-360, DOI: 10.1038/nrn2811
- Putterman, L., & Weil, D.N. (2010). Post-1500 population flows and the long-run determinants of economic growth and inequality. *The Quarterly Journal of Economics, 125*, 1627-1682. DOI: 10.1162/qjec.2010.125.4.1627
- Putnam, R. (1993). *Making democracy work*. Princeton, NJ: Princeton University Press.
- Reis, H. T., Wilson, I. M., Monestere, C., Bernstein, S., Clark, K., & Seidl, E. (1990). What is smiling is beautiful and good. *European Journal of Social Psychology, 20*, 259-267. DOI: 10.1002/ejsp.2420200307
- Rosen, W., Adamson, L., & Bakeman, R. (1992). An experimental investigation of infant social referencing: Mother's messages and gender differences. *Developmental Psychology, 28*, 1172-1178. DOI:10.1037/0012-1649.28.6.1172
- Ross, E. D. & Pulusu, V. K. (2012). Posed versus spontaneous facial expressions are modulated by opposite cerebral hemispheres. *Cortex, 49*, 1280-1291. DOI: 10.1016/j.cortex.2012.05.002
- Rovers, M. M., Numan, M. E., Langenbach, E., Grobbee, D. E., Verheij, T. J., & Schilder, A. G. (2008). Is pacifier use a risk factor for acute otitis media? A dynamic cohort study. *Family Practice, 25*, 233-236. DOI: 10.1093/fampra/cmn030
- Russo, N. (1975). Eye contact, interpersonal distance, and the equilibrium theory. *Journal of Personality and Social Psychology, 31*, 497-502. DOI : 10.1037/h0076476
- Ryan, C. S., Judd, C. M., & Park, B. (1996). Effects of racial stereotypes on judgments of individuals: The moderating role of perceived group variability. *Journal of Experimental Social Psychology, 32*, 71-103. DOI:10.1006/jesp.1996.0004
- Rychlowska, M., Jack, R. E., Garrod, O.G.B., Schyns, P.G., & Niedenthal, P. (2014). *What's in a smile? Specific facial actions combine with zygomaticus major in expressions of pleasure, affiliation and dominance*. Manuscript in preparation.
- Rychlowska, M., Niedenthal, P.M., Korb, S., Brauer, M., Droit-Volet, S., Augustinova, M., & Zinner, L. (2013). *Pacifiers disrupt adults' responses to infants' emotions*. Manuscript submitted for publication.
- Sabatelli, R. M., & Rubin, M. (1986). Nonverbal expressiveness and physical attractiveness as mediators of interpersonal perceptions. *Journal of Nonverbal Behavior, 10*(2), 120-133, DOI: 10.1007/BF01000008

- Sampson, R.J. (1991). Linking the micro- and macrolevel dimensions of community social organization. *Social Forces*, 70, 43-64. DOI: 10.1093/sf/70.1.43
- Sato, W., Fujimura, T., Kochiyama, T., & Suzuki, N. (2013). Relationships among facial mimicry, emotional experience, and emotion recognition. *PLOS ONE*, 8, 1-8. DOI: 10.1371/journal.pone.0057889
- Sato, A. & Itakura, S. (2013). Intersubjective action-effect binding: Eye contact modulates acquisition of bidirectional association between our and others' actions. *Cognition*, 127, 383-390. DOI : 10.1016/j.cognition.2013.02.010
- Scharlemann, J. P. W., Eckel, C. C., Kacelnik, A., & Wilson, R. K. (2001). The value of a smile: Game theory with a human face. *Journal of Economic Psychology*, 22, 617-640. DOI: 10.1.1.42.1210
- Schilbach, L., Eickhoff, S. B., Mojzisch, A., & Vogeley, K. (2008). What's in a smile? Neural correlates of facial embodiment during social interactions. *Social Neuroscience*, 3, 37-50. DOI: 10.1080/17470910701563228
- Schrammel, F., Pannasch, S., Graupner, S.-T., Mojzisch, A., & Velichovsky, B. M. (2009). Virtual friend or threat? The effects of facial expression and gaze interaction on psychophysiological responses and emotional experience. *Psychophysiology*, 46, 922-931. DOI: 10.1111/j.1469-8986.2009.00831.x
- Senior, C., Phillips, M. L., Barnes, J., & David, A. S. (1999). An investigation into the perception of dominance from schematic faces: A study using the World-Wide Web. *Behavior Research Methods*, 31(2), 341-346, DOI: 10.3758/BF03207730
- Shore, D.M., & Heerey, E.A. (2011). The value of genuine and polite smiles. *Emotion*, 11, 169-174, DOI: 10.1037/a0022601.
- Shrout, P. E., & Fiske, D. W. (1981). Nonverbal behaviors and social evaluation1. *Journal of Personality*, 49(2), 115-128, DOI: 10.1111/j.1467-6494.1981.tb00732.x
- Shweder, R.A., & Much, N.C. (1987). Determinations of meaning: Discourse and moral socialization. In W. Kurtines & J. Gewirtz (Eds.), *Moral development through social interaction* (pp. 197-244). New York: Wiley.
- Sigman, M., & Kasari, C. (1994). *Social referencing shared attention and empathy in infants*. Paper presented at the International Conference on Infant Studies, Paris France.
- Simpson, J. A., Rholes, W. S., & Phillips, D. (1996). Conflict in close relationships: An attachment perspective. *Journal of Personality and Social Psychology*, 71, 899-914. DOI:10.1037/0022-3514.71.5.899
- Slessor, G., Bailey, P. E., Rendell, P.G., Ruffman, T., Henry, J. D., & Miles, L. K. (in press). Examining the time-course of young and older adults' mimicry of enjoyment and non-enjoyment smiles. *Emotion*.
- Smith, J. D., Wilson, M., & Reisberg, D. (1995). The role of subvocalization in auditory imagery. *Neuropsychologia*, 33, 1433-1454. DOI: 10.1.1.211.6924

- Smith, M.L., Cottrell, G., Gosselin, F. & Schyns, P.G. (2005) Transmitting and decoding facial expressions of emotions. *Psychological Science*, 16, 184-189. DOI: 10.1111/j.0956-7976.2005.00801.x
- Sonnby-Borgström, M. (2002). Automatic mimicry reactions as related to differences in emotional empathy. *Scandinavian Journal of Psychology*, 43, 433-443. DOI: 10.1111/1467-9450.00312
- Soussignan, R. (2002). Duchenne smile, emotional experience, and autonomic reactivity: A test of the facial feedback hypothesis. *Emotion*, 2, 52-74. DOI: 10.1037/1528-3542.2.1.52
- Soussignan, R., Chadwick, M., Philip, L., Conty, L., Dezechache, G., & Grèzes, J. (2012). Self-Relevance Appraisal of Gaze Direction and Dynamic Facial Expressions: Effects on Facial Electromyographic and Autonomic Reactions. *Emotion*. DOI:10.1037/a0029892
- Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.
- Stein, T., Senju, A., Peelen, M. V., & Sterzer, P. (2011). Eye contact facilitates awareness of faces during interocular suppression. *Cognition*, 119, 307-311. DOI: 10.1016/j.cognition.2011.01.008
- Stel, M., & Van Knippenberg, A. (2008). The role of facial mimicry in the recognition of affect. *Psychological Science*, 19, 984-985. DOI: 10.1111/j.1467-9280.2008.02188.x
- Strack, F., Martin, L. L., & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: A nonobtrusive test of the facial feedback hypothesis. *Journal of Personality and Social Psychology*, 54, 768-777, DOI: 10.1037/0022-3514.54.5.768
- Strong, S.R., Taylor, R.G., Bratton, J.C., & Loper, R.G. (1971). Nonverbal behavior and perceived counselor characteristics. *Journal of Counseling Psychology*, 18, 554-561. DOI: 10.1037/a0031421
- Suh, E., Diener, E., Oishi, S., & Triandis, H. C. (1998). The shifting basis of life satisfaction judgments across cultures: Emotions versus norms. *Journal of Personality and Social Psychology*, 74(2), 482-493, DOI: 10.1037//0022-3514.74.2.482
- Surakka, V. & Hietanen, J. (1998). Facial and emotional reactions to Duchenne and non-Duchenne smiles. *International Journal of Psychophysiology*, 29, 23-33, DOI: 10.1016/S0167-8760(97)00088-3
- Thibault, P., Levesque, M., Gosselin, P., & Hess, U. (2012). The Duchenne marker is NOT a universal signal of smile authenticity: but it can be learned! *Special Issue of Social Psychology on Culture as Process*, *Social Psychology*, 43, 215-221. DOI: 2012-29848-007
- Thornton, G. R. (1943). The effect upon judgments of personality traits of varying a single factor in a photograph. *The Journal of Social Psychology*, 18(1), 127-148, DOI: 10.1080/00224545.1943.9921704

- Tipples, J., Atkinson, A. P., & Young, A. W. (2002). The eyebrow frown: A salient social signal. *Emotion*, 2(3), 288, DOI: 10.1037/1528-3542.2.3.288
- Tomat, L. R. & Manktelow, R. T. (2005). Evaluation of a new measurement tool for facial paralysis reconstruction. *Plastic and Reconstructive Surgery*, 115, 696-704. DOI:10.1097/01.PRS.0000152431.55774.7E
- Tracy, J. L., & Robins, R. W. (2004). Show your pride: Evidence for a discrete emotion expression. *Psychological Science*, 15, 194-197. DOI:10.1111/j.0956-7976.2004.-01503008.x
- Tracy, J. L., & Robins, R. W. (2008). The nonverbal expression of pride: Evidence for cross-cultural recognition. *Journal of Personality and Social Psychology*, 94, 516-530. DOI: 10.1037/0022-3514.94.3.516.
- Triandis, H. C. (1989). The self and social behavior in differing cultural contexts. *Psychological Review*, 96(3), 506. 10.1037/0033-295X.96.3.506
- Triandis, H. C. (1995). *Individualism & collectivism*. Westview Press.
- Triandis, H., Bontempo, R., Betancourt, H., Bond, M., Leung, K., Brenes, A., & De Montmollin, G. (1986). The measurement of the etic aspects of individualism and collectivism across cultures. *Australian Journal of Psychology*, 38(3), 257-267, DOI: 10.1080/00049538608259013
- Triandis, H. C., Bontempo, R., Villareal, M. J., Asai, M., & Lucca, N. (1988). Individualism and collectivism: Cross-cultural perspectives on self-ingroup relationships. *Journal of Personality and Social Psychology*, 54(2), 323. DOI: 10.1037/0022-3514.54.2.323
- Triandis, H. C., Leung, K., Villareal, M., & Clack, E (1985). Allocentric vs. idiocentric tendencies: Convergent and discriminant validation. *Journal of Research in Personality*, 19, 395-415. DOI: 10.1016/0092-6566(85)90008-X
- Triandis, H. C., McCusker, C., & Hui, C. H. (1990). Multimethod probes of individualism and collectivism. *Journal of personality and social psychology*, 59(5), 1006. DOI: 10.1037/0022-3514.59.5.1006
- Triandis, H. C., Suh, E.M. (2002). Cultural influences on personality. *Annual Review of Psychology*, 53, 133-160. DOI: 10.1146/annurev.psych.53.100901.135200
- Tsai, J. L., & Levenson, R. W. (1997). Cultural influences on emotional responding Chinese American and European American dating couples during interpersonal conflict. *Journal of Cross-Cultural Psychology*, 28(5), 600-625, DOI: 10.1177/0022022197285006
- United Nations, Department of Economic and Social Affairs, Population Division (2013). *Trends in International Migrant Stock: The 2013 Revision – Migrants by Destination and Origin*. (United Nations database POP/DB/MIG/Stock/Rev.2013/Origin)
- Vernon, D. (2008). Cognitive vision: The case for embodied perception. *Image and Vision Computing*, 26, 127-140, DOI: 10.1016/j.imavis.2005.08.009

- Voronov, M., & Singer, J. A. (2002). The Myth of Individualism-Collectivism: A Critical Review. *The Journal of Social Psychology*, 142(4), 461-480, DOI: 10.1080-/00224540209603912
- Walsh, D. G., Hewitt, J. (1985). Giving men the come-on: effect of eye contact and smiling in a bar environment. *Perceptual and motor skills*, 61, 873-874. DOI: 10.2466/pms.-1985.61.3.873
- Wang, Y., Newport, R., & Hamilton, A. F. D. C. (2011). Eye contact enhances mimicry of intransitive hand movements. *Biology letters*, 7(1), 7-10. DOI: 10.1098/rsbl.2010.0279
- Wang, Y., Ramsey, R., & Hamilton, A. F. (2011). The control of mimicry by eye contact is mediated by medial prefrontal cortex. *Journal of Neuroscience*, 31, 12001-12010, DOI: 10.1523/j.neurosci.0845-11.2011
- Want, S. C., & Harris, P. L. (2002). How do children ape? Applying concepts from the study of non-human primates to the developmental study of “imitation” in children. *Developmental Science*, 5, 1–13. DOI: 10.1111/1467-7687.00194
- Whitehill, J., Littlewort, G, Fasel, I., Bartlett, M., & Movellan, J. R. (2009). Toward practical smile detection. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 31, 2106-2111.
- Wiseman, R. L., & Pan, X. (2004). Smiling in the People's Republic of China and the United States: Status and situational influences on the social appropriateness of smiling. *Intercultural Communication*, 13, 1-18.
- Woodzicka, J. A. & LaFrance, M. (2001). Real versus imagined gender harassment. *Journal of Social Issues*, 57, 15-30. DOI: 10.1111/0022-4537.00199
- World Health Organization / United Nations Children’s Fund. (1989). *Protecting, promoting and supporting breastfeeding: The special role of maternity services*. Retrieved from <http://whqlibdoc.who.int/publications/9241561300.pdf>
- Yamagishi, T., Jin, N., & Miller, A.S. (1998). In-group bias and culture of collectivism. *Asian Journal of Social Psychology*, 1, 315-328. DOI: 10.1111/1467-839X.00020
- Yu, H., Garrod, O. G. B., & Schyns, F. (2012). Perception-driven facial expression synthesis. *Computers and Graphics*, 36, 152-162.
- Zahn Waxler, C., Radke-Yarrow, M., Wagner, E., & Chapman, M. (1992). Development of concern for others. *Developmental Psychology*, 28, 126–136. DOI: 1992-19536-001

APPENDIX A

4.1 EMOTIONAL EXPRESSION AND SMILING ACROSS CULTURES

1. Study 2 : questionnaire assessing feelings and motives producing smiles

Here is a list of possible reasons for a person to smile at you. Rate the degree to which you think that the cause listed is a good reason to smile. There are no right answers. If you strongly disagree that the reason is a good one, circle -3. If you neither agree nor disagree, circle 0. And if you strongly agree that the reason is good, circle 3. Intermediate numbers correspond to intermediate degrees of agreement and disagreement.

A person smiles at you for good reason because he or she...

	Strongly disagree		Neither agree nor disagree			Strongly agree	
	-3	-2	-1	0	1	2	3
a) is in a good mood	-3	-2	-1	0	1	2	3
b) is a happy person	-3	-2	-1	0	1	2	3
c) wants to sell you something	-3	-2	-1	0	1	2	3
d) has a friendly intention	-3	-2	-1	0	1	2	3
e) cares about you	-3	-2	-1	0	1	2	3
f) wants to manipulate or control you	-3	-2	-1	0	1	2	3
g) accepts you as an equal	-3	-2	-1	0	1	2	3
h) wants to acknowledge that you are in the same situation	-3	-2	-1	0	1	2	3
i) feels inferior to you	-3	-2	-1	0	1	2	3
j) wants you to like them	-3	-2	-1	0	1	2	3

k) wants to make you comfortable	-3	-2	-1	0	1	2	3
l) wants to be a close friend of yours	-3	-2	-1	0	1	2	3
m) wants to ask you for help	-3	-2	-1	0	1	2	3
n) feels superior to you	-3	-2	-1	0	1	2	3
o) is embarrassed about something	-3	-2	-1	0	1	2	3

2. Study 2 : details of the procedure

Country	University	Language of administration	N	Nb female	Age mean	Age range	Administration	Compensation	Comments
Canada	University of Alberta	English	70	47	19.31	7	Individual / lab sessions	Course credit	With an unrelated study
France	Clemont University	French (backtranslation)	72	40	23.50	34	Collective / in class	Volunteers	
Germany	University of Cologne	German (backtranslation)	71	37	25.39	15	Collective / in class	Volunteers	
India	Kamatak University	English	73	52	25.07	43	Individual / lab sessions	Volunteers	
Indonesia	Universitas Indonesia	Indonesian (backtranslation)	94	43	20.26	12	Collective / in class	Volunteers	
Israel	Bar Ilan University	Hebrew (backtranslation)	100	65	28.19	43	Individual / at home	Volunteers	
Japan	Waseda University	Japanese (backtranslation)	76	35	19.83	8	Collective (up to 5 participants) / lab sessions	Book coupon	With an unrelated study
New Zealand	University of Otago	English	85	50	19.94	12	Individual / lab sessions	Course credit	With an unrelated study
United States	University of Wisconsin-Madison	English	67	40	18.70	3	Collective (up to 5 participants) / lab sessions	Course credit	With an unrelated study

3. Study 2 : K-Means clustering

The validity of the two-step cluster solution was assessed with a second analysis using the K-Means clustering algorithm. This method is also adapted to large sample sizes but requires a prior specification of the number of clusters. The analysis was performed on the three indexes of motives for smiling. The number of clusters was specified as two. Convergence was achieved in 17 iterations. All 708 respondents were included in the K-Means solution. Cluster 1 included 366 participants and Cluster 2 included 342 participants (see Appendix A4 for details). The differences between clusters were similar to those obtained in TwoStep procedure. Accordingly, respondents from Cluster 1 rated hierarchy motives as less important for the generation of a smile compared to respondents from Cluster

2. They also rated reward and bonding motives as more important compared to respondents from Cluster 2 (see the table below for cluster centers). Even if the cluster composition with K-Means algorithm was slightly different from the one obtained with TwoStep procedure, both analyses yielded similar cluster profiles: Cluster 1 was lower than Cluster 2 on hierarchy, and higher in bonding and reward motives. In both solutions hierarchy motives were the strongest predictors of cluster membership, followed respectively by reward and bonding motives. Proportions of respondents in each country were also similar (see Appendix A4 for details): in both solutions, most respondents in the United States, New Zealand and Canada were classified in Cluster 1, whereas most respondents in Japan, Indonesia, France, Germany and India were assigned to Cluster 2. Percentages of respondents assigned to Cluster 1 by both algorithms were also strongly correlated, $r(7) = .98, p < .001$.

Table A. *Final cluster centers for the three smile indexes (K-Means clustering).*

<i>Smile index</i>	<i>Cluster 1</i>	<i>Cluster 2</i>	<i>F</i> (1, 206)	<i>p</i>
	<i>N</i> = 366 51.7%	<i>N</i> = 342 48.3 %		
<i>Hierarchy</i>	-1.24	.80	1410.69	.000
<i>Reward</i>	2.43	2.12	26.02	.000
<i>Bonding</i>	1.74	1.47	18.95	.000

4. Study 2 : Respondents in Cluster 1 and Cluster 2: Comparison of the TwoStep and K-Means solutions

	<i>TwoStep</i>						<i>K-Means</i>				
<i>Country</i>	<i>Cluster 1</i>		<i>Cluster 2</i>		N	<i>Cluster 1</i>		<i>Cluster 2</i>		N	
	N	%	N	%		N	%	N	%		
Canada	40	57.1	30	42.9	70	47	67.1	23	32.9	70	
France	21	29.6	50	70.4	71	31	43.1	41	56.9	72	
Germany	21	30.0	49	70.0	70	33	46.5	38	53.5	71	
India	19	27.5	50	72.5	69	34	46.6	39	53.4	73	
Indonesia	18	19.1	76	80.9	94	25	26.6	69	73.4	94	
Israel	47	47.5	52	52.5	99	55	55.0	45	45.0	100	

Japan	10	13.5	64	86.5	74	17	22.4	59	77.6	76
New Zealand	56	65.9	29	34.1	85	64	75.3	21	24.7	85
United States	55	82.1	12	17.9	67	60	89.6	7	10.4	67
Total	287	41.1	412	58.9	699	366	51.7	342	48.3	708

5. Cluster membership and endorsement of reward, bonding and hierarchy motives as a function of Homogeneity and related constructs

	1	2	3	4	5	6	7	8	9	10	11
1. Cluster 1 membership	-										
2. Reward Motives	.648	-									
3. Bonding Motives	.795 *	.643	-								
4. Dominance Motives	-.992 **	-.606	-.722 *	-							
5. Historical Homogeneity	-.929 **	-.619	-.812 **	.922 **	-						
6. Ethnic Fractionalization	.355	.402	.796 *	-.268	-.450	-					
7. Immigration	.703 *	.534	.582	-.696 *	-.774 *	.099	-				
8. Residential Mobility	.699 *	.818 **	.457	-.700 *	-.585	.126	.608	-			
9. GLOBE I-C *	.546	.485	.239	-.576	-.575	-.293	.705 *	.411	-		
10. Hofstede's I-C	.807 **	.540	.389	-.850 **	-.725 *	-.117	.640	.695 *	.782 *	-	
11. I-C (Suh et al.,1998)	.848 *	.590	.457	-.876 **	-.777 *	-.030	.911 **	.706	.804 *	.983 **	-

APPENDIX B

4.2 WHAT'S IN A SMILE? SPECIFIC FACIAL ACTIONS COMBINE WITH *ZYGOMATICUS MAJOR* IN EXPRESSIONS OF PLEASURE, AFFILIATION AND DOMINANCE

Supplementary Materials

Stage 1: Reverse correlation: reconstructing mental representations of functional smiles

Materials and Methods

Observers. Fifty-five observers (4 male, native English-speaking, age $M = 18.76$, $SD = 0.79$) participated in exchange for course credit. We excluded data from 11 observers (4 male), 9 of whom did not complete the experiment, one who did not follow the instructions or take the mandatory 3-hour breaks between blocks and one who did not rate same-race faces.

Materials. Stimuli comprised 2400 random facial animations, created using a Generative Face Grammar platform (GFG, Yu et al., 2012) and a 3D Morphable Model (3DMM, Blanz & Vetter, 1999). Figure 4.2.1 (Stimulus) illustrates the stimulus generation procedure. On each experimental trial, the GFG randomly selected from a set of 36 AUs a subset of 1 to 4 AUs (binomial distribution, $N = 4$, $P = 0.6$, in Figure 4.2.1, AU 4, AU1-2, AU25). In addition, the platform selected AU12 (lip corner puller) – a core facial movement of smiling – either bilaterally or unilaterally. For each AU, the GFG randomly selected values

specifying 6 temporal parameters: peak amplitude, peak latency, onset latency, offset latency, acceleration and deceleration (see color-coded curves). We used a cubic Hermite spline interpolation (5 control points, 30 time frames, 24 frames per second) to generate the time course of each AU. We then presented the random facial animation on one of eight white Caucasian face identities (4 female, age $M = 23.0$, $SD = 4.1$) captured under the same conditions of illumination (2600 lx) and recording distance (143 cm; Dimensional Imaging). All animations started and ended with a neutral expression, and had the same duration of 1.25 s.

Procedure

After signing in into the experiment website, participants were directed to the instructions screen with the definitions of the functional smiles and the link to the task. On each experimental trial, a random facial animation (size: 600 x 800 pixels, approximately 10 x 15 cm) appeared in the center of screen on a black background for a duration of 1.25 s and played only once. Following each animation, the smile type labels appeared on-screen and observers selected the perceived smile type and intensity on a 5-point scale. If the random facial movements did not correspond to the given smile type in the block, observers selected “neutral/other”. Each observer categorized 2400 random facial animations completed over 12 x 20 minute blocks with a week. We randomized the order of the smile-type blocks and randomized trials within each block across observers.

Observers completed the experiment using their own computers and an online interface, with a viewing distance of approximately 53 cm. They completed the first block in a laboratory with a female experimenter present only during access to the experimental website and reading the instructions. We defined the three smiles (Niedenthal et al., 2010) by providing, for each smile type, two examples of social situations where a person could make such a smile. We described pleasure smiles as reflecting a happy or joyful response;

affiliation smiles as reflecting positive social intentions and feelings; and dominance smiles as reflecting superiority and condescension. We selected examples of situations from a pilot study using 47 observers (7 male, French, age $M = 20.5$, $SD = 4.6$), which included learning about getting hired for a dream job (pleasure), thanking somebody for their help in a store (affiliation) and crossing paths with an enemy after winning an important prize (dominance). Observers completed the remaining blocks independently, outside of the laboratory, with an experimenter available by email. We instructed observers to take a minimum 3 hour break between, complete the experiment alone, and without distractions.

Model fitting

To model the dynamic face signals of the three smile types at each level of intensity, we followed established model fitting procedures (Yu et al., 2012; Jack et al., 2012). Specifically, for each observer and smile independently, we computed a Pearson correlation between each AU and the intensity response variable, retaining only the significantly correlated AUs ($p < .05$). As a result, we represented each smile type model as a 1 x 36 binary vector, which codes the AUs significantly correlated with the perception of that smile type.

Stage 2: Detection of functional smiles

Materials and Methods

Observers. One hundred seven American observers (71 female, age $M = 19.55$, $SD = 1.59$) participated in exchange for course credits. We excluded data from four observers (2 female) due to deviation from the experiment instructions.

Stimuli. We presented each of the 43 dynamic smile models reconstructed individually for each of the observers (Stage 1) on four white Caucasian face identities (2 female), resulting in a total of 2580 stimuli (43 observers x 3 smiles x 5 intensities x 4 face identities).

Each observer viewed 300 stimuli (100 of each smile type) selected randomly with replacement from the pool of 2580 stimuli.

Procedure

Observers viewed each stimulus displayed on a black background in the center of the screen. Stimuli subtended 14.71° (vertical) and 9.61° (horizontal) of visual angle with a chin rest maintaining a constant viewing distance of 51cm. Each animation played once for 1.25s, after which a label – either “enjoyment smile,” “affiliation smile,” “dominance smile” appeared on the screen. Observers then performed a verification task by selecting “yes” or “no” to indicate whether the animation corresponded with the given label. We blocked smile-type labels, with each block comprising 100 trials with 50% of trials comprising an equal number of the two other smile types as distractors. Each observer completed 6 blocks randomized across observers with trials presented randomly across the blocks. We used an online interface, tested observers on individual computer stations and used the same smile-type definitions as in the previous experiment.

Results

We assessed observers’ recognition performance by computing the proportion of correct responses for each smile type. Pleasure smiles elicited a mean accuracy of 69 % ($SD = 7.41$, range: 35), affiliative smiles 62 % ($SD = 7.20$, range: 36), and dominance smiles 73 % ($SD = 9.13$, range: 49). To assess systematic categorization confusions, we calculated the criterion C , reflecting observers’ tendency to select positive responses, and the parameter d' , reflecting the strength of the signal (Abdi, 2007). Values of d' varied significantly as a function of smile

type [$F(2, 206) = 24.08; p < .001$], where observers sensitivity to affiliative smiles ($M = 0.38$, $SD = 0.22$) is significantly lower than to enjoyment smiles ($M = 0.81$, $SD = 0.24$), $t(103) = -14.95; p < .001$, $d = -1.47$, and significantly lower than to dominance smiles ($M = 0.77$, $SD = 0.86$), $t(103) = -5.12; p < .001$, $d = -0.73$. Values of the criterion C significantly exceeded 0 for all the three smiles (enjoyment – 1.04, $SD = 0.31$, affiliative – 0.64, $SD = 0.18$, and dominance – 0.80, $SD = 0.31$, all $ts > 25$, $ps < .001$), indicating that observers adopted a conservative criterion and tended to choose negative responses.

Stage 2: Ratings of social motives

Materials and Methods

Observers. Twenty-three American observers (8 male, age $M = 19.39$, $SD = 1.27$) participated in exchange for course credit.

Stimuli. Using the dynamic smile models created in Stage 1 and averaged across all observers, we generated facial animations for every possible combination of 8 face identities x 3 smile types, resulting in 24 stimuli in total. We only used the most intense smiles (intensity level: 5).

Procedure

We presented each stimulus in the center of the screen on a black background. Each stimulus played for 1.25s and observers could replay the animation as many times as desired. Observers rated the animation according to perceived feelings and intentions of the expresser by responding to three questions presented on separate trials – “To what extent does this person feel positive emotions?”, “To what extent does this person have friendly intentions?”, and “To what extent does this person feel superior?” Observers responded using a 7-point Likert scale ranging from “not at all” to “very much.” We randomized the order of trials across observers and used an online interface created in Qualtrics (version 1.869s, Provo,

UT). Observers accessed the experiment outside of the lab with an experimenter available by email. The study was a fully within-subject experiment, with a total of 72 trials (3 smiles x 1 intensity x 8 identities x 3 presentations).

Results

We performed all statistical analyses using RStudio version 0.96 (RStudio, Inc.) and SPSS version 20.0 for Windows (SPSS Inc., Chicago, IL).

After screening for normality and for the presence of outliers, we averaged observers' ratings across identities and intensity levels. We performed separate analyses for each survey version and for each smile type to examine the effect of question type on observers' ratings of a given smile. According to an established procedure (Barr, Levy, Scheepers, & Tily, 2013), we included a by-subject random intercept, a by-subject random slope, a by-item (identity) random intercept, and a by-item random slope.

For pleasure smiles we created two planned orthogonal contrasts testing two separate predictions. First, we expected pleasure smiles to be perceived as reflecting positive emotions and friendly intentions significantly more than feelings of superiority (Contrast 1; positive emotions: 1, friendly intentions: 1, superiority: -2). A second prediction was that observers should associate pleasure smiles with positive emotions significantly more than with friendly intentions (Contrast 2; positive emotions: 1, friendly intentions: -1, superiority: 0). We then estimated a linear mixed-effects model, in which the effects of question type were coded by the two planned contrasts. Contrast 1 (1, 1, -2) was significant, $b = .52$, $SE = 0.14$, $t = 3.71$, suggesting that pleasure smiles received low ratings of superiority ($M = 3.43$, $SD = 1.58$), compared to their ratings of positive feelings ($M = 4.97$, $SD = 1.23$) and friendly intentions ($M = 5.01$, $SD = 1.35$). Contrast 2 (1, -1, 0) was not significant, $b = -0.02$, $SE = 0.06$, $t = -0.32$.

Thus, pleasure smiles did not significantly differ in their ratings of positive feelings and friendly intentions.

We used a similar procedure for the analysis of affiliation smiles. We predicted that affiliation smiles would elicit high ratings of friendly intentions and positive emotions compared to the ratings of superiority (Contrast 1: 1, 1, -2) and that their ratings of friendly intentions should be significantly higher than their ratings of positive emotions (Contrast 2: -1, 1, 0). Contrast 1 was significant, $b = 0.54$, $SE = 0.14$, $t = 3.90$, such that affiliation smiles were perceived as expressing friendly intentions ($M = 5.06$, $SD = 1.38$) and positive emotion ($M = 4.87$, $SD = 1.40$) more than superiority ($M = 3.34$, $SD = 1.69$). The difference between ratings of positive emotion and friendly intentions (Contrast 2) was not significant, $b = 0.09$, $SE = 0.06$, $t = 1.48$.

For dominance smiles, we predicted higher ratings of superiority compared to the ratings of positive emotions and friendly intentions. Contrast 1 (-1, -1, 2) was indeed significant, $b = 0.91$, $SE = 0.14$, $t = 6.60$, suggesting that dominance smiles were perceived as displays of superiority ($M = 4.38$, $SD = 1.97$) to a significantly higher degree than as displays of positive emotion ($M = 1.70$, $SD = 1.19$) or friendly intentions ($M = 1.60$, $SD = 1.07$). Contrast 2 (1, -1, 0), testing the residual within-group variance, was not significant, $b = 0.05$, $SE = 0.04$, $t = 1.19$