UNIVERSITY OF TRENTO
Department of Cognitive Sciences and Education

Doctoral School in Psychological Sciences and Education
XXIII Cycle

ON SYNCHRONY AND SOCIAL RELATIONS:

THE ROLE OF SYNCHRONOUS MULTISENSORY STIMULATIONS IN SELF-OTHER MERGING, SOCIAL BONDING AND INGROUP-BIAS REDUCTION.

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Academic Year 2009 – 2010

CONTENTS

Capitolo 1

Introduzione teorica.

Relazioni sociali e sincronia:

Il ruolo dell'integrazione multisensoriale

You're a part of me; I'm a part of you
Haruki Murakami

Le situazioni in cui gruppi di persone mettono in atto movimenti sincroni sono varie e sono una forma caratterizzante della socialità umana, riscontrabile in tutte le culture (McNeill, 1995; Fiske, 2004). Alcuni esempi sono il ballare (e.g., balli di gruppo o danze rituali) o cantare all'unisono, marciare a tempo, che sia in un'esercitazione militare o un corteo di protesta ma anche alcuni rituali religiosi (e.g., recita del rosario o dei mantra, genuflessioni nei riti di preghiera mussulmani o cattolici). Ancora, in alcuni sport, i giocatori di una squadra mettono in atto rituali in sincronia (e.g., haka nel rugby) e anche le tifoserie organizzate spesso manifestano il loro supporto coordinandosi in sincronia. Le persone che partecipano a questi tipi di esperienze, diverse tra loro per significati e contesti ma accumunate dall'agire all'unisono, spesso condividono un'appartenenza o identità comune (e.g., stessa religione, squadra, ecc.). L'agire in sincronia appare quindi un'attività che nasce all'interno di una relazione. La questione meno scontata è se agire in sincronia possa contribuire a creare o rafforzare questo legame. Questo capitolo si focalizzerà sul ruolo della sincronia interpersonale nel costituirsi delle relazioni. Dapprima verrà analizzato il contributo della Teoria dei Modelli Relazionali (*Relational Model Thoery*, RMT) di Alan Fiske (1992, 2004), che mette in relazione il muoversi in sincronia con uno specifica tipologia di relazioni, chiamate *Communal Sharing* (CS), che sono caratterizzate, dal punto di vista psicologico, da una

fusione o inclusione dell'altro nel concetto di sé (i.e., self-other merging). Successivamente verranno passati in rassegna recenti studi di psicologia sociale che hanno dimostrato come la sincronia interpersonale abbia degli effetti di tipo sociale come, ad esempio, aumentare l'affiliazione e i comportamenti cooperativi. Infine, verranno trattati dei possibili processi sottostanti cioè, in altri termini, perché agire in sincronia, un'attività che coinvolge i nostri corpi, arriva ad avere un effetto a livello di relazione. In particolare ci si soffermerà sui processi di integrazione multisensoriale e sulle illusioni corporee in quanto il contributo portato in questa tesi, relativamente al legame tra sincronia e legami sociali, è quello di aver proposto e testato l'*integrazione multisensoriale* come uno dei possibili processi che giocano un ruolo nella fusione che avviene tra il sé e l'altro (i.e., essere una cosa sola) durante un'esperienza sincrona.

1. Sincronia e relazioni: la prospettiva della Teoria dei Modelli Relazionali

Muoversi in contemporanea e nello stesso modo è descritto dall'antropologo cognitivo Alan Fiske (1992, 2004) come una delle tipiche manifestazione delle relazioni sociali *Communal Sharing* (CS)[1]. Queste sono le relazioni che tipicamente intercorrono tra

[1] Le relazioni Communal Sharing, a cui siamo interessati in questo contesto, fanno parte dei quattro tipi di relazione sociale che Fiske (1992, 2004), tramite osservazioni etnografiche iniziate nel villagio Moose del Burkina Faso nel 1979, studi sperimentali e cross-culturali, ha individuato come base dell'organizzazione della socialità umana. In tutte le culture sarebbe quindi possibile riconoscere dei modi comuni di costruire, coordinare e comprendere le relazioni sociali. Oltre alle CS, i rimanenti modelli relazionali sono l'Authority Ranking (AR), Equality Maching (EM) e, infine, Market Pricing (MP). In breve, le relazioni CS sono caratterizzate dalla totale equivalenza tra due persone o tra i membri di un gruppo (e.g., legami di parentela, di coppia, identità etnica o nazionale), dalla condivisione indifferenziata delle risorse e dall'idea di essere accomunati da una stessa essenza o sostanza (e.g., relazioni di "sangue"). La tipologia di relazione AR si ha quando esistono delle asimmetrie di potere e status, come nei luoghi di lavoro e in altre istituzioni di tipo gerarchico (e.g., organizzazioni militari); nelle relazioni EM, invece, l'attenzione è rivolta in particolar modo a mantenere l'equità, che sia nella distribuzione delle risorse (e.g., principio del 50-50) o nella gestione della relazione (e.g., turni per parlare). Infine, il modello MP, tipico delle culture occidentali, descrive le interazioni di tipo economico o che si basano su costi e benefici (per un approfondimento, si veda la Teoria dei Modelli Relazionali, RMT, Fiske 1992, 2004). Ognuno di queste strutture può essere utilizzata in diversi contesti della vita sociale (e.g., nel lavoro, nella gestione di uno scambio) e, nelle interazioni con una stessa persona o gruppo, si possono intrecciare le diverse tipologie di relazione. Ad esempio, in una famiglia, le risorse, come

i membri di una coppia, di una famiglia o di un gruppo (e.g., nazionale o etnico), in quanto sono caratterizzate da un'enfasi alle caratteristiche comuni, come, ad esempio, l'avere le stesse origini, la stessa etnia, o anche di condividere una stessa essenza o sostanza, ad esempio, lo stesso sangue. In questo tipo di legami le risorse sono in genere messe in comune e ogni individuo può prendere quello che gli serve, senza che gli venga chiesto nulla in cambio. Il principio base è dunque quello dell'equivalenza delle persone: ogni persona è uguale all'altra. Altra caratteristica è il senso di unità e fusione. La relazione è caratterizzata da coesione; il senso di collettività e appartenenza prevale su quello di individualità e questo si riflette anche nella conformità di idee ed espressioni, la tendenza a non dare posizioni individuali ma a basarsi piuttosto su un consenso di gruppo.

Prevalendo un senso di unità e condivisione, in una relazione CS le persone provano compassione e cercano di aiutarsi l'un l'altro quando in difficoltà. Se da una parte le relazioni CS comprendono il prendersi cura dell'altro, dall'altra può avere delle conseguenze meno positive. Gli sbagli o trasgressioni di una sola persona si riflettono e vanno pagati da tutto il suo gruppo (e.g., la famiglia). La paura che l'essenza del gruppo venga contaminata fa si che la vittima di una sfortuna (e.g., una violenza) venga allontanata e che il contatto con l'altro venga evitato, chiudendosi verso chi non fa parte della comunità o, nei casi più estremi, fino ad arrivare al genocidio per mantenere pura la razza.

Nelle relazioni CS le cose concrete, come oggetti ma anche luoghi, assumono spesso un significato simbolico e di connessione tra le persone. Ad esempio, la fede nuziale di una nonna, passata di generazione in generazione alle donne della famiglia da continuità al rapporto, rendendole una cosa sola. Anche nella religione, toccare le reliquie del santo o condividere il cibo con gli dei, crea un legame con l'assoluto e la

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il cibo e gli spazi della casa, sono a disposizione di tutti (CS). Se il padre di questa famiglia gestisce, con l'aiuto dei figli, una piccola azienda, sarà anche colui che prende la maggior parte delle decisioni (AR), cercando di dividere equamente i doveri tra i figli (EM). In cambio del loro lavoro, ognuno dei figli riceverà uno stipendio (MP). In uno stesso nucleo famigliare quindi i diversi modelli relazionali messi in atto possono variare a seconda della situazione e dei bisogni.

propria comunità religiosa. Le tradizioni, in generale, sono ritenute molto importanti perché perpetuano nel tempo il passato e l'identità collettiva.

Quel che è più importante per lo scopo di questo capitolo è che nelle relazioni Communal Sharing il corpo gioca un ruolo determinante. Secondo Fiske (2004) si crea in questi casi una sorta di equivalenza tra il corpo e la persona come entità psicologica e sociale. In questa logica, la vicinanza e il contatto fisico (e.g., una carezza tra madre e figlio o una coppia che si tiene per mano), il trasferimento e la condivisione di sostanze (e.g., l'allattamento, i riti di sangue e il prendere le pietanze da uno stesso vassoio ad una cena tra amici), il rendere simili le persone nell'apparenza (e.g., tramite tatuaggi, un modo di vestire distintivo di un dato gruppo sociale, l'indossare una stessa spilla che rappresenta l'impegno per una causa comune) o l'agire in sincronia (e.g., danzare, cantare, scandire all'unisono gli slogan in una manifestazione di protesta, marciare a tempo) sono attività che mettono in relazione i corpi ma allo stesso tempo creano un legame di tipo relazionale tra le persone. Fiske (2004) ritiene che la formazione dei legami CS si basi sull'assimilazione di una comune sostanza o essenza corporea (*consubstantial assimilation*) e che questo venga per lo più realizzato in modo metaforico creando una connessione tra i corpi (i.e., mettere in contatto la sua superficie, i movimenti ma anche il passaggio e la condivisione di sostanze).

L'aspetto interessante, proposto dalla teoria dei modelli relazionali, è che questo legame tra i corpi venga vissuto poi come un legame psicologico tra le persone. In questa logica la Teoria del Modelli Relazionali suggerisce una visione radicata nel corpo (*embodied*) dei legami relazionali di tipo intimo vissuti in genere all'interno di una coppia o di un gruppo, in quanto alcuni aspetti di queste relazioni sociali appaiono intrinsecamente basati sul corpo e, d'altra parte il corpo può allo stesso tempo contribuire a creare questo tipo di relazioni.

2. La fusione sé-altro

Dal punto di vista psicologico, le relazioni CS sono caratterizzate da un'inclusione o fusione della rappresentazione dell'altro con quella del sé ("inclusione dell'altro nel sé" - *Inclusion of the Other in the Self* o "fusione sé-altro" - *Self-Other Merging*) (Smith, 2002). A livello metaforico, questo vissuto è ben rappresentato dall'opera di Gustav Klimt "Il Bacio" (1907-08), dove i confini del corpo dei due amanti sono indistinti e la coppia risulta fusa in un'unica figura a dimostrare che la sensazione di fondersi e confondersi con l'altro avvenga sia su un piano emotivo, concettuale che corporeo. La psicologia sociale, e in particolare gli studi sulle relazioni intime (Aron, Aron, Tudor & Nelson,1991; Aron, McLaughlin-Volpe, Mashek, Lewandowski, Wright & Aron, 2004), hanno mostrato come questo sentimento di fusione con i nostri cari non è solo una metafora per descrivere la relazione affettiva. Numerosi studi infatti hanno dimostrato che in questi casi vi è una tendenza a riservare al proprio partner relazionale percezioni e comportamenti simili a quelli che in genere vengono rivolti a se stessi (Aron, Aron, Tudor, & Nelson, 1991; Aron, McLaughlin-Volpe, Mashek, Lewandowski, Wright & Aron, 2004). Ad esempio, dovendo dividere delle risorse queste vengono spartite equamente tra sé e un amico, piuttosto che con uno sconosciuto (Aron, Aron, Tudor, & Nelson, 1991, Studio 1). La persona con cui si condivide una relazione (i.e., partner o membro del gruppo), viene percepito come più simile a se stessi, proiettando su questa/e persona/e le proprie caratteristiche (Aron, Aron, Tudor & Nelson, 1991, Studio 3; Morry, 2007), oltre che a confondere le sue con le proprie. A livello descrittivo questo fenomeno è ben rappresentato dalla scala di Inclusione dell'Altro nel Sé (*Inclusion of the Other in the Self scale* – IOS, vedi Figura 1A) di Aron e colleghi (1992; vedi anche Schubert & Otten, 2002 per un adattamento alle relazioni intergruppi, Figura 1B). Questi studi dimostrano quindi come il senso di unità tipicamente descritto nelle relazioni CS (da chi ne è parte ma anche da chi le osserva) sia basato su una fusione, a livello cognitivo, tra il sé e l'altro.

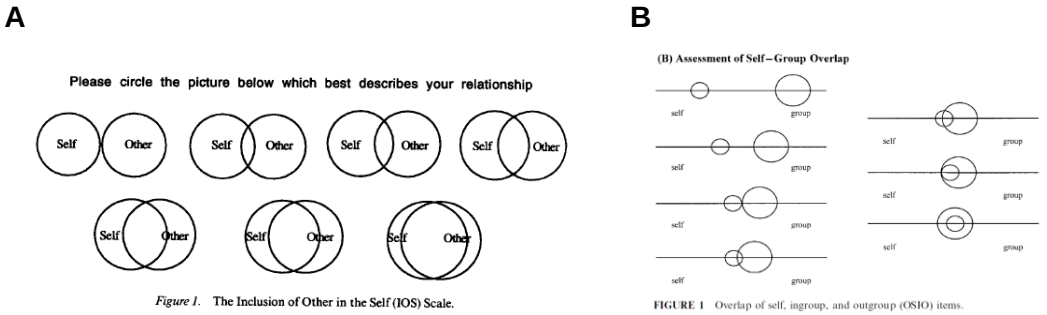

Figura 1. (A) Scala di Inclusione dell'Altro nel Sé (Aron, Aron & Smollan, 1992, pagina 597); (B) adattamento della scala IOS alle relazioni intergruppi (OSIO, Schubert & Otten, 2002, pagina 356).

3. La sincronia e i suoi effetti nella percezione sociale

Secondo la Teoria dei Modelli Relazionali, veder compiere un'azione all'unisono, comunica che qualcosa d'importante lega gli attori della scena e contribuisce a creare un legame e un senso d'unità (Fiske, 2004). Questa idea si basa per lo più su osservazioni antropologiche. Solo recentemente, in psicologia sociale, il ruolo della sincronia nelle relazioni sociali è stato studiato sperimentalmente, verificando i suoi possibili effetti sociali ed affettivi.

Come già osservato da Fiske (2004), le persone che compiono dei movimenti in sincronia vengono percepite come un'unica unità sociale. Lakens (2010; Lakens & Stel, in stampa) ha portato evidenze sperimentali riguardo alle informazione di *entatività* (i.e., l'essere un gruppo o un'unità coerente, con un'esistenza propria) che le persone estrapolano dal movimento sincrono, sia quando il target sono figure stilizzate che filmati di situazioni più naturalistiche (i.e., due persone che muovono una mano come per salutare o camminano in un cortile). La coordinazione temporale porta quindi a percepire un gruppo di persone come un'unità sociale. Percettivamente, il muoversi nella stessa maniera crea similarità, uno dei principi base della Gestalt, insieme a prossimità e destino comune, che fanno si che elementi singoli vengano visti come parte di un tutto più ampio organizzato e che sono riconducibili anche alla percezione dei gruppi (Campbell, 1958; Hamilton & Sherman, 1996). Oltre alla similarità percettiva, l'impressione di unità sociale delle azioni sincrone è guidata anche da inferenze. La

sincronia viene utilizzata come indizio del rapporto che lega gli attori della scena osservata e quindi anche del loro far parte di una stessa unità sociale (Lakens & Stel, in stampa; vedi anche Miles, Nind & Macrae, 2009). Se però l'attività sincrona viene descritta come dovuta non alla volontà delle persone (i.e., un insegnante ha ordinato a due studenti di camminare al passo, non è una loro scelta) non viene più considerata un indice attendibile di un legame e unità (Lakens & Stel, in stampa, Studio 2).

La sincronia fisica crea *connessione* tra le persone che condividono l'esperienza. Coordinare insieme i movimenti (i.e., muovere un braccio in-fase vs. anti-fase) aumenta l'interesse verso l'altro e le informazioni fornite da questa persona, con lo scopo di facililtarne gli scambi sociali (Macrae, Duffy, Miles & Lawrence, 2008). Inoltre, come succede nelle relazioni strette, la sincronia interpersonale attenua il tipico effetto di self-reference (SRE, Symons & Johnson, 1997), cioè la tendenza a ricordare maggiormente le informazioni che riguardano il sé, piuttosto che l'altro (Miles, Nind, Henderson & Macrae, 2010), promuovendo quindi la formazione di una sorta di attenzione condivisa.

La connessione che la sincronia crea è stata mostrata anche tramite la percezione di caratteristiche comuni attribuite agli attori dei movimenti coordinati temporalmente. Nella prima parte di un esperimento di Valdesolo e Winter (in revisione), i partecipanti osservavano altre due persone oscillare su sedie a dondolo in maniera sincrona o asincrona. Una di questi due, complice nell'esperimento, precedentemente si comportato in maniera ingiusta, non dividendo con gli altri e tendendo per sé tutti dei gettoni (i.e., gioco del dittatore). I partecipanti giudicavano anche la persona che aveva seguito un ritmo sincrono con lui come immorale, espandendo le caratteristiche di uno all'altro.

L'altro con cui si condivide un'esperienza sincrona viene valutato anche come maggiormente attraente (Marsh, Richaedson, Baron & Schmidt, 2006; Hove & Risen, 2009) e simile a sé (Valdesolo & DeSteno, in stampa). Hove e Risen (2009) trovarono che quando i partecipanti ad un esperimento battevano il tempo in sincronia con lo sperimentatore, questo veniva giudicato come più piacevole, in confronto a quando lo sperimentatore seguiva un altro ritmo. Questo effetto non era stato ottenuto quando i partecipanti dovevano seguire il ritmo di un metronomo. Non è quindi un ritmo

sincrono, per sua natura un evento strutturato e piacevole, a rendere le persone più propense a valutazioni positive. Perchè la sincronia abbia un effetto sociale, deve essere di tipo interpersonale.

Inoltre, come mostrato da Wiltermuth & Heath (2009), mettere in atto un'azione sincrona, come camminare al passo o cantare all'unisono, aumenta la *cooperazione* in termini di distribuzione di risorse come beni comuni da dividere tra le persone con cui si è condivisa l'esperienza. Azioni comuni ma asincrone, come anche non riuscire a coordinare il movimento con gli altri (i.e., battere un ritmo complicato), ha il costo di non accrescere la tendenza a comportamenti collaborativi (Kurzban, 2001). Valdesolo e DeSteno (in stampa) sottolineano come comportamenti di aiuto legati alla sincronia siano mediati da risposte di tipo emozionale (i.e., compassione), a loro volta dovute alla percezione di similarità e piacevolezza del compagno.

La sincronia promuove la cooperazione ma, potenzialmente, rende anche lo svolgimento di un'attività comune più funzionale da un punto di vista più alla base delle abilità sociali, come ad esempio, la coordinazione motoria. Valdesolo e colleghi (2010) hanno mostrato come un'attività sincrona condivisa con un'altra persona, come l'oscillare su una sedia allo stesso ritmo, piuttosto che un movimento non corrispondente, aumenta la sensibilità di tipo percettivo e la velocità di riuscita di un compito che richiede un'azione congiunta con il compagno e la capacità di coordinarsi con i suoi movimenti (i.e., muovere un labirinto in legno per guidare la pallina dall'inizio alla fine del percorso).

Un ulteriore effetto della forte coesione che il muoversi in sincronia riesce a creare, è la tendenza al *conformismo*, anche nel caso di comportamenti socialmente non desiderabili. In uno studio di Wiltermuth (in revisione), i partecipanti, sotto la pressione di un altro partecipante (in realtà un complice) con cui avevano condiviso un'azione sincrona, piuttosto che asincrona, mentivano maggiormente allo sperimentatore (Studio 1). Oltre a conformarsi ad un compagno, la sincronia influenza anche l'obbedienza verso una persona di status più elevato che, in questo contesto, ero lo sperimentatore. Dopo

aver camminato al passo con lui, accondiscendevano maggiormente alla sua richiesta di uccidere degli insetti (Studio 2). Nella seconda parte dello studio di Valdesolo e Winter (in revisione), dopo aver oscillato in sincronia su una sedia a dondolo con un'altra persona considerata ingiusta per la sua decisione di tenere per sé del denaro, senza dividerlo con l'altro partecipante dell'esperimento, conformavano maggiormente mettendo in atto a loro volta lo stesso tipo di comportamento, pur avendolo precedentemente condannato.

La sincronia ha quindi degli effetti positivi come l'aumentare la cooperazione, i comportamenti d'aiuto e l'affiliazione ma può anche essere utilizzata per conformare i giudizi, anche quando immorali, o guidare le decisioni verso azioni anti-sociali. I regimi totalitari, come quello nazista o fascista, ad esempio, hanno infatti fatto largo uso di parate militari e movimenti sincroni (e.g., saluto romano, passo dell'oca). Oltre a quello propagandistico, il fine era con molta probabilità quello di comunicare la forza e l'unità dello stato e indurre consenso nella folla (McNeill, 1995).

La sincronia quindi, che sia osservata o agita, ha degli effetti sul piano affettivo, della percezione dell'altro e del sé e del comportamento. Gli studi fino ad ora condotti mettono in luce come l'osservare un movimento sincrono, che sia di tipo artificiale (i.e., movimento di figure stilizzate) o attuato da delle persone (i.e., marciare, oscillare allo stesso tempo su una sedia a dondolo) porta ad una percezione di unità e di un legame condiviso tra gli attori della scena (Lakens, 2010; Lakens & Stel, in stampa; Miles, Nind & Macrae, 2009; Valdesolo & Winter, in revisione, Studio 1). Mettere in atto in prima persona azioni di tipo sincrono (i.e., muovere le braccia, camminare o cantare all'unisono, battere il ritmo) crea similarità tra il sé e le altre persone con cui si condivide l'esperienza (Valdesolo & DeSteno, in stampa; Miles, Nind, Henderson & Macrae, 2010) ma ha anche dei risvolti nelle scelte comportamentali, come una maggiore cooperazione (Wiltermuth & Heat, 2009; Wiltermuth, in revisione; Valdesolo & DeSteno, in stampa) e conformismo, anche per azioni moralmente non desiderabili (Wiltermuth, in revisione; Valdesolo & Winter, in revisione, Studio 2). In altri termini agire in sincronia ha una serie di conseguenze sul piano affettivo e sociale che in genere si osservano nelle relazioni

intime e in quelle all'interno del gruppo d'appartenenza. Coerentemente con la Teoria dei Modelli Relazionali, la sincronia interpersonale può contribuire a creare un legame relazionale.

4. L'integrazione multisensoriale come processo sottostante

Se, come appena illustrato, il legame tra sincronia ed effetti sociali è stato ampliamente dimostrato, i meccanismi sottostanti rimangono ancora incerti. In altri termini, perché un'esperienza che coinvolge il nostro corpo dovrebbe influenzare il vissuto relazionale?

Alcune proposte riguardano i substrati neuronali e neurochimici. Kokal e colleghi (manoscritto non pubblicato) hanno investigato i correlati neuronali della sincronia interpersonale, focalizzandosi in particolare sugli aspetti di gratificazione dell'esperienza. Attraverso uno studio di neuroimmagini funzionali (fMRI), è stato possibile evidenziare l'attivazione dell'area del nucleo caudato, parte del sistema cerebrale legato all'effetto della ricompensa (i.e., denaro), quando il partecipante riusciva a suonare con un tamburo uno stesso ritmo in sincronia con lo sperimentatore, piuttosto che quando il ritmo seguito non coincideva (asincrono), in particolar modo quando il compito risultava essere semplice. L'attivazione del caudato era in relazione anche con il comportamento d'aiuto verso lo sperimentatore con cui avevano suonato in sincronia. Questi risultati sottolineano l'importanza della positività e piacevolezza di un'azione comune, compiuta in sincronia, e il suo sistema neuronale collegato.

Che la sincronia possa essere gratificante è stato mostrato anche testando il rilascio di endorfine (Cohen, Ejsmond-Frey, Knight & Dunbar, 2010). Gli atleti che svolgono un allenamento molto energico all'unisono con i compagni di squadra, in confronto a coloro che seguono lo stesso tipo di allenamento da soli, raggiungono una soglia del dolore più alta, indice di una blanda analgesia data dal rilascio di endorfine. Il senso di benessere dato dagli oppioidi endogeni potrebbe giocare un ruolo nell'indurre una maggiore propensione verso i documentati effetti positivi connessi alle attività

sincrone (e.g., cooperazione e affiliazione). Tuttavia, in questo studio non è possibile dividere il ruolo della sincronia da quello dell'allenamento in squadra e questo andrebbe chiarito (ad esempio, aggiungendo una condizione dove l'allenamento avviene in gruppo, ma in maniera asincrona). La spiegazione neurochimica non può completamente spiegare il legame creato dal condividere un'esperienza sincrona. Il rilascio di endorfine avviene in particolar modo nel caso di attività intense e stancanti. Altri processi sottostanti devono essere responsabili nel caso, ad esempio, di un evento sincrono in cui non si ha un ruolo attivo o si è solo spettatori. Anche rispetto al rinforzo positivo di un'azione sincrona sottolineato da Kokal e colleghi (manoscritto non pubblicato), potrebbe in alcuni casi venire a mancare. Non sempre i riti sincroni hanno una valenza positiva o, nel caso di azioni forzate, come una marcia militare, potrebbero non essere vissuti come gratificanti.

Un ulteriore meccanismo potrebbe essere l'effetto di entatività descritto da Lakens (2010; Lakens & Stel, in stampa), cioè un'elaborazione di tipo bottom-up (i.e., processi sensoriali automatici) della similarità percettiva creata dal movimento sincrono e la successiva organizzazione degli elementi in un'unità sociale organizzata, basata sui principi Gestaltici.

La proposta che viene portata avanti in questa tesi è che uno dei processi alla base del legame tra la sincronia e le relazioni, quindi il senso di unità che comunica e i suoi effetti sul piano sociale e affettivo, possa essere l'esito dei processi di *integrazione multisensoriale*. Questi processi si riferiscono alla capacità del nostro cervello di integrare e organizzare in un'unità coerente stimoli provenienti simultaneamente da diversi canali sensoriali. L'assunzione di unità (Welch & Warren, 1980) alla base di questi processi è importante per la percezione degli oggetti o di un avvenimento (e.g., un fischio viene associato ad un bollitore da dove esce uno sbuffo di vapore, fanno parte di un unico evento; Jackson, 1956). Anche la rappresentazione del proprio corpo si basa sull'integrazione multisensoriale: essa viene infatti continuamente creata ed aggiornata a partire dai diverse informazioni provenienti, nello stesso momento, da più sensi (e.g., visione, tatto e propriocezione). In altri termini, riconosco che la mano che sto

guardando è la mia perché combino l'informazione visiva con quella propriocettiva, tattile, etc. Questo fa anche si che la rappresentazione corporea sia flessibile e che possa essere alterata (De Vignemont, 2007; Tsakiris, Schütz-Bosbach & Gallagher,2007). Le neuroscienze cognitive portano evidenze di come sia possibile includere, giocando sui processi di integrazione multisensoriale, un oggetto esterno nei confini del sé corporeo, come mostrato dall'*illusione della mano di gomma* (The rubber hand illusion – RHI, Botvinick & Cohen, 1998; vedi Makin, Holmes & Ehersson, 2008 per una rassegna). Per generare questa illusione, una protesi di un arto (i.e., mano e avambraccio) viene posta di fronte al partecipante all'esperimento e viene toccata in maniera sincrona alla sua vera mano, che però viene nascosta alla vista. Le informazioni visive (i.e., il tocco sulla mano finta) e tattili (i.e., l'effettiva sensazione sulla propria mano), simultanee ma provenienti da due oggetti diversi, vengono messe in relazione. Il conflitto crossmodale creato, cioè tra il vedere il tocco sulla mano di gomma e la sensazione tattile sulla propria, viene risolta in favore della visione, predominante rispetto a tatto e propriocezione. Il meccanismo, detto *cattura visuale del tocco* (Visual capture of touch; Tastevin, 1937; Pavani, Spence & Driver, 2000), fa si che la sensazione tattile venga attribuita alla mano finta. I partecipanti riportano la percezione illusoria che la mano di gomma diventi parte del proprio corpo. Questo effetto non avviene quando la stimolazione visuo-tattile non è simultanea. Una stimolazione asincrona quindi non permette di processare e integrare le due informazioni sensoriali come un insieme. L'illusione della mano di gomma viene quindi indotta solo nel caso di una stimolazione sincrona. La co-occorrenza degli eventi visivo e tattile (i.e., fattore bottom-up) è necessaria perchè l'illusione multisensoriale avvenga. D'altra parte anche fattori più cognitivi (i.e., top-down) ne modulano la comparsa, come ad esempio, una posizione della mano di gomma anatomicamente plausibile (e.g., parallela vs. a 90° rispetto al braccio reale del partecipante) (Tsakiris & Haggard, 2005; Costantini & Haggard, 2007; Tsakiris, 2010).

Al di là della sensazione soggettiva, l'effetto di questo tipo di illusione è anche una distorsione propriocettiva. Susseguentemente la stimolazione visuo-tattile sincrona

tra la mano del partecipante e quella di plastica, dovendo indicare sotto il tavolo la posizione della loro mano, i partecipanti tendono a indicarla più spostata verso la mano di plastica (e.g., Botvinick & Cohen, 1998). Questo cambiamento nella posizione percepita indica che la mano di gomma è entrata a far parte della rappresentazione corporea del partecipante. La modificazione dell'immagine del sé corporeo è tale da avere anche delle conseguenze a livello fisiologico. La temperatura della mano del partecipante decresce quanto più è vivida l'esperienza illusoria che la mano di gomma sia parte del proprio corpo (Moseley, Olthof, Venema, Don, Wijers, Gallace & Spence, 2008). Inoltre, se la mano di gomma viene colpita, dopo la stimolazione sincrona (vs. asincrona), vi è un maggiore arousal del partecipante, misurata tramite la risposta di conduttanza cutanea, come se la mano ferita fosse la sua (Armel & Ramachandran, 2003).

Questo tipo di illusione multisensoriale non si limita al braccio ed è stata recentemente adattata in modo tale da coinvolgere l'intero corpo, creando un esperienza extra-corporea (Leggenhager, Tadi, Metzinger & Blanke, 2007; Ehrsson, 2007) o di entrare nel corpo di un altro (Petkova & Ehrsson, 2008), o per parti rilevanti della propria identità come ad esempio il volto (Tsakiris, 2008; Sforza, Bufalari, Haggard & Aglioti, 2010; Paladino, Mazzurega, Pavani & Schubert, 2010). Nello studio di Tsakiris (2008), in particolare, i partecipanti venivano toccati con un pennello sulla guancia mentre guardavano un video dove un viso formato, tramite un morphing, per il 50% dal loro e per il 50% da quello di uno sconosciuto, veniva toccato sincronicamente o asincronicamente. Prima e dopo la stimolazione visuo-tattile, i partecipanti vedevano un video con l'intera sequenza del morphing, da 0% se stessi a 100% l'altro (o viceversa) e avevano il compito di fermarlo appena riconoscevano maggiormente se stessi (o il volto dell'altro, a seconda della condizione d'ordine). Data la differenza tra post e pre stimolazione, dopo la stimolazione sincrona (vs. asincrona), tendevano a riconoscersi maggiormente nel viso dell'altro. Questo mostra come una stimolazione multisensoriale sincrona avesse fatto sì che la rappresentazione del proprio volto e di quello dell'altro fosse stata in qualche modo sovrapposta.

In questa tesi ipotizziamo che i processi di integrazione multisensoriale, coinvolti nella rappresentazione e percezione del corpo, possano spiegare il ruolo della sincronia nelle creazione di legami e senso di unità. Se pensiamo ad esempio al marciare all'unisono, la "strana sensazione di allargamento personale" (McNeill, 1995; pag. 1) che questo crea, come se i confini del sé possano espandersi a comprendere i compagni, potrebbe essere spiegata tramite l'integrazione cross-modale delle diverse e simultanee informazioni sensoriali presenti. La sensazione tattile data dal battere i piedi ripetutamente sul suolo e, nello stesso momento, vedere i piedi degli altri colpire il terreno potrebbe creare l'effetto illusorio di fondersi con i compagni di marcia. L'integrazione multisensoriale quindi, oltre a influenzare la rappresentazione del proprio corpo, potrebbe essere causa di effetti più relazionali verso l'altro. Partendo dagli studi sull'illusione della mano di gomma e, in particolare, la versione adattata per il viso, noi[2] abbiamo voluto testare l'effetto di una stimolazione multisensoriale sincrona, in confronto ad una asincrona, nel costruire un legame che, sia a livello corporeo e concettuale, arriva a includere l'altro nel sé.

Nei prossimi capitoli verranno presentati alcuni degli gli studi esperimentali più significativi condotti all'interno di questo progetto di ricerca. Nel *Capitolo 2* verrà presentato un primo studio, basato su una nostra recente pubblicazione (Paladino, Mazzurega, Pavani & Schubert, 2010), in cui abbiamo testato l'ipotesi che l'allargamento dei confini corporei data da una stimolazione multisensoriale sincrona (vs. asincrona) si espanda da un livello corporeo ad uno più concettuale e sociale della percezione dell'altro. Rifacendosi quindi al paradigma di Tsakiris (2008), i partecipanti venivano toccati sulla guancia in maniera sincrona o asincrona rispetto ad un video dove il viso di una sconosciuta veniva toccato nella stessa maniera. Gli effetti di questa stimolazione visuo-tattile sincrona (vs. asincrona) sono stati rilevati su diverse di misure di tipo esplicito (i.e., questionari) ed implicito (i.e., compito di conformismo). Una

[2] Gli studi presentati sono il risultato della collaborazione con la mia advisor Maria Paola Paladino, Francesco Pavani e Thomas Schubert, per questo utilizzerò la prima persona plurale.

manipolazione sincrona, in confronto con l'asincrona, crea una fusione sé-altro sia ad un livello di percezione corporea (i.e., illusione di diventare l'altro, somiglianza) che concettuale (i.e., vicinanza, similarità, piacevolezza e conformismo). I risultati ottenuti sono stati ampliamente replicati negli studi successivi ed evidenze mediazionali mostrano come l'illusione corporea di diventare l'altro abbia un ruolo negli effetti sociali trovati. Ci siamo chiesti se, oltre all'illusione sensoriale, altre variabili potessero essere la causa degli effetti sociali ottenuti, e, in particolare, un diverso pattern di esplorazione del viso durante la stimolazione sincrona e asincrona. Nel *Capitolo 3* quindi, in un primo studio abbiamo analizzato i movimenti oculari registrati durante le due diverse stimolazioni. Le differenze trovate (i.e., maggiore attenzione per le zone centrali del viso nella condizione sincrona e per la zona toccata dal pennello nell'asincrona), non vanno però ad influenzare le variabili sociali misurate. Ad ulteriore prova, abbiamo somministrato ai partecipanti di un secondo studio una stimolazione audio-visiva sincrona o asincrona (che non comprendeva il loro corpo). Al seguito di questo tipo di stimolazione non è stata indotta nessuna illusione multisensoriale ed effetto sulla percezione dell'altro. I due diversi tipi di stimolazione hanno indotto un pattern di esplorazione visiva simile a quello del primo studio ma senza influenzare le variabili sociali. Questo ci ha permesso di approfondire il legame tra sincronia ed effetti sociali oltre che il ruolo dell'esplorazione del volto. Nel *Capitolo 4*, utilizzando una situazione di confronto con le sconosciute con cui i partecipanti condividevano una stimolazione sincrona o asincrona, sulle abilità in un compito di anagrammi, abbiamo osservato la reazione sulla valutazione del sé, mettendola in parallelo a studi sugli effetti del confronto sociale nelle relazioni importanti. Abbiamo evidenziando come una stimolazione multisensoriale sincrona non induca solo una semplice assimilazione percettiva ma un legame di tipo relazionale. Gli effetti sociali e relazionali dovuti ad una manipolazione visuo-tattile sincrona (vs. asincrona) possono estendersi anche al contesto intergruppi? Nel *Capitolo 5* abbiamo ripreso il classico paradigma della mano di gomma manipolando però l'appartenenza etnica (mano bianca vs. nera) e l'età (mano di un giovane vs. anziano) della mano finta per valutare da una parte l'effetto della

categorizzazione sociale sull'illusione e, dall'altra, l'effetto della manipolazione sia sulla percezione di un membro dell'in-group e dell'out-group, oltre che dei loro gruppi di appartenenza. Lo studio presentato nel *Capitolo 6*, su cui si basa un articolo da poco inviato per la pubblicazione (Mazzurega, Pavani, Paladino & Schubert), si colloca nel dibattito tra il peso dei fattori sensoriali bottom-up (i.e., sincronia) e delle conoscenze pregresse sul corpo, o top-down (e.g., legame funzionale tra gli stimoli) nelle illusioni multisensoriali (e.g., mano di gomma). Questi capitoli sperimentali sono in lingua inglese. Alcune informazioni, riguardo ad esempio al paradigma utilizzato (i.e., illusione della mano di gomma), potrebbero risultare ridondanti tra i capitoli. Il motivo è che, alcune parti di questa tesi sono state già pensate come articoli e, per completezza, non era quindi possibile solo rifarsi a capitoli precedenti. Infine, il *Capitolo 7* riguarda la discussione dei risultati e le conclusioni finali.

Chapter 2

Synchronous multisensory stimulation leads to a self-other merging[3]

"You are part of me" or "we are one" are examples of expressions that people often use to describe their dearest ones and that express a blurring of self-other boundaries. These expressions are more than just a metaphor, as it has shown by social psychology. In close and intimate relationships others become cognitively confounded and merged with the self (Aron, Aron, & Norman, 2001). However, the self and the other are not only psychological entities (i.e., concepts), but involve physical and sensorial bodies. Recent work in cognitive neuroscience suggests that a blurring of self-other boundaries can occur also for body perception (Blanke & Metzinger, 2009; Makin, Holmes & Ehrsson, 2008). Combine insights coming from these two different lines of research, my colleagues and I investigated the contribution of body perception to the merging of one's concepts of self and others (Paladino, Mazzurega, Pavani & Schubert, 2010).

Studies in social psychology have shown that the self-concept can expand and include the conceptual representation of another person (Aron, Aron, & Norman, 2001; Aron, McLaughlin-Volpe, Mashek, Lewandowski, Wright, & Aron, 2004). This process of self-other merging typically characterizes the relationships with close others (e.g., partners, friends, ingroup members). For instance, when asked to iconically describe these relationships, drawings are chosen in which the self and the other are represented graphically as two close or partially overlapping circles, rather than distant ones (see Figure 3C; Inclusion of the Other in the Self scale, IOS; Aron, Aron, & Smollan, 1992;

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[3] This chapter is base on:
Paladino, M.P., Mazzurega, M., Pavani, F., & Schubert, T.W. (2010). Synchronous multisensory stimulation blurs self-other boundaries. *Psychological Science*, 21, 1202-1207.

Schubert & Otten, 2002). Moreover, personality characteristics of the partner (Aron, Aron, Tudor, & Nelson, 1991) and in-group members (Smith & Henry, 1996) result to be confused with one's own characteristics in speeded classification tasks.

Self-other merging characterizes close relationships, but it emerges also when taking the perspective of another person (Davis, Conklin, Smith, & Luce, 1996; Galinsky & Moskowitz, 2000) and when we identify with somebody else (Cadinu & Rothbart, 1996; Goldstein & Cialdini, 2007).

Another prospective on merging, involving bodily perception, comes from recent cognitive neuroscience studies. Works about body ownership and multisensory integration have shown that one's representation of the own body is continuously updated based on simultaneous sensorial information, in particular vision, touch and proprioception. As a result, body representation is flexible, does not correspond to fix physical boundaries, as for instance, the skin. A paradigmatic example of that is the so called Rubber Hand Illusion (RHI). In the RHI, watching a fake hand being brushed in synchrony with one's own concealed hand causes the feeling of the rubber hand becoming a part of one's own body (Botvinick & Cohen, 1998; Tsakiris & Haggard, 2005). Neurologically healthy individuals can therefore include extracorporeal body parts within their own body boundaries. This illusion does not occur when the seen stimulation of the rubber hand and the felt stimulation of the own hand are not in synchrony (for recent reviews, see Makin, Holmes & Ehrsson, 2008; Blanke & Metzinger, 2009; Tsakiris, 2010).

This multisensory illusion of incorporation is not specific for hands. It also extends to body-parts that are salient for the identity, as the face (Tsakiris, 2008, see also Sforza, Bufalari, Agliotti & Haggard, 2010), and even the whole body (Ehrsson, 2007; Lenggenhager, Tadi, Metzinger & Blanke, 2007). In Tsakiris' (2008) study, participants were touched on their cheek while they were looking at a morphed face (50% of the participant facial features and 50% of someone else's features) being touched synchronously or asynchronously. After a synchronous (vs. asynchronous) visual-tactile

stimulation, participants tended to recognize more of themselves in the morphed face. This shows that the representation of the facial features of the own face became merged with those of the other person that received a synchronous visuo-tactile stimulation.

Could the self-other merging induced by correlated multisensory inputs extend beyond body perception to the conceptual merging to self and other? The self is generally experienced as localized within the borders of the body (Baumeister, 1999; deVignemont, 2007). In addition, feedback from one's body directly influences one's self concept (Schubert & Koole, 2009). Experiencing temporarily blurred boundaries between one's own and another's body could thus also affect conceptual representations of self and other. The hypothesis of this first study is that as the representation of the own body becomes overlapped with another's body, so the conceptual representation (i.e., personality, inner states, etc.) of the self and the other can become, to some extent, merged, increasing self-other similarity.

To test this hypothesis, a paradigm similar to Tsakiris's (2008) was used. Participants were brushed on the cheek in synchrony (vs. asynchrony) with the brushing on the face of a stranger shown in a video. We investigated the effect of this multisensory procedure on both body (i.e., self-other merging in terms of body sensations and resemblance), and social perception (i.e., self-other merging in terms of closeness, inner states, attraction and behavioral conformity). We predicted that participants would perceive and treat the synchronously stimulated other as more similar to the self than the asynchronously stimulated other. Finally, we tested whether the bodily illusion mediated the social outcomes.

Method

Participants

A total of 16 students (mean age: 21.87, *SD*= 2.06, 13 female) at the Faculty of Cognitive Sciences of the University of Trento participated in the experiment in exchange for course credits.

Materials

Two 3-minutes videos were used, each showing the face of a young woman (real life size; hair and background covered by a rectangular white mask) being touched on the left cheek by a small paintbrush moved in a constant rhythm (every 2 seconds). A pre-test showed that the two actors were judged equally attractive, (M = 5,01, SD = .99 and M = 5,11, SD = .86, t (68)= -.91, p = *n.s.*).

Procedure

The study was presented as a research on first impression of strangers. The experimental session consisted of two blocks. Similar to Tsakiris's (2008) study, participants were stroked on their cheek with a paintbrush while watching the video. In the two consecutive blocks, the video showed either the face of a stranger being stroked in exact spatio-temporal synchrony, or the face of another stranger being stroked asynchronously with respect to the touches felt by the participant. Order (synchrony or asynchrony first) and the identity of the strangers were counterbalanced across participants. Each stimulation phase was followed by a questionnaire and a conformity task. At the end of the experimental session, participants rated themselves and both targets on a series of issues (see Figure 2 for a schematic representation of the procedure). Then participants were debriefed and thanked for their participation.

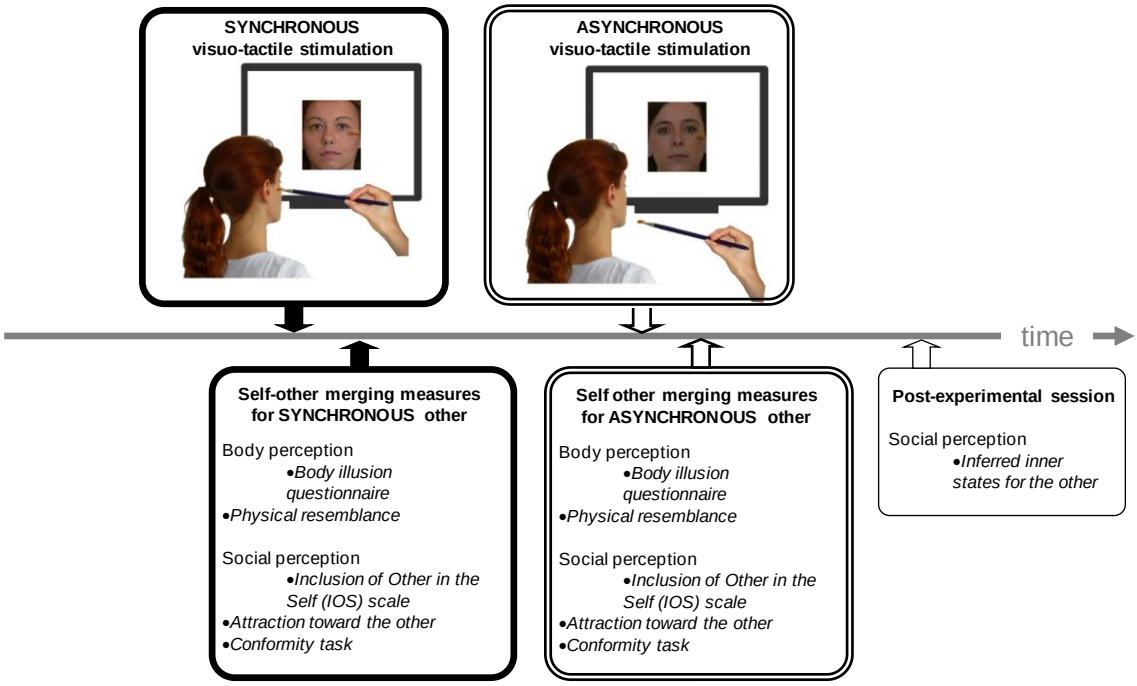

Figure 2. Schematic representation of the experimental procedure Synchronous and asynchronous conditions, as well as identity of the stranger, were counterbalanced across participants.

Dependent Variables

The questionnaire included the following measures to assess *self-other merging* on body and social perception.

Body perception

Body illusion. The questionnaire about the multisensory illusion assessed different facets of the experience. On items adapted from work of Longo and colleagues (2008), participants rated their sense of *ownership* (four items: 1. "I had the impression to see myself in a mirror"; 2. "It felt as if my face was turning into the face in the video"; 3. "Sometimes I had the impression to see my own face in the video"; 4. "I had the impression that the face in the video was starting to resemble to me"), control over the stranger's face (*agency*; three items 1. "Sometimes I had the impression that if I had moved my eyes, the eyes of the person in the video would have moved too"; 2. "It had the sensation that if I had moved my own face I would have seen movements of the face in the video"; 3. "It seemed that the face in the video had my same facial expressions"),

and whether they confused the locations of the seen and the felt touches (*location*; three items; 1. "It seemed as if the touch I felt was caused by the paintbrush touching the face in the movie"; 2. "It seemed as if I were feeling the touch in the location where I saw the face in the video being touched"; 3. "Sometimes I did not know whether the paintbrush was touching my face or the face in the video").

Pleasantness of the stimulation. Two items assessed the pleasantness of the experience (1. "I found the experience pleasant"; 2. "The touch of the paintbrush on my cheek was pleasant"). Responses to these and the body illusion items were given on a bipolar continuum of 100 mm (-50 mm = totally disagree, 50 mm = totally agree).

Physical resemblance. Participants rated how similar the target was to themselves regarding several facial features. To increase their feeling of being entitled to judge, we told that previous studies showed how people can easily and fast detect similarities between their face and the face of another person (Yzerbyt, Schadron, Leyens, & Rocher, 1994). An index of resemblance of core facial features was obtained by averaging the responses on mouth, nose and eyes. Ratings of the remaining features (forehead, cheeks, chin, face shape) formed an index of resemblance on peripheral face regions. Finally, participants rated their general resemblance to the stranger. All responses were given on a 7-point scale (1 = not at all; 7 = completely).

Social perception

Inclusion of the Other in the Self. Participants rated their relation toward the other on a variant of the IOS scale (Schubert & Otten, 2002; see Figure 3C). The circles' distance varies from a larger distance in comparison to classic Aron and colleagues' scale (Aron, Aron & Smollan, 1992; Aron, Aron, Tudor & Nelson, 1992) to a high overlap (7 -point scale). Participants were asked to rate their relation toward the other on this pictorial measure.

Attraction toward the other. Responses to two questions (1. "Based on your first impression, how likeable is the person you saw in the video?", 2. "Would you like to

meet this person?") were averaged to form an index of attraction toward the other (1 = not at all; 7 = completely).

Conformity task. An estimation task served as a subtle measure of conformity (Castelli, Vanzetto, Sherman, & Arcuri, 2001; Vaes, Paladino, Castelli, Leyens & Giovanazzi, 2003). A series of letters "a" appeared on the computer screen and participants estimated the number of letters displayed. At the top of the screen, the estimate given by the person they just watched in the video appeared. In each of the 14 trials, there were 200 letters "a", but they were differently distributed on the screen, giving the impression of variation from trial to trial. The estimates supposedly provided by the person in the video varied as well, their average again being 200. Conformity was operationalized as the averaged absolute differences between the participant's estimate and the anchors that were provided by the person in the video.

Inferences on inner states. After both stimulation blocks, an inference task was presented. This task is similar to those used in functional neuroimaging studies that investigated brain regions involved when perceivers make mental state inferences about similar and dissimilar others (Mitchell, Macrae, & Banaji, 2006). Participants had to respond to 17 questions on personality and inner states. Each questions was presented 3 times: once referring to self (e.g., "do you hate to stay in the traffic?", "Are you a sensitive person?"), imagining the synchronously and the asynchronously stimulated stranger (e.g., does the < inserted photo of the synchronously/asynchronously stimulated other > hate to stay in the traffic?). Participants responded Yes or No to all 51 questions, except for the question on politics (i.e., "Which coalition did you/the synchronously/asynchronously stimulated actor voted in the last election?"). The 51 questions were presented on a booklet, one for each page, in random order. To enhance the participants' feeling of being entitled to judge the actor, we told them that during the video they received some subliminal information (Yzerbyt, Schadron, Leyens, & Rocher, 1994). Obviously, no subliminal information was given. Within-participant correlations were calculated between the responses to the questions referring to the self and the responses referring to the synchronous target, and the self and the asynchronous target.

These correlation indices were then Fisher *z* transformed. Self-other merging was operationalized as a greater positive correlation resulting from basing the inferences on the personality of the other on self knowledge.

Manipulation check. At the end of the entire procedure participants indicated for each stimulation phase whether the felt touch on their own face and seen brushing on the face in the movie was time-looked (synchronous) or not (asynchronous). All the participants coherently perceived the stimulations with the synchronous and asynchronous conditions.

Results

All the dependent variables were submitted to a 2 (synchronous vs. asynchronous stimulation) repeated measure ANOVA.

Body perception

Body illusion. The results about *body perception*, show that synchronous stimulation led to an enhanced illusion of bodily merging in all three facets of the experience, compared to asynchrony. First, feelings of *ownership* for the face in the video were higher after synchronous (M = -17.19, SD = 20.35, α = .85) than asynchronous stimulation (M = -27.36, SD = 21.13, α = .89), F (1, 15) = 4.55, p = .05, η_p^2 = .23. Second, confusion of *locations* of seen and the felt touches was higher after synchronous (M = -11.31, SD = 20.52, α = .77) than asynchronous stimulation (M = -32.15, SD = 22.86, α = .87), F (1, 15) = 12.57, p = .003, η_p^2 = .46. Third, synchrony led to more feelings of *control/agency* over the face in the video (M = -8.15, SD = 18.91, α = .58) than asynchrony (M = -21.17, SD = 20.81, α = .67), F (1,15) = 6.86, p = .019, η_p^2 = .31 (see Figure 3A). The synchronous stimulation was also perceived as being more positive (M = 20.72, SD = 17.02, α = .86) than the asynchronous stimulation (M = 9.44, SD = 26.33, α = .92), F (1, 15) = 4.70, p = .047, η_p^2 = .24.

Physical resemblance. Continuing on body perception, we found that participants judged themselves as resembling more the synchronously (*general resemblance*, M = 2.94, SD = .93) than the asynchronously stimulated other (M = 2.38, SD = 1.20; Figure 3B), F (1, 15) = 4.77, p = .045, η_p^2 = .24. Specifically, resemblance regarding *peripheral features* of the face was higher after synchronous stimulation (M = 3.30, SD = .99, α = .74) than asynchronous stimulation (M = 2.78, SD = .98, α = .82), F (1, 15) = 4.66, p = .047, η_p^2 = .24. There was no effect on perceived resemblance of *core features* of the face, F < 1 (α = .45 and α = .47, respectively for the synchronous stimulated other and asynchronous one) (see Figure 3B). Presumably, peripheral regions, being less explored (Walker-Smith, Gale & Findlay, 19977; Mertens, Siegmund, & Grusser, 1993; Emery, 2000; see also eye tracking results in Chapter 3, Study 1) and more vaguely retained, were more readily replaced.

Social perception

Inclusion of the Other in the Self. We found that participants indicated more overlap on the IOS scale to the synchronously stimulated stranger (M = 2.88, SD = 1.46) than to the asynchronously stimulated stranger (M = 2.06, SD = .85), F (1, 15) = 9.64, p = .007, η_p^2 = .39, Figure 3C).

Inference of inner states. As shown in Figure 3D, only the within participants correlation of self descriptions and other descriptions in the synchronous condition was positive and significantly different from zero (M = .43, SD = .55), t *(15)* = 3.17, p = .006, showing that judgments of the synchronously, but not the asynchronously (M = .08, SD = .36) stimulated other were anchored in self knowledge. The difference between the self-other correlations in the two stimulation conditions was marginal, F (1, 15) = 3.70, p = .074, η_p^2 = .20.

Attraction toward the other. The manipulation influenced also the perceived *attractiveness* of the stranger (Figure 3E). Participants were more attracted toward the synchronously stimulated other (M = 4.41, SD = 0.82, α = .73) than the asynchronously stimulated other (M = 3.66, SD = 1.19, α = .90), F (1, 15) = 5.19, p = .038, η_p^2 = .26.

Conformity behaviour. Finally, the analysis of conformity behavior (Figure 3F) revealed that participants' estimates differed less from the estimates provided by the synchronously stimulated target (M = 50.69, SD = 33.73) than from those provided by the asynchronously stimulated target (M = 59.83, SD = 34.58), F (1, 15) = 6.26, p = 0.02, η_p^2 = .29.

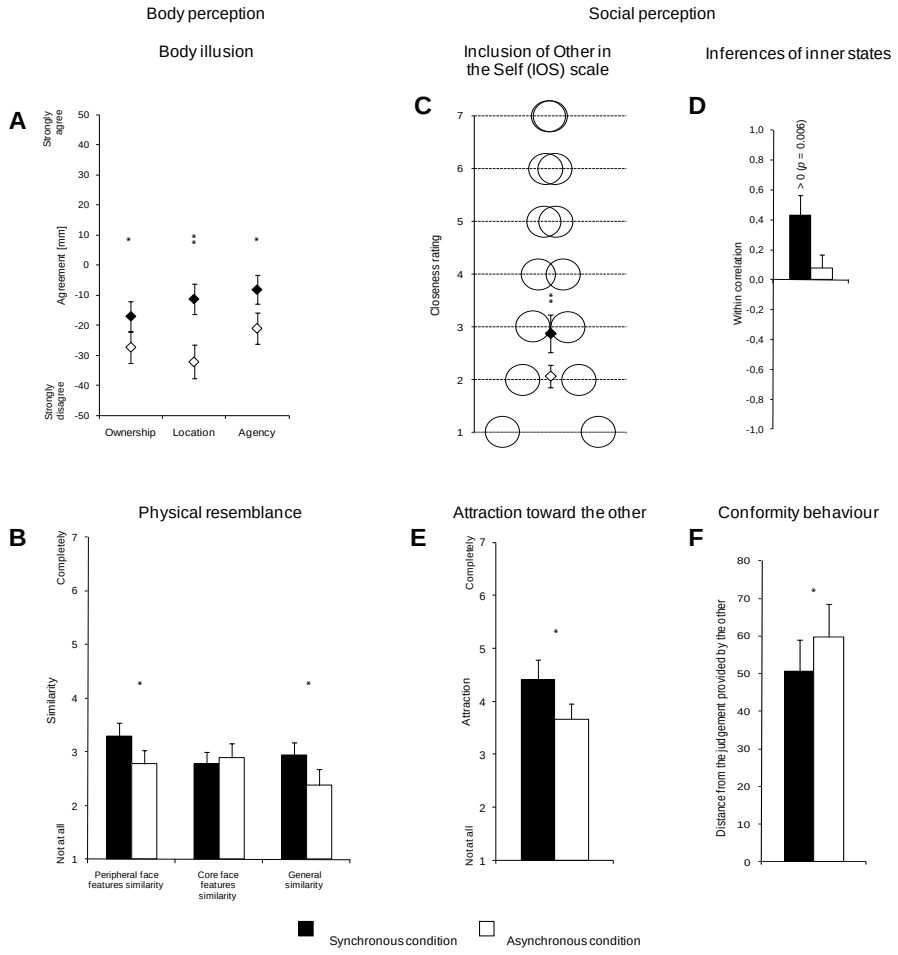

Figure 3. Effects of a synchronous (black) vs. asynchronous (white) visuo-tactile stimulations on: (A) the different facets of the body illusion (ownership, location and agency); (B) the general resemblance and physical resemblance on the core and peripheral facial features; (C) closeness with the stranger (Inclusion of the Other in the Self scale); (D) inference of inner states (within-correlations between self and the synchronous stimulated other and the self and the asynchronous stimulated other); (E) attraction toward the other and, finally, (F) conformity behaviors. Means and standard error of the mean (error bars) are reported.
*** p<.001, ** p<.01 and * p<.05

Mediational analysis. A mediation analyses for within subject designs tested whether the experienced body illusion was responsible for the effects on the other variables, namely resemblance and social perception.

This approach tests at the same time whether a variable X is the mediator and/or a moderator of a variable Y. The *mediation* question concerns whether the variable X is the process that produces a treatment effect on Y, while the *moderation* question addresses whether the variable X affects the magnitude of the between condition difference on Y.

Here, the variable X is the averaged feelings of ownership and agency, given that the effects on these variables (i.e., the differences between conditions) were correlated with each other, but not with the effect on location, and Y is the difference in the synchronous and the asynchronous condition observed on the measures of body (i.e., general physical resemblance and resemblance on peripheral features) and social perception (i.e., IOS, inferred personality traits for the other, conformity task, and attraction toward the other).

Mediation was tested by computing the difference between synchronous and asynchronous conditions, and regressing this difference on both the sum of the tested predictor in the two conditions, and its difference between the two conditions (Judd, Kenny & McClelland, 2001). Mediation is indicated by a significant prediction by the difference; full mediation is shown when the estimated intercept is no longer significant (assuming that the sum variable was centered). As shown in Table 1, averaged ownership and agency feelings completely mediated the effects on general self-other resemblance, overlap, and conformity, but not on inference of the other's personality nor attraction. No mediation effect emerged for location.

	Dependent variable Y in the model																							
	Physical resemblance								Social perception															
	General				Peripheral face feature				IOS				Inference task				Conformity task				Attraction			
Predictor	*B*	*SE*	*t*	*p*	*B*	*SE*	*t*	*p*	*B*	*SE*	*T*	*p*	*B*	*SE*	*t*	*p*	*B*	*SE*	*t*	*p*	*B*	*SE*	*t*	*p*
d_0	0.17	0.27	0.64	.536	0.29	0.29	1.01	.331	0.45	0.29	1.53	.150	0.37	0.24	1.54	.148	4.02	3.97	1.01	.329	0.42	0.39	1.06	.311
X_S (d_1)	0.01	0.01	1.37	.194	0.01	0.01	0.77	.454	0.00	0.01	0.52	.615	0.00	0.01	0.11	.911	-0.07	0.11	-0.68	.509	0.01	0.01	0.71	.493
X_D (d_2)	0.04	0.01	2.60	.022	0.02	0.01	1.36	.197	0.03	0.02	2.19	.048	-0.01	0.01	-0.12	.906	0.45	0.20	2.26	.042	0.03	0.02	1.48	.162

Table 1. Mediation of effects of synchrony (vs. asynchrony) on resemblance perception and social variables by averaged feelings of ownership and agency.

Note. Following Judd, Kenny and McClelland (2001), mediation of effects of a within subjects factor on a dependent variable Y by a mediator X was tested with the equation $Y_D = d_0 + d_1X_S + d_2X_D$, where Y_D is the difference between the synchronous and asynchronous condition in Y (resemblance judgment and social outcomes), X_S is the sum of X in both conditions, and X_D the difference between conditions in X. In all displayed regressions, the tested mediator X was the average of assessed feelings of ownership and agency.If the difference X_D significantly predicts the Y_D, then this indicates a mediational model. If the X_D is significant and X_S is centered, the estimated intercept, d, no longer significant reflects a full mediation pattern. The illusory perception of ownership and agency for the stimulated face was a significant mediator of the more general physical resemblance, closeness rated on the IOS scale, and conformity toward the other in the synchronous compared to the asynchronous condition.

Conclusion

Previous works, in cognitive neuroscience field, demonstrated that synchronous multisensory stimulation can alter our body representation and influence what is included in it (e.g., Blanke & Metzinger, 2009; Tsakiris, 2008). In the present research, we showed, for the first time, that multisensory integration processes underlying body perception can have effects on social aspects of our cognition and behavior, leading a blurring in self-other conceptual boundaries.

Participants felt a stranger to be closer and more similar to themselves after they observed the face of this person receiving synchronous stimulation than after they observed the face receiving asynchronous stimulation. In addition, observing synchronous stimulation elicited more positive affective reactions and conformity toward the other than observing asynchronous stimulation. It appears that both projecting the self onto the other (as in the inference task) and anchoring one's behavior in that of the other (as in the conformity task) resulted from observing the face of a

stranger being stimulated in synchrony with one's own face. This phenomenon emerged as a relative difference between synchronous and asynchronous conditions, rather than as a delusional disregard of the obvious discrepancies between the observer and the stranger in terms of facial features and location in space.

The bodily illusion mediated most but not all the social cognitive outcomes. Presumably, the affected variables are better proxies of the sense of self-other similarity. The unmediated effects on attractiveness of others and inferences on their traits are both likely to be influenced also by factors other than similarity (e.g., the actual attractiveness of the actor and the specific aspect to infer). The effects on attractiveness of others and inferences on their traits were not mediated by bodily illusion, and it is likely that these variables were also influenced by factors other than similarity (e.g., interpersonal differences in attractiveness judgments and the specific aspect to infer).

The current study shows that the cognitive and affective phenomenon of self-other merging, which is typically experienced with close others and in-group members, can arise from a purely sensorial experience. Unlike other bodily cues investigated in social relations (i.e., interpersonal touch; Gallace & Spence, 2008; Schubert, Waldzus, & Seibt, 2008), synchronous visuo-tactile inputs, as those used in our studies, are hardly semantically associated to affective and intimate relationships. Because of that, our findings provide a compelling evidence of the contribution of the more sensorial part of the self in the foundation of self-other overlap and social identification. More importantly, our research highlights the process implicated, namely the *multisensory integration*. This suggests that the social self-concept can be partly grounded in overlapping sensory representations of one's own and others' bodies.

Our findings provide a novel account for the understanding the bonding effect of shared synchronized behaviors (e.g., dancing, singing, marching together), which characterize ancient as well as modern group rituals. According to anthropological and psychological work, acting in synchrony is a common way to implement and express a communal relationship, that is characterized by the feeling of being all the same and united by a common identity (Fiske, 2004). Recent researches showed that acting in

synchrony can foster group unity (Lakens, 2010) and cooperation (Wilthermuth & Heath, 2009), induce self-other similarity (Valdesolo & DeSteno, in press), affiliation (Hove & Risen, 2009) and conformity (Wilthermuth, under review). Our findings suggest that spatio-temporally correlated multisensory stimulations might be one of the processes that underlie the effects of synchronous behavior. When marching in synchrony, for example, one *feels* one's feet striking the ground, repeatedly and in close temporal synchrony with *seeing* other people's feet striking the ground. To state it differently, acting in synchrony can create conditions for multisensory integration. As we showed, the integration of these multisensory signals creates both a body illusion to blur self other boundaries but also increases self-other similarities, in thoughts and behaviors.

Chapter 3

Two follow-up studies on synchronous multisensory stimulations, face exploration and self-other merging

In the previous chapter we showed that a blurring self-other boundaries at bodily level, induced by synchronous multisensory inputs, had also an effect at conceptual level of representation of the self and the other. In addition to the feeling of becoming/being the face in the movie and a perceived physical resemblance, a synchronous visuo-tactile stimulation led to a more similarity (in terms of inner states) and closeness with the synchronous (rated the Inclusion of the Other in Self scale, IOS, Aron, Aron and Smollan, 1992; Schubert & Otten, 2002), in comparison to the asynchronous stimulated stranger (Paladino, Mazzurega, Pavani and Schubert, 2010). Indeed, mediational analysis revealed that the illusory feeling of becoming and controlling the other, two facets of the multisensory illusion (i.e., ownership and agency), mediated only part of the social outcomes, namely a general resemblance perception, closeness and conformity behavior. We wondered if other processes, in addition to the multisensory illusion, played a role in leading to a self-other merging in the more conceptual representation of the other.

Recently, Buchan and colleagues (2007) showed that the presence of - or being exposed to - non-correlated sensorial inputs (i.e., acoustic noise in an emotion/speech recognition task) can alter face exploration, reducing the fixations on the eyes region in advantage of a more central and strategically spatial distribution of gaze. Interestingly, eye contact is linked to social ability, such as recognition of other's identity (Schyns, Bonnar & Gosselin, 2002), understanding of emotional (Hall, Hutton & Morgan., 2010) and mental states and others intentions (Emery, 2000). Moreover, individuals with autism pay less attention to the eyes of an interacting partner and this is linked with their problems in the social development and communication (Jones, Carr & Klin, 2008; Klin, Jones, Schultz, Volkmar & Cohen, 2002). In the study presented in the previous

chapter (see also Paladino, Mazzurega, Pavani & Schubert, 2010), the asynchrony between the seen and felt touch could have attracted the attention on the discordant input, namely the paintbrush movement, and impaired face exploration, in particular, the attention for the core facial features, as the eyes region, an important area for capturing social cues.

Study 1 aims to replicate our previous findings (see Chapter 2 and Paladino, Mazzurega, Pavani & Schubert, 2010). We would thus expect participants to report a stronger illusory bodily merging effect in the synchronous vs. asynchronous condition. In addition, we would expect to find a stronger sense of relational self-other merging (closeness to the stranger) and similarity (self-projection on her of their own personality traits) toward the person shown in the movie with whom they share a synchronous rather than asynchronous touch. Furthermore, participants' eyes movements were recorded with the Tobii eye-tracker. In this way, it was possible to examine any differences in the facial exploration in a shared synchronous and asynchronous experience, as well as its role in modulating social perception.

Study 1

Method

Participants

25 female students at the Faculty of Cognitive Sciences of the University of Trento participated in the experiment in exchange of course credits. One participant was excluded from the analysis for problems in eyes movement recording, leaving the sample to 24 participants (mean age: 20.29, *SD* = 4.28).

Materials

Two videos of 3 minutes each showing the face of two different young women, of about participants' age, being touched by a small paintbrush on the left cheek every 2 seconds. Each stroke covered a distance of approximately 2 cm on the face. A pre-test

showed that the two women that played in the videos as actresses were judged equally attractive (M = 4.98, SD = 1.12 and M = 4.67, SD = 1.23, t (43) = 1.65, p = *n.s.*). Differently from the videos used in the study described in Chapter 2, the actresses' hair and the background (i.e., white wall) were showed (see Figure 4).

Procedure

The research was presented to the participants as a study about the first impression on strangers. It consisted of 2 sessions (see figure 4 for a schematic representation of the procedure).

Pre-experimental session. One week to one day before the experiment, participants were contacted by e-mail and asked to respond to an online questionnaire. Students described themselves along ten positive (active, creative, competent, honest, trustworthy, helpful, intelligent, responsible, sensitive, sociable) and nine negative (anxious, boring, conformist, disorganized, impulsive, indecisive, intolerant, quarrelsome, superficial) personality traits. Their responses were registered on 7-point scales (1=not at all; 7=completely).

Experimental session. The experimental session consisted of two blocks. In each block participants were asked to watch a movie showing a young woman while she was touched on the left cheek by a small paintbrush. While watching the movie, the experimenter touched the participant's left cheek with an identical paintbrush either in synchrony or asynchrony (across blocks) with the touch delivered to the face of the movie actresses. At the end of each movie and stimulation phase, participants responded to a questionnaire directed to assess the self-other merging both on the bodily and social level. They were asked to rate the strength of the experienced body illusion due to the multisensory stimulation and to report their impression of the actress seen in the movie and the sense of closeness that they felt toward her.

At the end of the experiment participants were debriefed and thanked for their participation.

Below, I will describe the dependent variables in details.

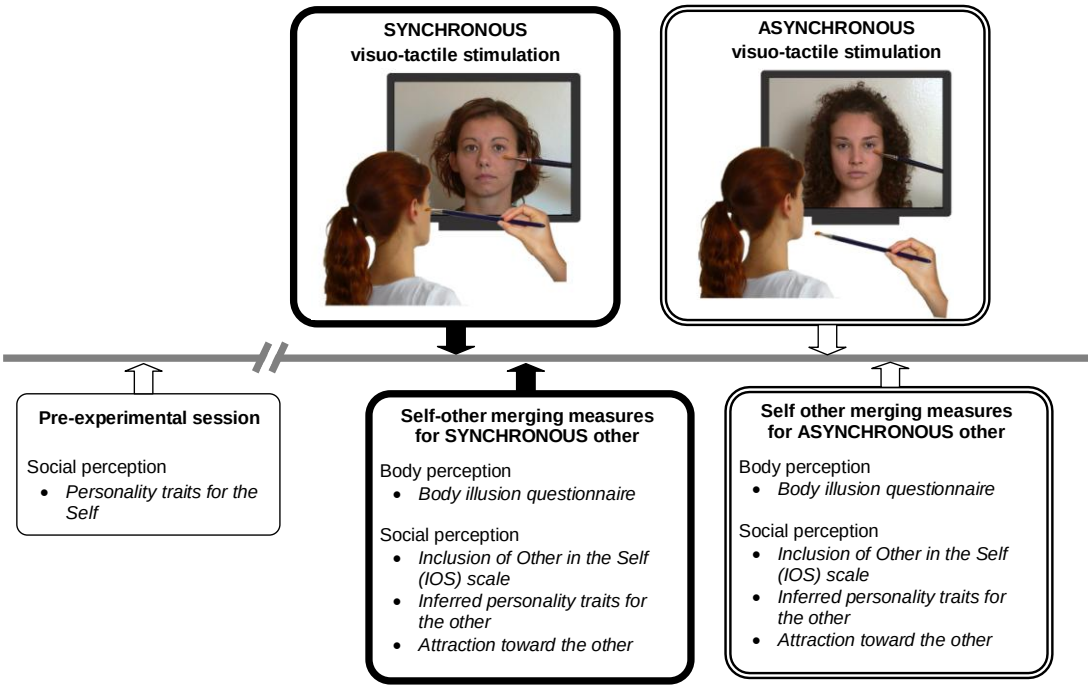

Figure 4. Schematic representation of the experimental procedure. Pre-experimental session consisted in an on-line questionnaire while the experimental session was conducted in the laboratory. Note that synchronous and asynchronous conditions, as well as identity of the stranger, were counterbalanced across participants.

Dependent Variables

Body perception

Body illusion. Four items concerning body illusions were adapted from the rubber hand illusion studies (Botvinick & Cohen, 1998; Longo, Schüür, Kammers, Tsakiris & Haggard, 2008): 1. "It seemed as if I were feeling the touch in the location where I saw the face in the movie being touched", 2. "It seemed as if the touch I felt was caused by the paintbrush touching the face in the movie", 3. "I had the impression to see myself in a mirror; 4. It felt as if my face was turning into the face in the video". These items aimed at assessing the sensations of a causation between the seen and the felt touches (illusion related to *location*, items 1 and 2) and the feelings of being/becoming the body in the movie (illusion of *ownership*, items 3 and 4). Participants rated their agreement to each item on 7-point scale (1= not at all, 7=completely).

Social perception

Inclusion of the Other in the Self. Participants evaluated the closeness they felt toward the actress on the Aron and colleagues' Inclusion of Other in the Self (IOS) scale (Aron, Aron & Smollan, 1992, see Figure 5B). Being developed and validated as a measure of interconnectedness and self-other merging for romantic relationships, this single item scale ranges from two close, but not overlapping, circles to two almost complete overlapping circles (7-point scale).

Attraction toward the other. The same two questions used in the experiment of the previous chapter investigated the attraction toward the stranger (1. "Based on your first impression, how likeable is the person you saw in the video?", 2. "Would you like to meet this person?"; average index).

Inference on the personality traits. To further assess self-other merging, we asked participants to rate the strangers on the same positive and negative personality-traits on which they had described themselves in the pre-experimental session. Preliminary analyses revealed that 1 positive (i.e., creative) and 2 negative traits (i.e., anxious and indecisive) were, on average, irrelevant for the self description (i.e., not different from 4, all *p*'s >.27). Following previous studies on self-projection and self-stereotyping (Latrofa, Vaes, Pastore & Cadinu, 2009) we focused our analysis only on target-relevant traits. The traits irrelevant for self-description were thus not further considered. Within-participant correlations were calculated between the ratings for the self (measured in the pre-experimental session) and the ratings for the synchronous stranger, and between the ratings for the self and the ratings for the asynchronous stranger, separately for positive and negative traits (9 and 7 traits, respectively). Self-other merging was operationalized as a greater positive correlation resulting from basing the inferences on the personality of the other on self-knowledge.

To sum up, each participant performed two blocks, receiving thus synchronous and asynchronous visuo-tactile stimulation. She reported in a questionnaire any bodily illusion and rated both the synchronously and asynchronously stimulated others immediately after each multisensory stimulation. The identity of the stranger assigned to the block and the order of the blocks were completely counterbalanced.

Results

All the dependent variables were submitted to a 2 (synchronous vs. asynchronous stimulation) repeated measure ANOVA, except for the inferences on the personality of the target.

Body perception

Body illusion. About *body perception*, participants reported stronger feelings of causation between the seen and the felt touch (*location*, $M = 3.06$, $SD = 1.61$, $\alpha = .60$) when the sensorial stimulation was synchronous (vs. asynchronous, $M = 1.73$ and $SD = .99$, $\alpha = .20$). F (1, 23) = 16.68, $p = .001$, $\eta_p^2 = .42$. Given that the ratings of the two location items in the asynchronous condition showed low internal consistency ($\alpha = .20$), additional analyses were conducted on the single items. Item 1 and 2 were thus submitted to a 2 (synchronous vs. asynchronous stimulation) repeated measure ANOVA. The analysis yielded a highly significant and a marginally significant effect for item 1 (F (1, 23) = 23.49, $p = .001$, $\eta_p^2 = .50$) and 2 (F (1, 23) = 3.76, $p = .065$, $\eta_p^2 = .14$), respectively. The illusory sensation of being the same person was also stronger (*ownership*, $M = 3.46$, $SD = 1.72$, $\alpha = .68$) when the visuo-tactile stimulation was synchronous (vs. asynchronous, and $M = 1.92$ and $SD = 1.21$ $\alpha = .81$) , F (1, 23) = 21.18, $p = .001$, $\eta_p^2 = .48$ (see Figure 5A). The relative feeling of incorporating the other in the physical boundaries was found, consistently with other studies (Paladino, Mazzurega, Pavani & Schubert, 2010; Tsakiris, 2008; Sforza, Bufalari, Haggard & Aglioti, 2010).

More importantly, the effects of multisensory correlated inputs extended beyond the perceptual body illusion and affected *social perception* and the relation toward the other.

Social perception

Inclusion of the Other in the Self. When asked to describe the relationship felt toward the strangers on the IOS scale, participants reported greater overlap with the synchronous ($M = 3.92$, SD = 1.93) than the asynchronous other ($M = 2.58$, SD = 1.77), F (1, 23) = 12.69, $p = .002$, $\eta_p^2 = .36$; see Figure 5B).

Inference on the personality traits. Within-participant correlations between the ratings of the self and the synchronously stimulated stranger, and between the self and the asynchronously stimulated stranger on positive and negative traits, were first transformed in Fisher *z*-scores and then analyzed in a 2 (synchronous vs. asynchronous stimulation) X 2 (positive vs. negative traits) repeated measure ANOVA. We expected that the self-other merging would be reflected in a self-anchoring of the other's traits in the self. Indeed, within-participant correlations between the personality trait ratings for the self and personality trait ratings for the strangers changed as a function of whether the face had been stimulated in synchrony or asynchrony (greater correlation is caused by inferring from the self to the other and it indexes conceptual self-other merging). Independently of the type of traits (i.e., positive and negative) participants' self-description showed a tendency to correlate more strongly with their description of the synchronous (M = .184, SD = .40) compared to the asynchronous face (M = -.001, SD = .42), F (1, 23) = 3.52, p = .07, η_p^2 = .13. Even though the effect was marginally significant, it should be noted that only the correlation for the self and the synchronous other was positive and significantly different from zero, t (23) = 2.23, p = .04 (t (23) = -0.13, p = n.s., in case of the correlation for the self and asynchronous other, see Figure 5C). This indicates that self knowledge was used to infer the unknown personality of the stranger only when sharing a synchronous stimulation.

Attraction toward the other. No effect of synchrony manipulation on attraction toward the other was found, F (1, 23) = 1.10, p = n.s., η_p^2 = .05 (α_synch = .44, α_asynch = .80).

Taken together, the results for the IOS scale and the trait ratings support the idea that sharing a multisensory experience affects social perception, leading to self-other merging of conceptual representations.

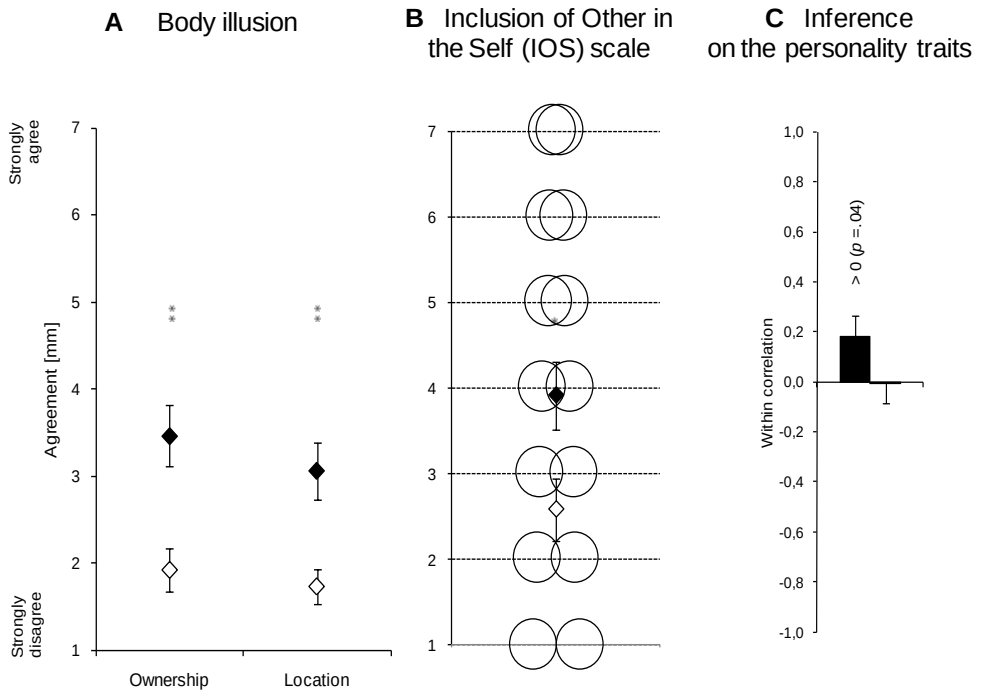

Figure 5. Effects of a synchronous (black) vs. asynchronous (white) visuo-tactile stimulations on: (A) the different facets of the body illusion (ownership, location); (B) Closeness with the stranger (Inclusion of the Other in the Self scale); (C) Inference on the personality traits (within-correlations between self and the synchronous stimulated other and the self and the asynchronous stimulated other). Means and standard error of the mean (error bars) are reported. *** $p < .001$, ** $p < .01$ and * $p < .05$

Eye movement pattern

Figure 6 displays the relative spatial distribution of gaze, separately for the face of the two actresses[4]. The colors indicate the difference between the average duration (in ms) of the gaze on a particular screen location during the synchronous and the asynchronous stimulation. The areas explored more in the synchronous or in the asynchronous condition are indicated respectively in red and in blue (see the color legend). A first look at the figure shows that the eyes region attracted more participants' attention in the synchronous (vs. asynchronous) condition. Other areas differently explored were the core facial features and the brushed cheek. More time was spent on

[4] Given the differences between the actresses' features and their position in the screen, the spatial distribution of gaze was formerly explored for each of the two actresses separately.

the first ones in the synchronous condition, whereas the brushed cheek attracted more the attention in asynchronous stimulation.

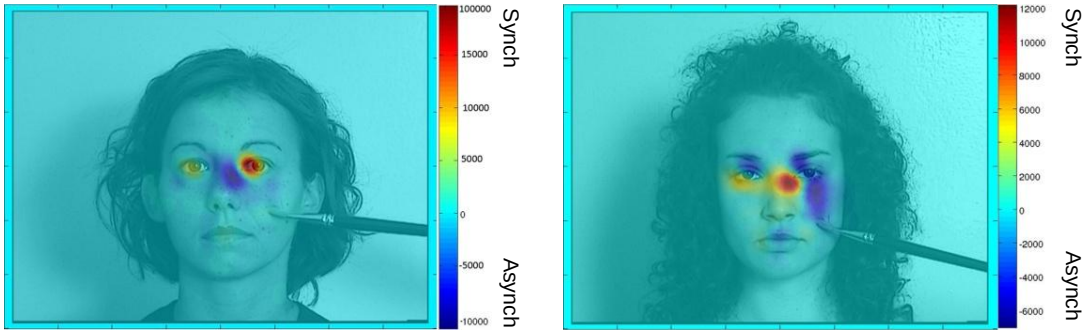

Figure 6. Spatial distribution of gaze. Differences between the average duration of fixations on a particular screen location, during the synchronous and the asynchronous stimulation, separately for each actress. Red indicates that the zone was more explored during synchronous stimulation, whereas blue in the asynchronous. Time range (in ms) is indicated in the legend.

Subsequently eyes movements data were recoded in the area of interests. These were the eyes region, the core facial features (i.e., the nose and mouth), the brushed cheek and the peripheral face features (i.e., forehead, cheeks, chin and face shape) during both the synchronous and the asynchronous stimulation (Figure 7). The areas of interest were individuated to fit both the faces of the actresses. Several indices were considered: the total amount of time (milliseconds) spent in looking at the different areas of the face, the percentage of the number of fixations and the mean duration of each fixation.

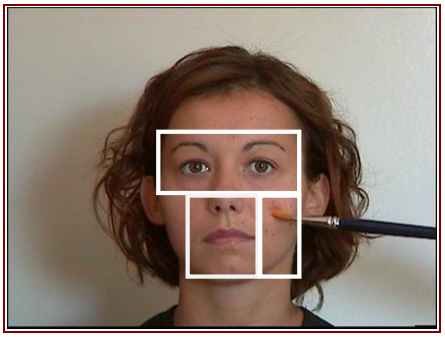

Figure 7. Areas of interest: eyes region, core facial features (mouth and nose), brushed cheek and remaining areas.

All of the indices were submitted to a 4 (areas of interest: eyes vs. nose and mouth vs. brushed cheek vs. peripheral feature) X 2 (target: synchronous vs. asynchronous stimulation) repeated measures ANOVA.

Regarding the *percentage of fixations*, some differences in the exploration of the face emerged. The main effect of the area of interest indicated that 57% of the fixations (*SEM* = 3.75) dropped in the eyes region, followed by 19% of the fixations toward the nose and mouth (*SEM* = 1.98) ,18% of fixations in the brushed cheek area (*SEM* = 2.31) and 7% of fixations in the remaining areas (*SEM* = 1.38), F (3, 69) = 57.12, $p < .001$, $\eta_p^2 = .71$ (Figure 8A). Interestingly, a interaction between the areas of interest and the synchrony was significant, F (3, 69) = 5.23, $p = .003$, $\eta_p^2 = .19$. During both types of stimulation the eyes area was the one mostly monitored by the participants, with a non-significantly higher tendency for the synchronous manipulation, (*M* = 59%, *SEM* = 3.79) in comparison with the asynchronous one (*M* = 55%, *SEM* = 4.36), F (1, 23) = 2.18, $p = .15$. The same trend was revealed by the nose and mouth region (M_{synch} = 20%, *SEM* = 1.83; M_{asynch} = 17%, *SEM* = 2.44), F (1, 23) = 3.82, $p = .06$, whereas in the case of the brushed cheek area the trend was reversed, showing a higher number of fixations in the asynchronous (*M* = 22%, *SEM* = 3.04) vs. synchronous condition (*M* = 14%, *SEM* = 1.92), F (1, 23) = 14.04, $p < .001$. No differences for the two types of synchrony were found for the remaining areas (both *M* = 7%, SEM_{synch} = 1.47, SEM_{asynch} = 1.41) F (1, 23) = 0,61, p = n.s. (see Figure 8B).

As for the *amount of time spent*, the main effect of the area indicated that the amount of time participants spent in looking at specific face area constantly decreased when considering the eyes (*M* = 85851.90 ms, *SEM* = 7034.07), the brushed cheek (*M* = 28943.63 ms, *SEM* = 3707.70), the nose and mouth (*M* = 24423.75 ms, *SEM* = 2995.75) and the peripheral area (*M* = 6352.50 ms, *SEM* = 1362.14), F (3, 69) = 49.40, $p < .001$, $\eta_p^2 = .68$ (Figure 8C). Overall, participants tended to look longer at the face of the synchronous (*M* = 37236.29 ms, *SEM* = 656.95) with respect to the asynchronous target (*M* = 35549.59 ms, *SEM* = 945.53), F (1, 23) = 6.89, $p = .015$, $\eta_p^2 = .23$ (Figure 8D). Such main effects were qualified by the interaction, F (3, 69) = 3.81, $p = .01$, $\eta_p^2 = .14$. Participants tended to look longer at the eyes area and mouth and nose area during the synchronous (M_{eyes} = 90918.58 ms, *SEM* = 7122.60; $M_{nose\ and\ mouth}$ = 27092.46 ms, *SEM* = 3830.39) than the asynchronous stimulation (M_{eyes} = 80785.21 ms, *SEM* = 7956.49; $M_{nose\ and\ mouth}$ = 21755.04 ms, *SEM* = 2494.78), respectively F (1, 23) = 3.40, $p = .08$ and F (1, 23) = 4.83, p =

.04. The opposite pattern of results emerged for the brushed cheek area. This area was explored longer in the face of the asynchronous (M = 33529.08 ms, SEM = 4687.07) than the synchronous target (M = 24358.17 ms, SEM = 4866.74), F (1, 23) = 4,46, p = .05. The exploration of the peripheral features did not differ for the two targets (M = 6575.96 ms, SEM = 1437.16 and M = 6129.04 ms, SEM = 1344.54 for the synchronous and the asynchronous target, respectively), F (1, 23) = 0,61, p = n.s. (see Figure 8E).

The last index we considered is the *mean time of fixation* in a specific face area. The main effect of the area of interest showed that the mean time of fixations was greater, on average, in the eyes region (M = 547.80 ms, SEM = 67.81) and where the paintbrush touched the stranger's face (M = 529.53 ms, SEM = 39.46), whereas it decreased in the mouth and nose area (M = 456.73 ms, SEM = 34.10) and the remaining areas (M = 293.98 ms, SEM = 22.14), F (3, 69) = 10.23, p < .001, η_p^2 = .31 (Figure 8F). In general, fixations during the synchronous stimulation (M = 498.61 ms, SEM = 37.17) were longer than during the asynchronous stimulation (M = 415.41 ms, SEM = 29.28), F (1, 23) = 11.78, p = .002, η_p^2 = .34 (Figure 8G).

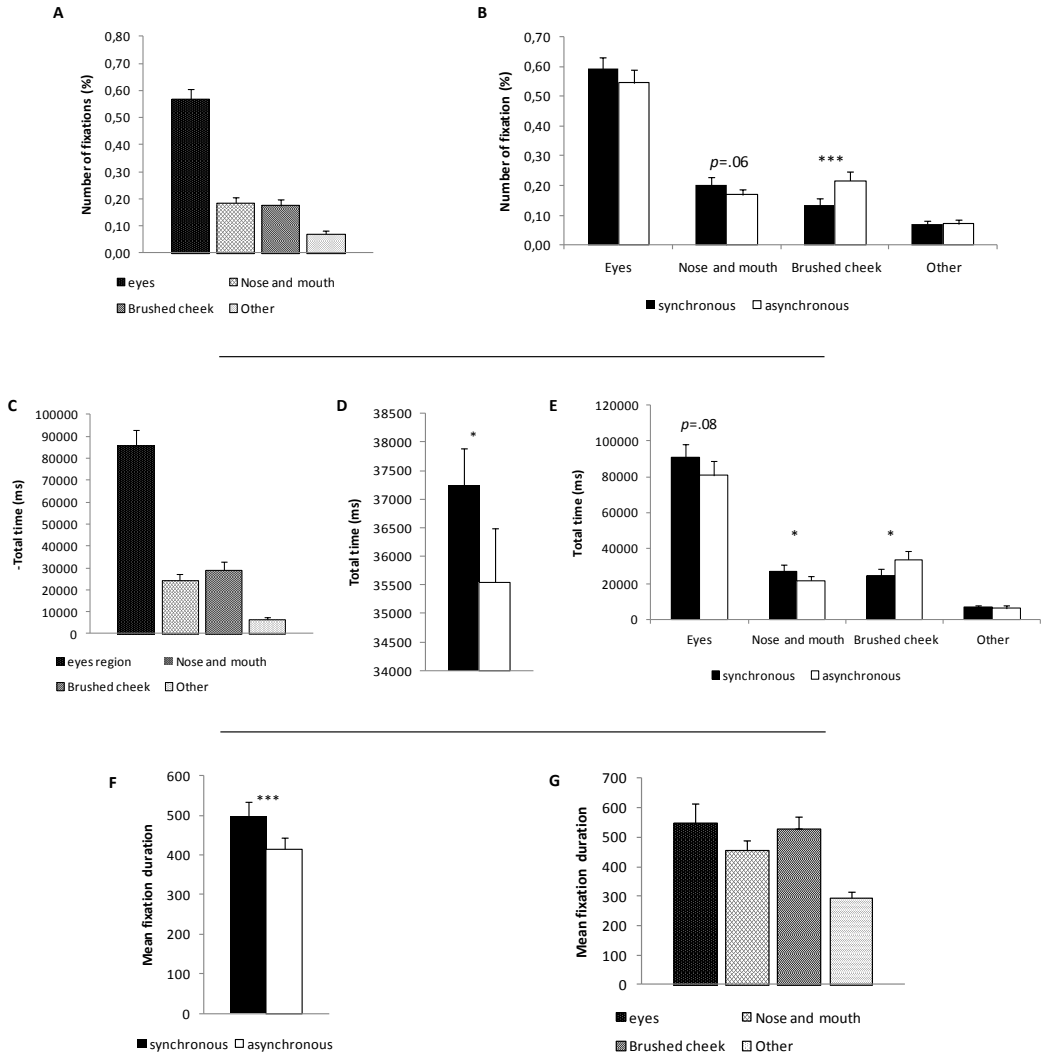

Figure 8. Percentage of number of fixations in each area of interest (A) and the interaction between face areas and synchrony (B); total time spent in each area of interest (C) during the synchronous and asynchronous stimulation (D) and the interaction between synchrony and areas of interest (E); mean duration of each fixation (ms) in each area of interest (F) and during the synchronous and asynchronous stimulation (G).Means and standard error of the mean (error bars) are reported. *** $p < .001$, ** $p < .01$ and * $p < .05$

Correlations between the bodily illusion, the social outcomes and eyes movements (computed as the difference between rates after the synchronous and asynchronous condition) are showed in Table 2. Focusing on the link between the illusion, the face exploration pattern and the social aspects, only the sense of ownership positively correlates with the closeness, r (24) = .70, $p < .001$.

	1	2	3	4	5	6	7	8	9	10	11
1. Ownership	-										
2. Location	,293	-									
3. IOS	,696**	,175	-								
4. Self-projection	,019	-,090	-,306	-							
5. % num. fixations, nose and mouth	,185	,122	,184	,207	-						
6. % num. fixations, brushed cheek	-,010	-,065	-,112	-,045	,059	-					
7. Amount of time, condition	-,124	,179	-,194	-,106	,091	,109	-				
8. Amount of time, eyes region	-,156	,062	-,121	-,106	-,481*	-,739**	,383	-			
9. Amount of time, nose and mouth	,185	,122	,184	,207	1,000**	,059	,091	-,481*	-		
10. Amount of time, brushed cheek	-,010	-,065	-,112	-,045	,059	1,000**	,109	-,739**	,059	-	
11. Mean time of each fixation, condition	-,193	,008	-,346	-,022	-,170	,174	,476*	,216	-,170	,174	-

** p< .01 * p< .05

Table 2. Correlations between different facets of the bodily illusion (ownership and location), the social outcomes and eyes movements (computed as the difference between rates after the synchronous and asynchronous condition).

Conclusion

The present study replicated the effect of synchronous multisensory stimulation on social perception. The synchronous visuo-tactile, in comparison to the asynchronous input generated the illusory effect of becoming the person in the movie and confounding the location of the felt touch. A blurring in self-other boundaries, at the bodily level, extended also at relational level. A greater sense of relational overlap, rated through the Inclusion of Other in the Self scale (Aron, Aron & Smollan, 1992), and the tendency to see the other more similar in terms of personality, was found toward the partner of the synchronous (vs. asynchronous) stimulation. This supports our previous finding that sharing a synchronous multisensory experience leads to self-other merging also at the conceptual representations of the self (Paladino, Mazzurega, Pavani & Schubert, 2010).

Remarkably, then, the results coming from the eye-movements data highlighted differences in face exploration pattern due to synchronous and asynchronous stimulation. Core facial features were more explored (in terms of number of fixations and total time spent in those areas) in the synchronous condition while the paintbrush area attracted participants' attention more in the asynchronous condition. In general, when the stimulation was synchronous, rather than asynchronous, more time was spent

in exploring the stranger's face and the fixations were longer. Given that face exploration was not correlated with the social outcomes, a meditation, besides the multisensory illusion, could not be tested. Taking together these results suggest that, although participants explored and processed the face of the partner of the stimulation differently, during the synchronous vs. asynchronous stimulation , this was not responsible for the social effects.

To better understand the role of illusory feeling of becoming the other in self-other merging at conceptual level we conducted another study. In this study participants received a synchronous and asynchronous audio-visual stimulation. They watched a movie where a woman was tapped on her cheek with a paintbrush and, in synchrony or with a different rhythms, they heard a sound. Differently from study 1 in this chapter, participants did not receive any tactile stimulation on their faces. The correlated occurrence of an audio and visual inputs makes possible the integration of the stimuli as a coherent unit (Welch & Warren, 1980) but, given the absence of a stimulation that involve the participants' body (a tactile stimulation), synchrony was not expected to yield any multisensory illusion. This study allows to answer whether every synchronous multisensory experience leads to a self-other merging or whether blurring boundaries between the self and the other at physical level is a necessary condition for building a connection between the self and the other (when stimulated in synchrony). If the social outcomes are due to the self-other merging induced by the conflict in integration of different multisensory inputs (i.e., seeing on another body what is happening on one's own body) and not multisensory synchrony in itself, we should expect no effects on social variables when receiving a synchronous audio-visual stimulation. Moreover, we investigated the effect of the synchronous and asynchronous audio-visual stimulation on face exploration, to verify whether, in absence of a bodily illusion, the presence of changes in the pattern would affect the rising of social outcomes.

Study 2

Method

Participants

24 female students (mean age: 20.58, *SD* = 1.72) of the University of Trento participated to the experiment in exchange of course credits.

Materials

Two videos, with a duration of three minutes, were used. Each video displayed the face of a young woman (real life size; hair and background covered by a rectangular white mask) being tapped on the left cheek by a small paintbrush every 2 seconds. The two actress were judged equally attractive in a pre-test (M = 4.17, SD = 1.42 and M = 4.00, SD = 1.27, t (7) = .33, p = *n.s.*). For each video, a synchronous and an asynchronous audio-visual versions were created. The former version involved a sound that was phase-locked (and thus rhythmic) with the touch of the paintbrush, whereas the latter version employed a sound that was not phase-locked (i.e., randomly assigned). The total amounts of sounds were kept constant during the two stimulations.

Procedure

To compare the results of the present study to the previous one, the procedure followed exactly our first experiment, presented in Chapter 2 (see also Paladino, Mazzurega, Pavani & Schubert, 2010). Participants performed two experimental blocks[5].

[5] Before the experimental part, participants filled a first questionnaire. A scale investigated individual differences in four dimensions of empathy (Interpersonal Reactivity Index by Davis, 1980, 1983; Italian version by Albiero, Ingoglia & Lo Coco., 2006). Following Sforza and colleagues (2010), we planned to investigate correlations between different scores about bodily and social self-other merging and different aspects of empathy tendency. The questionnaire is formed by 28 items that take in consideration 4 different factors linked to empathy to rate on a 5-point likert scale (the statement is 1= never true for me , 5= always true for me): the tendency to take the point of view of the others (perspective taking scale - PT; e.g., "Before criticizing somebody, I try to imagine how I would feel if I were in their place"), the imaginative skill to transpose oneself into fictional characters or situations as, for instance, books or movies (fantasy scale - FS; e.g., "I really get involved with the feelings of the characters in a novel"), the sympathy and concern for others (empathic concern scale - EC; e.g., "I often have tender, concerned feelings for people less fortunate than me") and, finally, the strength of anxiety and feelings linked to emergency situations in helping others (personal distress scale - PD; e.g., "In emergency situations, I feel

In each block they watched a three minutes movie where a stranger was receiving a tapping by a paintbrush on her cheek and heard a sound in synchrony or not with the touch. Participants did not receive any tactile stimulation. The order of presentation of the type of stimulation and identity of the targets were counterbalanced between participants. Right after each stimulation, participants filled a questionnaire and performed a conformity task. The questionnaire regarded the different aspects of the bodily illusion of merging with the stranger shown in the movie (ownership, agency and location), the pleasantness of the audio-visual stimulation, the perceived physical resemblance with her and the feeling of relational closeness and attraction. At the end of the two blocks, they answered to questions assessing an inference task and to manipulation check questions (see Figure 9). Finally participants were debriefed and thanked for their participation. Details on the measures can be found in Chapter 2.

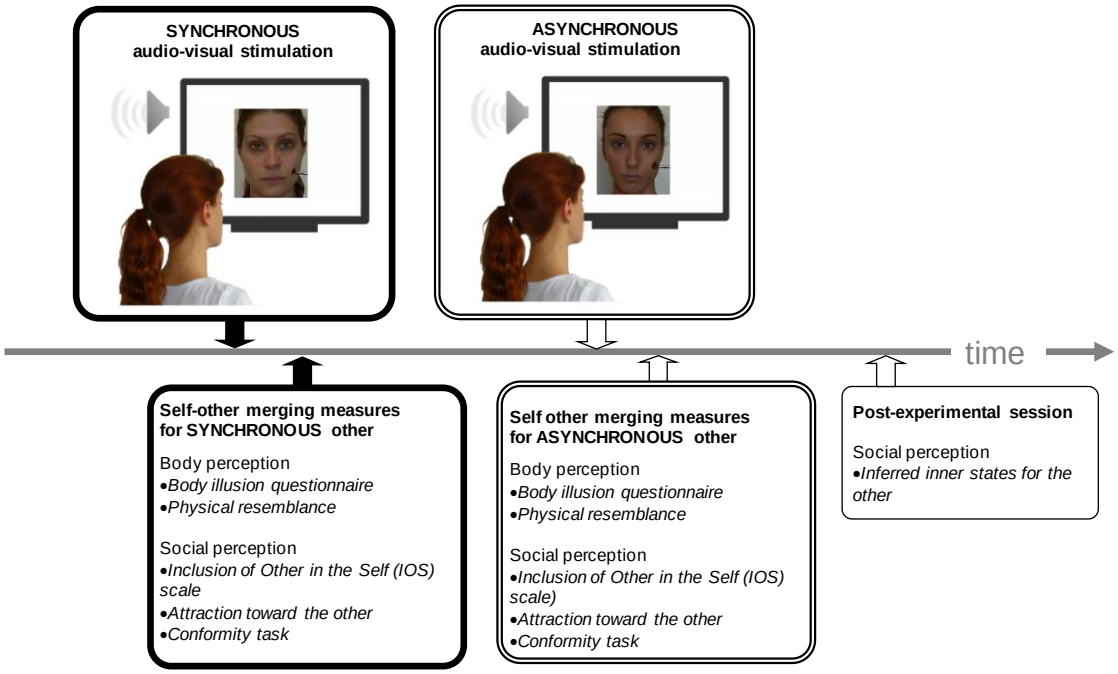

Figure 9. Schematic representation of the experimental procedure. Note that synchronous and asynchronous audio-visual conditions, as well as identity of the stranger, were counterbalanced across participants.

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apprehensive and ill-at-ease"). Table 3, at the end of this chapter, will display correlations between the different aspects of empathy, the bodily illusion (ownership, location and agency), the social outcomes and eyes movements.

Results

All the dependent variables were submitted to a 2 (synchronous vs. asynchronous stimulation) repeated measures ANOVA.

Body perception

Bodily illusion. The audio-visual synchrony did not lead to the illusory perception of either the feeling of being/becoming the face in the movie (*ownership*, 4 items, α_{synch} = .93, α_asynch = .93), or being able to control it (*agency*, 4 items, α_{synch} = .87, α_asynch = .83), all $F < 1$. Nevertheless, participants had the sensation of perceiving the seen touch on their own face (*location*, 3 items) more often in the synchronous (M = -25.46, SD = 20.66, α = .64) than in the asynchronous stimulation (M = -33.92, SD = 12.23, α = .15), F (1, 23) = 4.88, p = .04, η_p^2 = .18. As in Study 1, location items in the asynchronous condition showed low internal consistency, therefore single items analysis were conducted, showing significant effects in all the cases (item 1, "It seemed as the sound that I heard was caused by the paintbrush touching the face in the movie", M_{synch} = 17.71 SD = 29.80, M_{asynch} = -22.87, SD = 29.90, F (1, 23) = 25.90, $p < .001$, η_p^2 = .53; item 2, "Sometimes I did not know if the touch of the paintbrush was on my face or on the face of the person in the movie", M_{synch} = -27.25, SD = 20.54, M_{asynch} = -35.17, SD = 12.53, F (1, 23) = 4.20, p =.05, η_p^2 = .14; item 3, "It seemed as I felt the touch of the paintbrush on the face of the person in the movie as it was on my own face", M_{synch} = -23.67, SD = 21.93, M_{asynch}= -32.67, SD = 14.23, F (1, 23) = 4.71, p = .04, η_p^2 = .17).

The synchronous and asynchronous experience were equally judged as a neutral (*affect*, 3 items; respectively M = .47, SD = 22.25, α = .83 and M = -3.67, SD = 16.97, α = .54), F (1, 23) = 1.00, p = n.s., η_p^2 = .04. This was witnessed by the means that did not significantly diverge from the middle point (0) of the scale (t (23) = .10, p = n.s. and t (23) = -.06, p = n.s., respectively).

The audio-visual synchronous (vs. asynchronous) stimulation elicited only a confusion in the location of the stimulation, but no effect on being and controlling the movements of the person in the video.

Physical resemblance. No effect was found on perception of resemblance in general on the core (i.e., eyes, nose and mouth) and peripheral facial features (i.e., chin, forehead, shape of the face, cheeks), all the $F < 1$.

Social perception

Also the analysis on the social outcomes did not yield any significant effect, all the $F < 1$. Sense of closeness, attraction (3 items, $\alpha_{synch} = .62$, $\alpha_{asynch} = .81$), conformity behavior, and similarity in terms of personality (i.e., inference of mental states) toward the person shown in the video did not differ after the audio-visual synchronous and asynchronous experience.

Eye movement pattern

As in Study 1 of this chapter, Figure 10 shows the relative spatial distribution of gaze, separately for the face of the two actresses. The colors indicated the difference between the average duration (in ms) of the gaze on a particular screen location during the synchronous and the asynchronous stimulation. The areas explored more in the synchronous or in the asynchronous condition are indicated respectively in red and blue (see the color legend). Also in this study the most explored areas were the core facial feature, namely the eyes, nose and the mouth, plus the part of the stranger's face touched by the paintbrush. Even if with respect to one of the actress the face exploration pattern seems to be different (more time spent in the brushed cheek in the synchronous condition and central features for the asynchronous) from the other woman in this study and the two actresses in Study 1 of this chapter, note that, in this particular case, the differences between synchronous and asynchronous condition are very small.

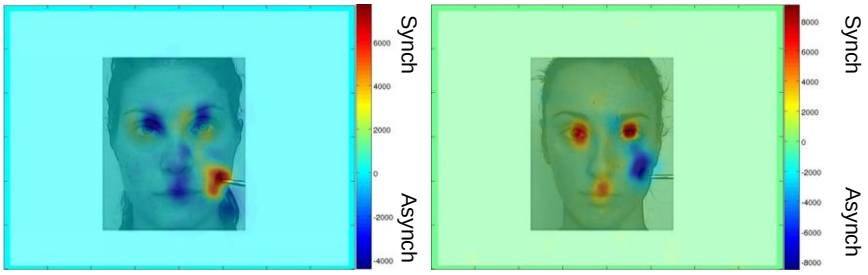


Figure 10. Spatial distribution of gaze. Differences between the average duration of fixations on a particular screen location, during the synchronous and the asynchronous stimulation, separately for each actress. Red indicates that the zone was more explored during synchronous stimulation, whereas blue in the asynchronous. Time range (in ms) is indicated in the legend.

Similar to Study 1, eyes tracking data were recoded in areas of interests and treated with a 4 (areas of interest: eyes vs. nose and mouth vs. brushed cheek vs. peripheral feature) X 2 (target: synchronous vs. asynchronous stimulation) repeated measures ANOVA.

An effect on the *percentage of the number of fixations* in the different areas were found, F (3, 69) = 30.12, $p < .001$, $\eta_p^2 = .57$. The eyes attracted half of the fixations (M = 50%, SEM = 3.86) followed by the brushed area (M = 22%, SEM = 3.38), nose and mouth (M = 17%, SEM = 1.30) and the other areas (M = 11%, SEM = 1.07) (see Figure 11A). This main effect is qualified by a marginal effect of the interaction between the facial parts and the type of stimulation, F (3, 69) = 2.55, p =.06, $\eta_p^2 = .10$. The eyes region was explored more in the synchronous (M = 53%, SEM = 4.33) than asynchronous condition (M = 47%, SEM = 3.89), F (1, 23) = 4.19, p =.05. No differences emerged for the nose and mouth (M_synch= 17%, SEM = 1.35 and M_asynch = 17%, SEM = 1.50, F (1, 23) = .45, p = n.s.), brushed cheek (M_synch = 21%, SEM = 3.81 and M_asynch = 23%, SEM = 3.44, F (1, 23) = .80, p =n.s.) and remaining areas (M_synch = 10%, SEM = 1.05 and M_asynch = 13%, SEM = 1.30, F (1, 23) = 4.19, p = .09) (see Figure 11B).

Taking into account the *total amount* of time spent in looking at different areas of the face and the mean duration of each fixation, only a main effect of the areas of the face yielded a significant effect, respectively F (3, 69) = 22.19, $p < .001$, $\eta_p^2 = .49$ and F (3, 69) = 19.95, $p < .001$, $\eta_p^2 = .46$. Participants looked longer at the eyes (M = 70923.10, SEM =

6633.98), than to the brushed cheek (*M* = 42596.60, *SEM* = 6863.52), mouth and nose (*M* = 21250.44, *SEM* = 1948.55) and the remaining features (*M* = 11954.67, *SEM* = 1254.48) (see Figure 11C).

The *mean duration* of each fixation was longer in the part of the face touched by the paintbrush (*M* = 608.42, *SEM* = 52.17). The duration was inferior in the eyes region (*M* = 460.06, *SEM* = 40.23), the core (*M* = 402.85, *SEM* = 25.06) and peripheral features (*M* = 332.10, *SEM* = 20.78) (see Figure 11D).

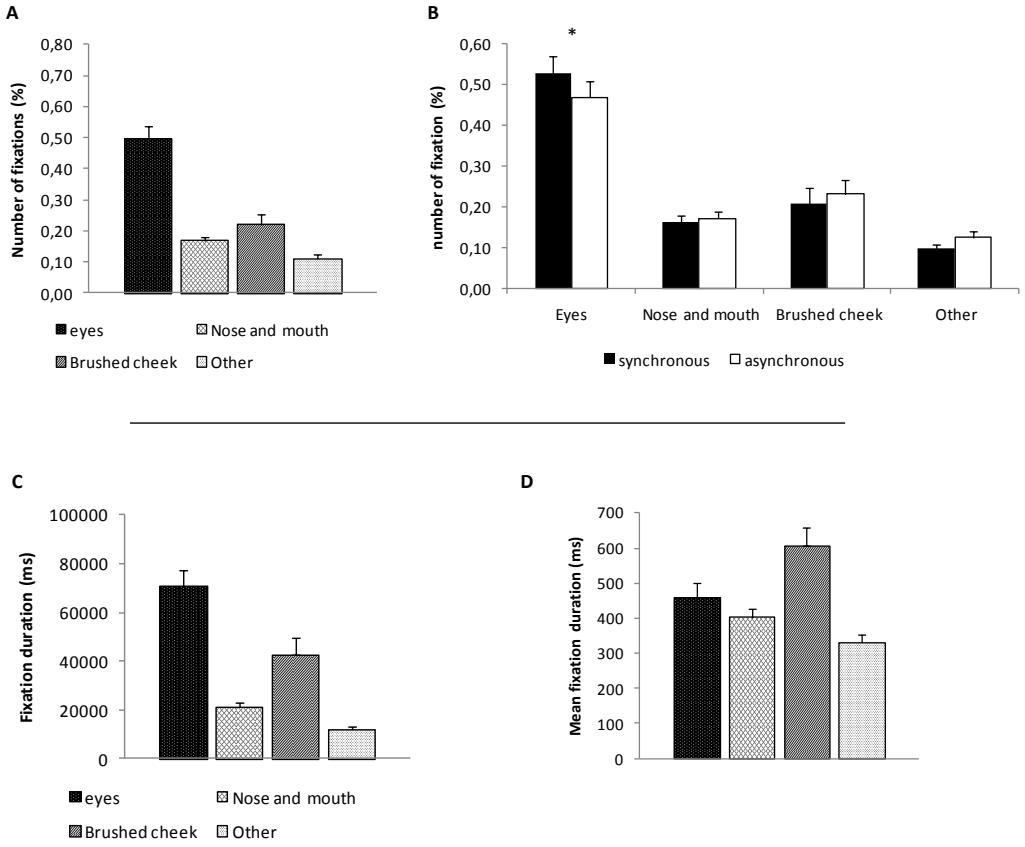


Figure 11. Percentage of number of the fixations in each area of interest (A) and the interaction between face areas and synchrony (B); total time spent and (C) mean duration of each fixation (D) (ms) in each area of interest. Means and standard error of the mean (error bars) are reported.
*** $p < .001$, ** $p <. 01$ and * $p < .05$

Conclusion

As expected, an audio-visual synchronous (vs. asynchronous) stimulation did not elicit a multisensory illusion. A repeatedly touch made by a paintbrush on the cheek of the woman in the movie presented matched (vs. mismatched) with a metronome sound did not lead to any feeling of becoming the person in the movie or being able to control her movements. However, participants had an illusory effect of mislocating the source of the stimulation. In the synchronous, rather than the asynchronous, condition, they reported lesser disagreement to items indicating the perception to feel the observed touch on their own face. This finding is in line with a recent study (Pihko, Nangini, Jousmäki & Hari, 2010) showing that seeing another person's hand being touched activates the primary somatosensory (SI) cortex, similar to activation resulting from actual experienced touch on one's own hand. The audio-visual synchrony led to this illusory perception but it did not elicit a social bounding. Feeling of closeness, attractiveness, conformity and similarity did not differentiate between the synchronous and asynchronous stimulated other. Indeed, in our fist study (Chapter 2; see also Paladino, Mazzurega, Pavani & Schubert, 2010) we found that the illusory perception of ownership and agency, but not of location, mediated the social outcomes. After an audio-visual synchronous stimulation participants were able to empathically feel the touch that happened on the stranger's face but not "to become" her and to merge with her also to a more conceptual level. Taking together the findings of the two studies we presented, we suggest that an illusory experience, and not only a synchronic multisensory stimulation, is necessary for blurring self-other boundaries at both bodily and more conceptual level affecting social perception. Playing on acoustic and visual sensory inputs (vs. visual and tactile) we separate the effect of multisensory synchrony from those induced by the illusion. Again, as in the first study, we found different exploration pattern in the two conditions: a greater number of fixations on the eyes area was observed in the synchronous compared to the asynchronous condition. Multisensory synchrony itself seems thus to affect face exploration, but not to create a self-other bonding.

Chapter 3 endnote

Correlations between the different aspects of empathy, the bodily illusion (ownership, location and agency), the social outcomes and eyes movements (computed as the difference between rates after the synchronous and asynchronous condition) are showed in Table 3.

Focusing on the link between the empathy dimensions and illusion, social aspects and the face exploration pattern, only the Personal Distress dimension positively correlates with the closeness (rated on the IOS scale), r (24) = .48, p = .02 (i.e., more I feel stressed for others emergency situations, more I feel close to the synchronous, in comparison to the asynchronous, stimulated other).

	1. PT	2. FS	3. EC	4. PD
1. Perspective taking	-			
2. Fantasy scale	-,445*	-		
3. Empathic concern	,058	,357	-	
4. Personal distress	-,196	-,010	-,279	-
5. Ownership	,287	-,093	,000	-,013
6. Location	-,078	,135	-,031	,076
7. Agency	,125	-,183	,091	,104
8 Pleasantness of the stimulation	-,137	-,056	,097	-,029
9. General resemblance	,128	-,066	,057	-,077
10. Resemblance on the peripheral facial features	,172	,004	-,063	-,080
11. Resemblance on the core facial features	,140	-,099	-,029	,159
12. IOS	-,014	-,159	-,232	,482*
13. Attraction	-,053	-,093	-,080	,350
14. Conformity	-,291	,316	-,060	-,172
15. Inference of inner states of the other	,266	-,050	,153	,048
16. % num. fixations, eyes area	-,244	,213	-,149	,106

* p< .05, ** p< .01

Table 3. Correlations between empathy (four dimensions), bodily illusion (ownership, location and agency), the social outcomes and eyes movements (computed as the difference between rates after the synchronous and asynchronous condition).

Chapter 4

It is a relation, not just a self-other perceptual assimilation: The effect of a synchronous multisensory stimulation on self-perception

Marching, in a military drill or in a pacifist protest, dancing and singing in a concert the same song or in general acting in unison are examples of physical interactions that communicate the existence of a special connection between people (Fiske, 1992, 2004). According to recent studies, these behaviors do not only reveal, but also contribute to create and consolidate social bonds. Wiltermuth and Heath (2009) and Valdesolo and DeSteno (in press) for instance, found more attraction and similarity toward those with whom participants acted in synchrony (vs. asynchrony) (see also Hove & Risen, 2009). In a recent study, my colleagues and I (Chapter 2; see also Paladino, Mazzurega, Pavani & Schubert, 2010) advanced an interesting account for these findings. Specifically, we suggested that multisensory integration processes and illusory bodily perceptions, arising when visual and tactile stimulations are synchronous, may play a role in the socio-affective consequences of acting in synchrony. The research presented in this chapter extends this work, by examining the role of multisensory synchronous stimulations in self-perception and social bonding.

We noted that, at pure sensorial level, acting in synchrony creates a condition of synchronous multisensory stimulations: tactile, proprioceptive and audio information match visual information coming from synchronized mirror motion. Researches on multisensory integration have shown that these inputs coming from senses simultaneously have a special status as they are linked together as a unity (Welch & Warren, 1980; Holmes & Spence, 2004) in affecting perception. Specifically, synchronous visual (i.e., what I see) and tactile (i.e., what I feel) information influences self-body recognition (e.g., Botvinick & Cohen, 1998), and the perception of self-other physical and

personality similarities (Paladino, Mazzurega, Pavani & Schubert, 2010; Longo, Schüür, Kammers, Tsakiris & Haggard, 2009). In the well known rubber hand illusion, for example, when participants watch a prosthetic arm being touched in exact visuo-spatial synchrony with their own hidden hand, they report the illusory feeling of ownership and control on the rubber hand (Botvinick & Cohen, 1998; Tsakiris & Haggard, 2005; Makin, Holmes & Ehersson, 2008). In other studies (Tsakiris, 2008; Paladino, Mazzurega, Pavani & Schubert, 2010; Bufalari, Haggard & Aglioti, 2010), where participants shared a synchronous (vs. an asynchronous) brushing on their cheek with a stranger, the integration of the simultaneous information coming from the vision (i.e., seeing a stranger being touched on the cheek with a paintbrush) and the tact (i.e., feeling simultaneously the touch of the same paintbrush on one's own face) led to the relative sensation of looking oneself in a mirror. In our previous study, when stimulated in synchrony (vs. asynchrony), participants of our study, for instance, reported at a larger extent an illusory perception of becoming the person in the video, of controlling her facial expression and, consistently with this, judged the face of the person as more resembling to the self face (for similar results on body perception, see also Sforza, Bufalari, Haggard & Aglioti, 2010; Tsakiris, 2008; Longo, Schüür, Kammers, Tsakiris & Haggard, 2009). Interestingly, participants judged the person stimulated in synchrony also as more similar to the self in terms of personality, reported a greater sense of unity (i.e., inclusion of the other in the self) and a tendency to conform to the person stimulated in synchrony (vs. asynchrony). This study suggested thus that the effect of synchronous visuo-tactile stimulation can go beyond the mere physical level, affecting also social cognition, creating outcomes generally observed when people act in synchrony, such as self-other similarity and the sensation of oneness. Therefore, a pure sensorial experience can contribute to create a social bonding. One could however argue that what we previously showed is that the self-other perceptual assimilation induced by a multisensory synchronous stimulation extends from the body to a more conceptual representation of the self and the other (i.e., personality) and that a social bond is something more complex than this.

From studies in social psychology we know that the link between similarity and closeness is quite complex (e.g., Montoya, Horton & Kirchner, 2008; Morry, 2007). Similarities in personality increase interpersonal attraction and close others become over time more similar to the self even in the body reactions such as emotional expression (Zajonc, Adelmann, Murphy & Niedenthal, 1987). However comparison with close other may also lead to a contrast effect in self-evaluation. This idea is supported by two different lines of research: the *Self Salience Model* by Stapel and Van der Zee (2006) and the *Self-Evaluation Model* (SEM) by Tesser (1988; Guay, Boivin, & Hodges, 1999).

The Self Salience Model (SSM, Stapel & Van der Zee, 2006) integrated in a single framework the different possible reactions (i.e., assimilation and contrast) in self perception when interacting with the others. The main claim of the SSM is that the salience of the personal, relational or collective self-construal (Brewer & Gardner, 1996) drives different patterns of self-evaluation. If the *personal-self* is salient people tend to assimilate information about others' positive characteristics while contrasting information about others' negative characteristics, particularly if they are relevant for describing the self (e.g., Cialdini, Borden, Thorne, Walker, Freeman & Sloan, 1976). When people take a relational perspective, activating the *relational-self*, they became more concerned about how the own's and the other abilities are balanced and coordinated in the relationship. Both c*omplementarity* and *similarity* contributes to maintain a relationship enjoyable, depending on the dimension. On power/competence dimension (i.e., dominance vs. submissiveness) roles and self-definition are established by contrasting information about the other (i.e., If the other is high in power/competence, I am low on this dimension). Conversely, self-affiliation (i.e., agreeableness leads to agreeableness and quarrelsomeness to quarrelsomeness) (Tiedens & Jimenez, 2003), leads assimilation independently from the valence. Finally, when the others are part of a relevant group, the perception of the self as integrated in social group (collective-self) assimilative reactions to others (i.e., imitation) should be expected.

The *Self-Evaluation Model* (SEM – Tesser, 1988) predicts that comparison with the performance of a close other has an effect on self-evaluation. This occurs when the performance of the other is high and in a self relevant domain. In this case, the

performance of the close other becomes a standard of comparison, lowering self-evaluation. The SEM has received empirical supports in several studies. A recent application of this model (Summers, Schallert & Ritter, 2001) showed that, not only the relevance of the domain, but also the motivation behind the performance can play a role. Students high in mastery orientation and internally motivated to study math (i.e., motivated to be proficient at the best of their ability) do not compare themselves with close friends, while students low in mastery orientation and therefore extrinsically motivated (i.e., who are motivated to do well only for external reasons, i.e., grades) do compare and evaluate themselves as less able in math than their friends, in accordance with the SEM. According to this study, a close other good performance, would lead to a decrease in self evaluation only in people who are not internally motivated to the task. Following both the Stapel and Van der Zee (2006)'s SSM and the Tesser (1988)'s SEM, comparing with a close other should lead to a contrast effect in self-evaluation.

Overview of the study

In the present research we used the same paradigm presented in Chapter 2 (see also Paladino, Mazzurega, Pavani & Schubert, 2010) in order to create a blurring in self-other boundaries. Moreover we manipulated information on (low vs. high) competence in an anagram game of the synchronous stimulated others. Some days before the experimental session participants rated how frequently they played brain games and the perceived self-efficacy in an anagram task. Frequency in performing brain puzzles was used as proxy of internal motivation. After the synchronous and asynchronous manipulations and before playing the anagram task, they rated again self-efficacy in an anagram task. Shaping our hypothesis on the previously presented models about self-other comparison effects (Stapel & Van der Zee, 2006; Tesser, 1988; Summers, Schallert & Ritter, 2001), we thus expected that, if the synchronous multisensory manipulation leads to a relational bonding, participants who are not internally motivated to solve brain puzzles and are informed that the synchronous stimulated other is highly competent in the task would decrease their self-efficacy in anagram task.

Method

Participants

26 female students of the University of Trento participated to the experiment in exchange of course credits. Data of one participant was not considered in the analysis because she did not remember which of the two women presented in the movie was described as competent in the anagram task. The analysis were thus conducted on 25 participants (mean age 21.72, *SD*= 3.53).

Materials

Two 3 minutes videos were used, each showing the face of a young woman (real life size; hair and background covered by a rectangular white mask) being touched on the left cheek by a small paintbrush moved in a constant rhythm (every 2 seconds). A pre-test showed that the two actress were judged equally attractive (M = 4.98, *SD* = 1.12 and *M* = 4.67, *SD* = 1.23, *t* (43) = 1.65, *p* = *n.s.*).

Procedure

The study consisted of two parts: an on-line questionnaire and the experimental session that took place in the laboratory

On-line questionnaire. From 1 to 5 days before participating to the experimental session, participants completed an on-line questionnaire. Among other questions about their hobbies (e.g., sports, reading novels), they were asked to indicate how often they used to play puzzle brain games (1 = never to 5 = several times in a day) and the self-efficacy specifically for the anagram task.

Self-efficacy. Four items from the Generic Self-Efficacy Scale (Scholz, Dona, Sud & Schwarzer, 2002) were adapted to assess participants' self-efficacy in solving anagrams (1. "I will find all the possible solutions If I try hard enough"; 2. "I am confident that I could complete an anagram for the most part of it"; 3. "Even if in the beginning I do not find the solution, thanks to my resourcefulness, I will find it"; 4. "If I invest the necessary effort I will find the solution also when it seems difficult"), plus a question about the pleasantness of the task ("If I play an anagram game, I will consider it stimulating").

Experimental session

Once arrived to the laboratory, participants were informed that in the course of the experiment they would have watched two movies, responded to a questionnaire and then tested on their ability to solve anagrams. To give an idea of the last task, they were presented with a simple anagram and asked to solve it. All participants easily found the solution. Afterwards, participants performed two experimental blocks[6]. In each of them (1) they watched a video where a stranger, a young woman, was rhythmically stroked with a paintbrush on her cheek while they were stimulated in visuo-spatial synchrony or asynchrony; (2) then they responded to a questionnaire the strength of the body illusion that they felt during the stimulation, the perceived physical resemblance, the relationship (i.e., closeness and hierarchy), attraction towards the woman in the movie and their mood; (3) finally participants were informed on the (high vs. low) competence in solving anagrams of the women seen in the movie. At the end of the two blocks, participant's self-evaluation and ability to solve anagrams was tested. They were asked to fill in a self-efficacy scale and to solve series of anagrams (for an overview of the procedure see Figure 12A).

Thus, each participant watched two movies and received both the synchronous and the asynchronous visuo-tactile stimulation. For half of the participants the person with whom they shared the synchronous touch was described as highly competent in solving anagrams, for the other half she was fairly competent. The order of the type of stimulation (synchrony or asynchrony first), the identity of the person in the movies and the competence attribution to the women were counterbalanced across participants.

Below a more detailed description of each phase of the experiment.

Visual-tactile stimulation. In each block participants watched a video where a stranger, a young woman, was rhythmically stroked with a paintbrush on her cheek. In the meantime, the experimenter brushed the participants' face both in synchrony and in

[6] As in Chapter 3, study 2, before starting the experimental session, participants completed the Italian version (Albiero, Ingoglia, & Lo Coco, 2006) of the Interpersonal Reactivity Index (IRI; Davis, 1983; see also Sforza, Bufalari, Haggard & Aglioti, 2010; see Chapter 3, footnote 5 for details about the IRI scale). Table 6, at the end of this chapter, will display correlations between the different aspects of empathy, the bodily illusion (ownership, location and agency), the social outcomes.

the same way or in asynchrony and in a different direction with the touch showed in the movies, depending on the block.

Questionnaire. Straight after each stimulation phase participants filled in a questionnaire investigating both body and social perception of the women seen in the movies.

Body perception

Body illusion questionnaire. 11 items, adapted for faces, from Longo and colleagues' study (2008) investigated the strength of the multisensory illusion induced by the (synchronous vs. asynchronous) visuo-tactile stimulation. The different aspects of this multisensory illusion concerned the sensation of *ownership* (e.g., "It felt as if my face was turning into the face in the video," 4 items), the feeling of control over the stranger's face (*agency*; e.g., "Sometimes I had the impression that if I had moved my eyes, the eyes of the person in the video would have moved too," 4 items), the confusion between the locations of the felt and seen touches (*location*; e.g., "It seemed as if the touch I felt was caused by the paintbrush touching the face in the movie," 3 items)[7].

Pleasantness of the stimulation. 3 items assessed the pleasantness of the tactile and the stimulation in general (e.g., "I found the experience pleasant"; Longo, Schüür, Kammers, Tsakiris & Haggard, 2008).

To register their responses to these and the body illusion items, participants used a bipolar continuum scale of 100 millimeters (-50 mm = totally disagree, 50 mm = totally agree).

Physical resemblance. Participants rated how similar the target was to themselves on several features and parts of the face. As in the study presented in the Chapter 2 (see also Paladino, Mazzurega, Pavani & Schubert, 2010), an index of core facial features was obtained by averaging the responses on eyes, nose and mouth, while the average of ratings for the forehead, shape of the face, chin and cheeks formed an index about the

[7] An item about warmth perception was added ("It seemed as I felt a warm/cold sensation on my face") (Durgin, Evans, Dunphy, Klostermann & Simmons, 2007) Responses were given on a bipolar continuum of 100 mm (-50 mm = totally disagree, 50 mm = totally agree; thermal item -50 mm = cold, 50 mm = warm). No difference in warmth perception was found, F (1, 24) = 1.70, p=n.s., η_p^2 = .21 (M_synch = 9.12, SD = 20.66 and M_asynch = 4.48, SD = 13.30).

peripheral facial regions. Then they rated the perceived general resemblance with the women in the video. All responses were given on a 7-point scale (1 = not at all; 7 = completely).

Social perception

Inclusion of the Other in the Self. Participants rated the closeness that they felt toward the stranger on a variant of the Inclusion of Others in the Self scale (IOS; Schubert & Otten, 2002; see Figure 14C). The IOS scale, describing closeness, can be considered a proxy of Communal Sharing (CS) relationship, a bounding based on the sense of being a unit, reciprocity and equality (Fiske, 1992, 2004)

Authority Ranking scale. On another pictorial scale, participant described their feeling of hierarchy towards the other. Differences in status or power are typical of Authority Ranking (AR) relationships. The typical perceptual symbol or bodily clue of this type of relation is vertical position in space (Schubert, 2005; Fiske, 2004). Therefore, the scale consisted of 7 figures, each showing different levels of vertical distance between two rectangles representing the self and the person saw in the movie (Authority Ranking scale, Schubert, unpublished scale, see Figure 13; for a description of CS and AR relationship, in the Relational Model Theory context, see Chapter 1).

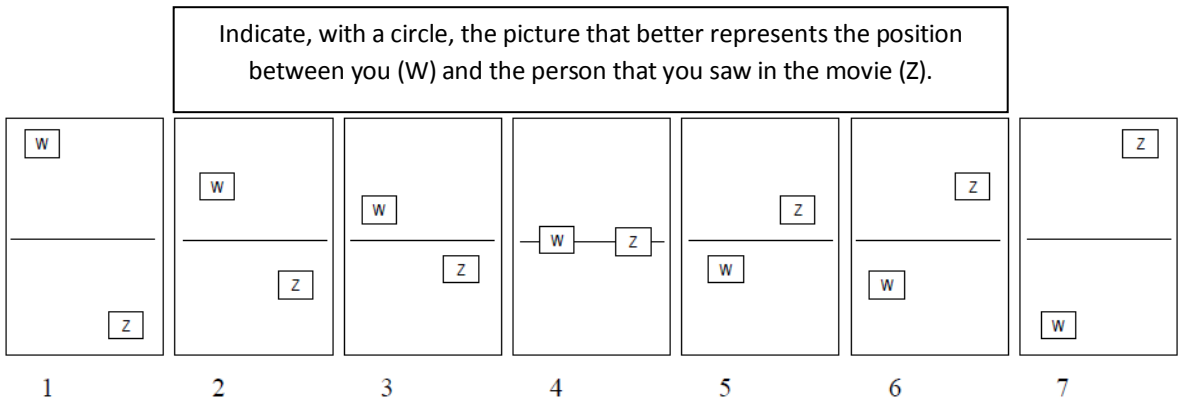


Figure 13. The Authority Ranking scale (Schubert, unpublished scale)

Attraction toward the other. An attraction index was computed as the average of the responses to 3 questions about the stranger pleasantness (1. "Based on your first impression, how pleasant is the person you saw in the video?", 2. "How much do you

think that the person you saw in the video is likeable?", 3. "Would you like to meet this person?", 1 = not at all; 7 = completely).

Mood. Finally participants described their mood on 6 positive ("active, inspired, attentive, self-confident, relaxed, happy") and 6 negative emotions ("nervous, hostile, afraid, upset, bored, ashamed"). These were chosen among the emotions of the short form of the Positive and Negative Affect Schedule (PANAS, Thompson, 2007). Responses were given on a 7-point scale (1 = not at all; 7 = completely).

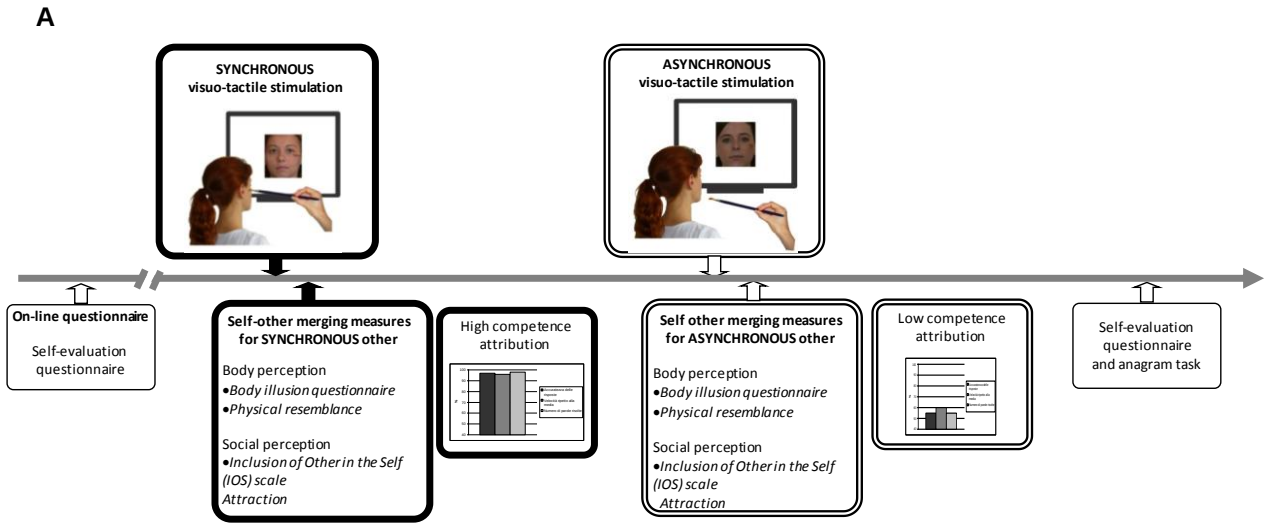
Competence of the women in the movie. Once completed the questionnaires (i.e., before watching the second movie for the first block and before performing the anagram task for the second block), participants received some information on the women seen in the video. They were told that the woman had previously participated to an anagram task and were informed about her performance. A description and graphs representing the accuracy, speed and number of solved anagrams were shown (see Figure 12B). One of the two women was described as highly competent (i.e., more the 90% of accuracy; high competent target), whereas the other as fairly competent (i.e., around the 55% of accuracy; low competent target). For half of the participants the person with whom they shared the synchronous touch was described as highly competent in solving anagrams, for the other half she was moderately competent.

Self-efficacy and anagrams task. At the end of the two blocks, participants filled in the same scale assessing self-efficacy on solving anagrams they completed in the on-line session. Then they were presented with a word, one for each trial for a total of 5 words/trials, and asked to find as many anagrams as possible. It was specified that the criteria to evaluate the performance were the number and the length of correct words found. Participants had a limited amount of time (3 minutes) to solve each trial. After this, they could decide whether to quit the game or pass to the next trial. The complete task consisted of 5 trials of increasing difficulty, as the starting word become longer (i.e., a 4-word letters in the first trials to a 9 word-letters in the fifth trials). None of the participants quitted the game, all tried all the five anagrams.

Manipulation check. At the end of the entire procedure participants were asked to indicate the woman described as highly competent in the anagram task and to rate the

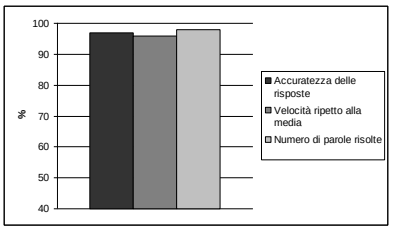
degree of synchrony between the tactile (i.e., the paintbrush on their own face) and visual (i.e., the paintbrush touching the face in the movie) stimulation that they perceived in the 2 stimulation blocks on a 7-point scale (1 = not at all; 7 = completely).

Finally participants were debriefed and thanked for their participation.



B

The person that you just saw in the movie had also participated to this study. She had played the anagram game, a game that is linked with the linguistic logic. She reached excellent results. She had solved also the most difficult anagrams, finding about 98% of the possible combinations in each level. She was also faster than the average.
Here you can see a summary of her performance:



Also this other person that you just saw in this last movie had participated to this study and played to the anagram game. She obtained low results in this task. She did not complete all the levels and solved only 55% of the possible solutions. Her speed was average.
Here you can see a summary of her performance:

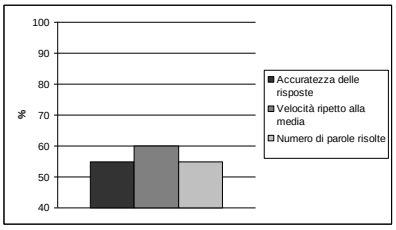


Figure 12. (A) Schematic representation of the procedure (synchronous and asynchronous conditions, as well as identity of the other and high vs. low competence attribution were counterbalanced across participants); (B) Description and summarizing graph of the competence attribution to the target.

Results

If not further specified, all the dependent variables were submitted to a 2 (synchronous vs. asynchronous stimulation) repeated measure ANOVA.

Body perception

Body illusion. As showed in Figure 14A, the relative illusory body perception induced by the synchronous visuo-tactile stimulation found in previous studies was replicated (see Chapter 2 and 3). The feeling of *ownership* for the face in the video was higher after the synchronous (M = -8.24, SD = 24.43, α = .85) than the asynchronous stimulation (M = -30.53, SD = 20.26, α = .92), F (1, 24) = 13.90, p = .001, η_p^2 = .37. The synchronous touch led also to the illusion of more control over the stranger's face (*agency*, M = 2.69, SD = 23.83, α =.81), than the asynchronous touch (M = -14.89, SD = 16.00, α =.37), F (1, 24) = 14.39, p = .001, η_p^2 = .38. Moreover, the synchronous stimulation elicited a feeling of confusion of the *location* of the source of the tactile stimulation (M = -5.83, SD = 27.54, α =.87) in comparison to the asynchrony (M = -35.55, SD = 16.35, α =.93), F (1, 24) = 30.38, p < .001, η_p^2 = .56.. Finally, the synchronous experience was judged more pleasant (M = 25.88, SD = 13.50, α =.77) than the asynchronous stimulation, (M = 12.67, SD = 23.79, α =.93), F (1, 24) = 7.84, p = .01, η_p^2 = .25.

Physical resemblance. Continuing on body perception, a greater resemblance was perceived with the synchronously (M = 3.32, SD = 1.22) than with the asynchronously stimulated stranger (M = 2.64, SD = 1.08), F (1, 24) = 4.83, p = .04, η_p^2 = .17. A similar effect emerged also on the peripheral but not on the core facial features, (α_{synch} = .47 and α_{asynch} = .44), F (1, 24) = 1.68, p= n.s., η_p^2 = .07. The peripheral facial features of the person shown in the video were judged more resembling to those of self face when the stimulation was synchronous M = 3.61, SD = 1.36, α =.82 rather than asynchronous M = 2.93, SD = 1.08, α =.74, F (1, 24) = 6.48, p = .02, η_p^2 = .21, (see Figure 14B).

Social perception

Inclusion of the Other in the Self. The synchrony effect spread also to feeling of closeness towards the stranger. Participants indicated to feel closer to the person with whom they shared the synchronous (M = 2.80, SD = 1.35) rather than the asynchronous

touch (M = 2.12, SD = .97), F (1, 24) = 7.41, p = .01., η_p^2 = .24) (see Figure 14C). Importantly, synchrony did not affect the perception of relation status toward the woman in the movie (Authority Ranking Scale), F > 1. This shows that sharing a synchronous experience selectively affect feeling of closeness and not other relational dimension.

Attraction toward the other. Differently from our previous studies (Chapter 2; Paladino, Mazzurega, Pavani & Schubert, 2010) no effect of synchrony manipulation on attraction toward the other was found, F < 1.

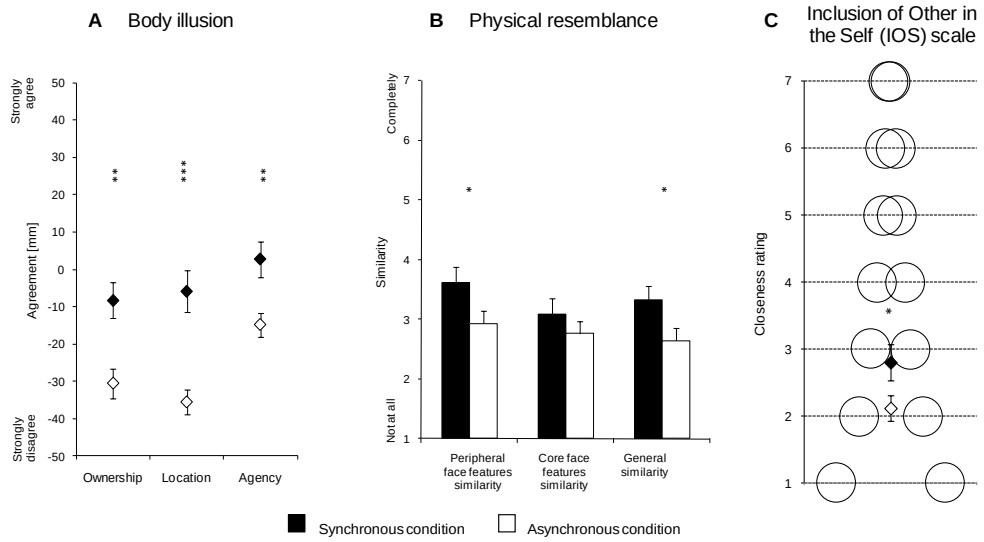


Figure 14. Effects of a synchronous (black) vs. asynchronous (white) visuo-tactile stimulations on: (A) the different facets of the body illusion (ownership, location and agency); (B) physical resemblance on the peripheral and core facial features; (C) inclusion of the other in the self (IOS scale). Means and standard error of the mean (error bars) are reported.
***p < .001, ** p < .01 and * p < .05

The effect of synchronous stimulation on participants' mood was analyzed submitting the emotions to a 2 (positive vs. negative valence) X 2 (synchronous vs. asynchronous stimulation) repeated measure ANOVA. A main effect of the valence of the emotions emerged, F (1, 24) = 221.33, p < .001., η_p^2 = .90. In general, participants mood was positive (M = 5.09, SD = .83, α =.84) rather than negative (M = 1.59, SD = .56, α = .73). Moreover the interaction between valence and the type of stimulation was marginally significant, F (1, 24) = 3.07, p = .09, η_p^2 = .11. Although the stimulation did not affect the

experience of negative emotions (M_synch = 1.53, SD = .66, M_asynch = 1.65, SD = .59), $F(1,24)$ = 1.15, p = n.s., η_p^2 = .05.), it somehow influenced the intensity of positive emotions. Participants reported more positive emotions after the synchronous (M = 5.16, SD = .84) than the asynchronous stimulations (M = 5.02, SD = .84). Note however that this difference is marginally significant, F (1, 24) = 3.27, p = .08., η_p^2 = .12.

Effects on self-perception and performance. The novel aim of the present research was to investigate if the social effects linked to a synchronous (vs. asynchronous) visuo-tactile stimulation are due to the creation of a relational bonding with the stranger. We expected that, if the synchronous multisensory manipulation leads to a relational bonding, participants, who are not internally motivated to solve brain puzzles (i.e., low frequency in playing brain puzzles) and are informed that the synchronous stimulated other is highly competent in the task, would decrease their self-efficacy in the anagram task. No changes in self-efficacy expected when participants are internally motivated to solve brain puzzle (i.e., high frequency) or when they compare themselves with the competent asynchronous other.

A linear regression was used to test the effect of synchrony on self-perception. The difference between the self-evaluation regarding the ability in the anagram task reported during the experimental session (4 items, α = .86) and the on-line questionnaire (4 items, α= .83) was regressed on the attribution of high competence to the synchronous (1) or the asynchronous target (0) (dummy coded), motivation/frequency in doing brain puzzles (i.e., "how often do you usually play brain puzzle?", centred variable) and the interaction between these two variables (attribution of competence to the synchronous or asynchronous target and the centred values of the frequency item) to control if the effect of stimulation was modulated by individual motivation in solving the task. The overall model is significant, R = .71, F (3, 21) = 7.29, p = .002, R^2 = .51 and adjusted R = .44. As shown in the Table 4, the frequency in the task was positively associated with the change in self-evaluation between the on-line and the experimental session (β = .65, t (21) = 4.04, p < .001). The attribution of high vs. low competence to the stranger also predicted the self-efficacy evaluation (β = .38, t (21) = 2.40, p = .03). Self-perception was lower when the stranger described as highly competent in the anagram task was the one with whom the

participant shared the synchronous (*M*= - .85, *SEM* = .24) rather than the asynchronous stimulation (*M* = -.02, *SEM* = .25). Also the interaction between the participants' frequency in performing brain puzzle and competence attribution to the synchronous or asynchronous stranger yielded a significant effect (β = -.38, *t* (21)= -2.47, *p* = .02) as a predictor of the change in self-evaluation, enlightening that participants which often play to these type of game and were thus more motivated in solving the game (i.e., high frequency), were not affected from the manipulation (β = .65, *t* (21) = 4.04, *p* = n.s.) while those who were not internally motivated in solving brain puzzles (i.e., low frequency), compared themselves with the synchronous other and when she was described as highly competent, for a contrast effect they felt less confident (β = .65, *t* (21) = 4.04, *p* < .001) (see Figure 15 for a graphic representation of this result).

Predictor	B	SE B	β
Attribution of competence	.41	.17	.38 *
Frequency	.66	.16	-.65 ***
Attribution of competence x frequency	-.41	.16	-.38*

Table 4. Linear regression results in predicting changes in self-efficacy perception (difference between the evaluation in the experimental and on-line session) regarding the anagram task, in relation to competence attribution to the strangers and frequency in performing brain puzzles.
****p* < .001, ** *p* < .01 and * *p* < .05

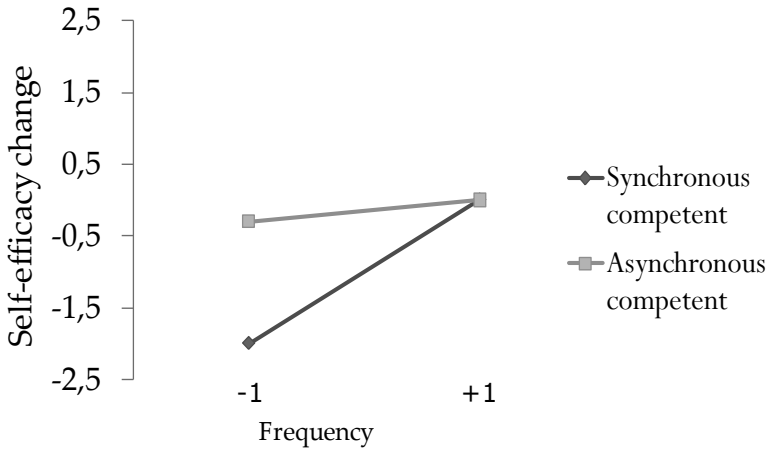


Figure 15. Graphic representation of results in self-efficacy change for the interaction between the participants' frequency in performing brain puzzle (-1 low, +1 high) and high competence attribution to the synchronous or asynchronous stranger.

We tested also the actual performance in the anagram task. A linear regression was used for this purpose. An index of the participant performance in the anagram task was created (total number of words found X mean length of the word) and analyzed in a linear regression model, where the predictors were the attribution of high or low competence to the synchronous target (dummy coded), the perceived self-efficacy in the on-line questionnaire, and the interaction between these two variables (attribution of competence to the synchronous or asynchronous target and standardized values of the on-line questionnaire), to control if the effect of stimulation was modulated by individual difference in the baseline anagrams self-efficacy. The model was not significant, $R = .10$, $F\ (3, 21) = .07$, p = n.s., $R^2 = .01$ and adjusted R = -.13. Any of the factors did not significantly predict the performance in the anagram task, all the p values > .05. Neither using frequency in solving puzzle brain as a predictor for the actual performance, instead the self-efficacy in the on-line questionnaire, and the interaction between frequency (standardized value) and the competence attribution, the model yielded a significant effect, $R = .39$, $F\ (3, 21) = 1.25$, p = n.s., $R^2 = .15$ and adjusted R = .03, all the p values > .05.

Thus, sharing a synchronous multisensory experience had an effect on participants' subjective perception of self-efficacy but not on their actual performance in the task.

Finally, in Table 5, correlations between the different bodily and social perception measures (computed as the difference between rates after the synchronous and asynchronous condition) are showed. Below I will discuss the link between the different facets of the illusion and the similarity and the social aspects.

Ownership. A link between the feeling to become the other person in the movie and physical resemblance is showed, either from a generic point of view, $r\ (25) = .64$, $p = .001$, on the core, $r\ (25) = .56$, $p = .003$, or peripheral facial features, $r\ (25) = .68$, $p < .001$. Moreover it correlates with the sense of closeness with the stranger, $r\ (25) = .69$, $p < .001$ and person attractiveness, $r\ (25) = .42$, $p = .04$.

Agency. Sense of control over the face in the movie is linked with physical resemblance in all its parts: generic, $r\ (25) = .40$, $p = .05$., core facial features, $r\ (25) = .43$, $p =$

.03, and (marginally) the peripheral facial features resemblance, r (25) =.38, p = .06. Agency effect correlates also with the closeness toward the other, r (25) = .48, p = .01.

Affect. The pleasantness of the experience correlates with the peripheral face feature resemblance, r (25) =.45, p = .02. Moreover it is positively linked with the IOS scale, r (25) = .59, p = .002 but negatively with the AR scale, r (25) = -.53, p = .006.

	1	2	3	4	5	6	7	8	9	10	11	12
1. Ownership	-											
2- Location	,532**	-										
3. Agency	,699***	,699***	-									
4. Thermal sensation	,542**	,407*	,447*	-								
5. Affect	,372	,393*	,393	,359	-							
6. Peripheral facial features	,683***	,312	,375	,486*	,450*	-						
7. Core facial features	,564**	,211	,432*	,478*	,133	,525**	-					
8. General resemblance	,641**	,239	,396*	,403*	,229	,892***	,689***	-				
9. Positive emotions	,241	-,158	,186	,131	,248	,316	-,103	,240	-			
10. Negative emotions	-,194	-,236	-,257	-,107	-,185	-,059	-,228	-,169	-,294	-		
11. IOS	,692***	,306	,484*	,321	,591**	,536**	,379	,506**	,228	-,259	-	
12. AR	-,164	-,311	,007	-,166	-,531**	-,088	,237	,087	,076	-,030	-,309	-

* p< .05 , ** p< .01, *** p< .001

Table 5. Correlations between the different bodily and social perception measures (computed as the difference between rates after the synchronous and asynchronous condition)

Conclusion

In Chapter 2 (see also Paladino, Mazzurega, Pavani & Schubert, 2010) we showed that the effect of synchronous (vs. asynchronous) multisensory inputs (visual and tactile) extended from bodily to social perception, enhancing the sense of closeness and similarity between the self and the other. We confirmed these findings in the present study. A perceptual illusion of becoming the woman displayed in the movie was successfully induced by correlated visuo-tactile information. A synchronous (vs. asynchronous) stimulation led also greater perceived physical resemblance and sense of being in contact with the stranger. Moreover, we showed that merging with the other, based on a mere physical clue, means not only to project the self onto the other (in terms of inner states or personality traits, see Chapter 2 and 3, Study 1; Paladino, Mazzurega, Pavani & Schubert, 2010; Morry, 2007) but also permits to infer self capabilities and worth from the comparison with the other.

The novelty of this research is to bring evidence that this connection, created by a multisensory synchronous stimulation, is relational in its nature, and not only a perceptual assimilation.

In the present chapter, we investigated the effect of synchronous (vs. asynchronous) stimulation on self-evaluation and social bond. After being stimulated on their cheek in synchrony (vs. asynchrony) with the face of a stranger, participants received information on the partner of the stimulation. The synchronously stimulated partner was introduced as highly (vs. poorly) performing on an anagram task similar to that one participants were about to respond. Consistently with the study presented in Chapter 2, a perceptual illusion of becoming the woman showed in the movie was successfully induced by correlated visuo-tactile inputs. Synchronous stimulation also led to greater perceived physical resemblance and closeness with the partner of the stimulation. We found again that the effect of synchronous multisensory inputs (visual and tactile) extends from bodily to social perception. As far as the self-evaluation is concerned, we found that, participants low in internal motivation felt less self-confident in solving anagrams game when the partner of the synchronous stimulation was described as highly performing in the task. Importantly, this contrast effect in self-evaluation occurred only when the good anagrams solver was the partner of the synchronous stimulation, suggesting that participants did not engage in such a comparison process with the person stimulated in asynchrony. According to Self-Salience Model and Self Evaluation Model this different reaction of low internally motivated participants toward the outperforming synchronous and asynchronous stimulated partner means that the first, but not the latter was somehow considered a close other. This finding shows the effect of synchronous multisensory stimulation on self-evaluation and, more importantly, it establishes that sharing a synchronous multisensory stimulation leads to a social relation and not only to a perceptive assimilation. It is worthy to note that our synchronous manipulation created a perceptive assimilation in the body representation (i.e., self and other face similarities), but it was not extended to self-perception. This indicates that the effect of synchronous

multisensory stimulation on social perception is not due to an assimilation mindset, but to the rising of a social bond.

The fact that the effect is restricted to participants low in internal motivations replicated findings in school domain by Summers, Schallert and Ritter, (2001), showing that only children with a low internal motivation to learn math reported a lower self-evaluation in that domain when comparing themselves to close classmates with good grades. As motivation was operationalized in terms of frequency in performing puzzle games, likely participants low in internally motivation were also those who had a less stable opinion about their capacity and therefore were more vulnerable to the comparison (Stajkovic & Luthans, 1998).

The present research contributes to understand the nature of the socio-affective effects of multisensory integration process showing that synchronous stimulations create a social bond.

Chapter 4 endnote

In Table 6, correlations between different dimensions of the empathy scale and the bodily and social perception measures (computed as the difference between rates after the synchronous and asynchronous condition) are showed. The links between the different empathic dimensions and the multisensory illusion different facets and the social aspects will be discussed.

P*erspective taking* scale showed a negative link with positive emotions, $r(25) = -.41$, $p=.04$, *fantasy scale* with the Authority Ranking scale, $r\ (25) = -.52$, $p = .009$. Also *personal distress scale* negatively correlate, even if only marginally, with the Authority Ranking scale, $r\ (25) = -.36$, $p = .07$.

	1	2	3	4
1. PT	-			
2. FS	,488*	-		
3. EC	,459*	,374	-	
4. PD	,169	,423*	,475*	-
5. Ownership	-,053	-,116	,096	-,203
6. Location	-,095	,025	,112	-,172
8. Agency	-,065	-,090	-,048	-,270
9. Thermal sensation	-,077	,107	-,014	-,009
10. Affect	,123	,395*	,000	-,006
11. Peripheral facial features	,106	-,098	,185	,007
12. Core facial features	,061	-,067	,123	-,281
13. General resemblance	,056	-,173	,294	,028
14. Positive emotions	-,412*	-,095	-,298	-,003
15. Negative emotions	,338	-,006	-,158	,290
16. IOS	-,016	,071	,231	,165
17. AR	-,151	-,515**	-,230	-,366

* p< .05 , ** p< .01

Table 6. Correlations between empathy (four dimensions), bodily illusion (ownership, location and agency), the social outcomes (computed as the difference between rates after the synchronous and asynchronous condition).

Chapter 5

The rubber hand illusion in a intergroup context: Sharing a synchronous stimulation leads to ingroup bias reduction

We are not constantly conscious about our body and all the information coming from our senses. Focus now on your hand while grabbing a fresh glass of water: you will perceive the position and the movement of your hand, observe a congruent motion and then feel the cold contact with the glass. The ability of our brain to coherently integrate all these sensorial inputs when correlated makes it possible to indicate, without any doubts, that this hand is actually our own hand. This integration of multisensory stimulations is responsible for body ownership but also for creating bodily illusions (De Vignemont, 2007; Tsakiris, Schütz-Bosbach & Gallagher, 2007). The rubber hand illusion (RHI) is a clear example of how the self body boundaries can be altered by playing with correlated information coming from vision and touch (Botvinick & Cohen, 1998). A fake hand is placed in front of the participants and their real hand is concealed to the view. When the participants' and the rubber hand are stroked in synchrony, the integration of the seen touch on the rubber hand and the felt touch creates a new artificial matching. The incongruence between the two simultaneous sensorial inputs is solved in favor of vision that is dominate over tactile sensations and proprioception. In this line of reasoning, vision captures touch (Tastevin, 1937; Pavani, Spence & Driver, 2000), creating a displacement of the tactile input toward the visual stimulation on the rubber hand. Participants report the illusory sensation that the fake hand becomes part of their body. This is not only a subjective sensation. After the synchronous, in comparison with the asynchronous, stimulation a proprioceptive distortion of the position of the real hand toward the fake hand occurs (Botvinick & Cohen, 1998; Tsakiris & Haggard, 2005). Moreover, it is possible to observe physiological changes as a consequence of the bodily illusion. Moosey and colleagues (2008) showed that the stronger the illusory perception of owning the fake hand is, the more participant's hand temperature decreases. Armel

and Ramachandran (2003) found that, when the rubber hand is threatened the skin conductance response increases, as if the hand were one's own.

An asynchronous visuo-tactile stimulation does not create this multisensory illusion, since the different sensory information cannot be integrated as part of a single entity (Botvinick & Cohen, 1998; Makin, Holmes & Ehersson, 2008). Thus, the boundaries of our bodily representation can be altered and an external object can be incorporated in the one's own body representation.

Recently, my colleagues and I (Chapter 2; see also Paladino, Mazzurega, Pavani & Schubert 2010) showed that this bodily illusion can also affect social perception. This occurs when the stimulated object is not a fake arm, but a body part of a real person. Participants in our study were touched with a paintbrush on a cheek while they watched the face of person receiving the same stimulation in synchrony or in asynchrony (see also Sforza, Bufalari, Agliotti & Haggard, 2009; Tsakiris, 2008). Then they were asked to report their impression about the stranger. Interestingly, participants felt closer, more similar (in terms of physical resemblance and personality) and attracted by the stranger stimulated in synchrony (vs. asynchrony). This research suggests that a mere sensorial experience, as receiving a visuo-tactile stimulation, contributes to create a social bonding with a stranger. In the study illustrated in Chapter 2 (Paladino, Mazzurega, Pavani & Schubert, 2010), strangers shown in the movies were of the same age and ethnicity, as the participants. Here we present two experiments using the rubber hand paradigm where we manipulated the ethnicity (i.e., skin color, Study 1) and the age (Study 2) of the stimulated hand. The participant's hand was stroked with a paintbrush, both in synchrony and asynchrony, with a hand shown on a screen, touched in the same way. The hand in the movie was of a white or a black person (Study 1) or of a young or an elderly (Study 2). This manipulation offered the possibility to investigate whether the rubber hand illusion and a social bonding arises also when the other is visibly an out-group member. The necessary conditions for the rising rubber hand illusion are the integration of correlated visual and tactile stimulations (i.e., bottom-up sensorial component) and the plausibility of the stimulated object with the body image (i.e., top-down cognitive elaboration). For instance, presenting the rubber hand in a not

anatomical possible position (90° angle with participant's real hand; Tsakiris & Haggard, 2005) does not elicit a proprioceptive drift toward the rubber hand. The same disruption of the multisensory illusion happens showing a rubber hand of a reduced size (in comparison with participants' real hand) (Pavani & Zampini, 2007). The present study allows to verify whether body features such as skin color and skin texture could play a role in the RHI. In the classical rubber hand paradigm characteristics as color of gender are usually not controlled (Botvinick & Cohen, 1998; Holmes, Snijders & Spence, 2006) and to our knowledge never directly manipulated. In our previous study (Chapter 2 and 3, Paladino, Mazzurega, Pavani & Schubert, 2010), the multisensory illusion to become the synchronous (vs. asynchronous) stranger led also to a more self-other similarity, attraction and closeness toward her. We wondered if these positive social outcomes can spread also to the group of which the stranger stimulated in synchrony is a member. Intergroup contact, for example friendship with an out-group member, can lead to the inclusion of this person in the self and to a reduction of stereotyping and discrimination toward the out-group (Aron, McLaughlin-Volpe, Mashek, Lewandowski, Wright & Aron, 2004). This is due to the fact that including the out-group member into the self means also to incorporate the out-group in the self concept. If a synchronous visuo-tactile stimulation contributes to create a social tie toward the person stimulated in synchrony, independently to his/her ethnicity and age, we would expect that this experience with an out-group member would reduce in-group favoritism.

Study 1 – Ethnicity

Method

Participants

37 students at the Lisbon University Institute (all white) took part to the study in exchange of shop voucher of 5 Euros of value. One of the participants indicated, in the demographic variables, to belong to the black ethnicity so he/she was excluded from further analyses. The data of 36 participants were retained for the analysis (19 females, mean age 24.83, *SD* = 7.18).

Experimental setting and material

Participants sat at a table, in front of the experimenter, and placed their left hand inside a cubic black box. Participants therefore could not see their own left hand. A flat screen lay on the table, next to the box. A dark blanket covered the participants left arm and the bottom border of the screen, giving an impression of continuity between the participants' body and the screen. Two movies of 6 minutes each were displayed for each participant. Initially (first minute) a real size hand of a white or a black man (forearm, wrist and hand) was shown; in the other 5 minutes, the hand was stroked by a paintbrush on the whole length of the fingers (thumb excluded), 4 strokes for each, one after the other, in sequence. While shooting the movies, the brushing rhythm, was kept following a metronome (50 Hz, 4/4 time with a different beat for the last quarter). During the experimental session, the audio track was listened to on headphone only by the experimenter to enable synchronizing as much as possible the stroking rhythm on participants' fingers with the stroking showed in the movie (in the visuo-tactile synchronous condition; in the asynchronous condition the tactile stimulus was un-phase and on different fingers in comparison to the movie). In order to match participants' gender with the shown "rubber hand", in other 2 movies the stroked hand, white or black, was feminine. The position of the movie rubber hand, in front and perpendicularly to participants' body, reproduced an anatomically possible position (see Figure 16).

Figure 16. Experimental setting.

In the typical rubber hand experiment, the illusion effect is observed comparing the reaction of the same person to the synchronous and asynchronous stimulation (Longo, Schüür, Kammers, Tsakiris, & Haggard, 2008, Tsakiris & Haggard, 2005, Makin, Holmes and Ehrsson, 2008). In the present research we were also interest in the role of the ethnic identity of the hand shown in the video. A complete crossing of these two factors (stimulation and hand identity) would have implied that each participant were stimulated twice in synchrony (once with the white and black hand) and twice in asynchrony with the hand shown in the video. To avoid possible cross-over effect that such a design would likely have yielded, each participant was stimulated only once in synchrony, either with a white or a black hand, and once in asynchrony (either with a white or a black hand depending on the identity of the hand in the synchronous stimulation)[8]. Thus, each participant was confronted only once with a white and a black hand. The order of hand identity and type of stimulation was counterbalanced across participants. This led to four different combinations, displayed below, in Table 7.

[8] One of the aims of the present research was to investigate whether the positive outcomes (i.e. sense of closeness) of being stimulated in synchrony would generalize from the specific target to the ethnic group in general. Manipulating ethnic identity between-subjects (i.e. participant hand stimulated in synchrony and in asynchrony with either white or black hands) would have not allowed verifying a generalization to group perception.

	1st movie		2nd movie	
	Ethnic identity	Stimulation	Ethnic identity	Stimulation
1	White	Synch	Black	Asynch
2	White	Asynch	Black	Synch
3	Black	Synch	White	Asynch
4	Black	Asynch	White	Synch

Table 7. Four conditions resulting from the ethnic identity of the hand in the movie and the type of visuo-tactile stimulation combination.

Procedure

The study was presented as a study on body perception. Participants were informed that they were going to watch two movies, one showing the hand of a white person and the other the hand of a black person, while they were stroked with a paintbrush on their fingers. Participants sat at the table where the screen was put and placed their left hand in the box. They were instructed to not move their own hand during the stimulation.

The experimental session consisted of two blocks. In each block they received a visual stimulation (i.e., watching the movie showing a black/white hand being stroked by a paintbrush) and a tactile stimulation. These stimulations were delivered either in synchrony or asynchrony and involved either a white or a black hand. Straight after, they filled in a questionnaire assessing body (i.e., illusory perception of ownership, location and agency of the hand and perception of physical resemblance) and social perception of the person whose hand was shown (i.e., closeness and attraction). After the two blocks, participants responded to a final questionnaire that assessed closeness and attitudes toward the Whites (i.e., the in-group) and the Blacks in general (i.e., the out-group), an ethnic and biologically-based racism scale and demographic variables for the sample description (see Figure 17 for a schematic representation of the procedure). Finally, participants' hand size was taken.

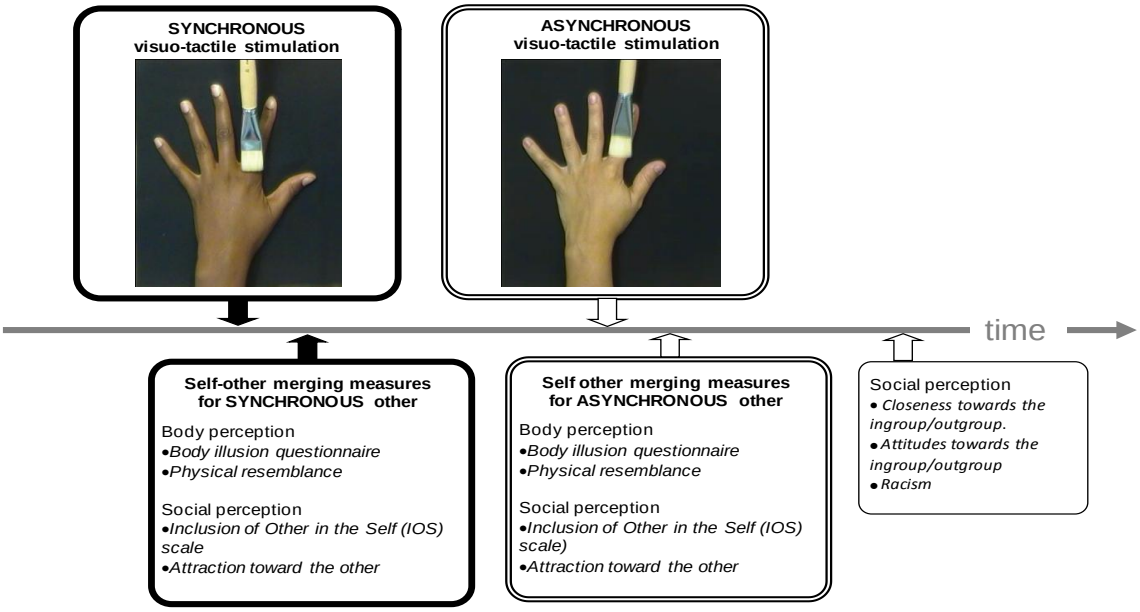


Figure 17. Schematic representation of the experimental procedure Synchronous and asynchronous conditions, as well as ethnicity of the hands, were counterbalanced across participants.

Below, in details a description of the dependent variables.

Body perception

Body illusion. 5 items investigated the participants' illusory feeling that the hand shown in the movie became part of their own body (*ownership*, e.g., "It seemed like the hand in the movie belonged to me"), 3 items assessed the confusion in the origin - their hand or the shown hand? - of the tactile input and the location of the fake hand (*location*, e.g., "It seemed like the touch I felt was caused by the paintbrush touching the rubber hand"), 3 items referred to the sense of being able to control the rubber hand (*agency*, e.g., "It seemed like I could have moved the rubber hand if I had wanted") and 3 items about the pleasantness of the stimulations and of the experience (*affect*, *e.g.,* "The touch of the paintbrush on my finger was pleasant", Longo, Schüür, Kammers, Tsakiris, & Haggard, 2008, scale translated into Portuguese). The responses scale, for all the items, ranged from -3, completely disagree, to 3, completely agree.

Physical resemblance. Similar to Paladino and colleagues (2010), we asked participants to rate the perceived resemblance between their own's and the hand shown

in the video on 7 different parts and physical characteristics (i.e., fingers, nails, wrist, shape of the hand, texture of the skin, size of the hand, generic resemblance). In addition, a specific question assessed the skin color similarity between the hands. The responses were given on a 7-point scale (1 = not at all; 7 = completely).

Social perception

Inclusion of the Other in the Self. Participants rated the feeling of closeness toward the other on a variant of the Inclusion of other in the Self Scale (Schubert & Otten, 2002, see Figure 18C). In this measure, different degrees of overlap between two circles (from separate circles to totally overlapped circles, 7-point scale) graphically illustrate different degree of closeness between the self and the person saw in the movie.

Pleasantness of the other. 4 items investigated to what extent participants liked the hand in the movie (e.g., "how much did you like the hand that you just saw?") but also the person to whom the hand in the movie belonged (e.g., "To what extent do you think that the person whose hand you watched in the movie is pleasant?"). Also in this case, the answers were given on a 7-point scale (1 = not at all; 7 = completely).

Closeness toward the in-group/out-group. Participants indicated how close they felt toward the Whites (in-group) and toward the Blacks in general (out-group) on an adaptation of the IOS scale for inter-group relations (Overlap of Self, In-group and Out-group items, OSIO, Schubert & Otten, 2002). The small circle represented the self while the bigger circle represented the group. 7 different degrees of distance/inclusion of the small into the big circle (i.e., the group) graphically illustrated the closeness of the participant toward the group (see Figure 19A).

Attitudes toward the in-group/out-group. Three questions investigated the attitudes toward the Whites and Blacks (3 items each, a 7-point-Likert scale, "Your attitude toward Whites/Blacks is: 1-not favorable/favorable, 2- negative/positive, 3-I do not like them at all/I like them a lot).

Racism/ethnocentrism scale. Participants responded to a 14 items scale on general racial and ethnic beliefs, not directly targeted to any specific group (Vala, Pereira & Costa-Lopez, 2009). Half of the statements regarded racial prejudice (e.g., "We have to protect our racial essence from contamination of other races characteristics"), the other

half, ethnocentrism (e.g., "Some ethnic groups are culturally more civilized than others"). Participants indicated their agreement with each of the items on 7-point scales (from 1=totally disagree to 7=totally agree).

Finally, participants described themselves on some demographic variables (i.e., gender, age, ethnic belonging). As a manipulation check, participants were asked to rate the perceived synchrony between the visual and the tactile stimulation in each movie ("In the first/second movie, how much was the brushing on your hand synchronized with the brushing shown in the movie? 5-point scale, from "at all" to "completely") and to indicate the skin color of hand ("Describe the person that you saw in the first/second movie", 4-point scale, from black to white). Hand-size of the participants was taken (the length of the middle finger and the full hand, from the top of the middle finger to the beginning of the wrist). At the end, participants were debriefed and thanked.

Results

We used a Linear Mixed Model (LMM) procedure, by SPSS software (West, 2009; West, Welch, & Galecki, 2007) to assess the effects of the (synchronous vs. asynchronous) visuo-tactile stimulation and the ethnic identity of the rubber hand (white vs. black) on body (multisensory illusion and physical resemblance) and social perception of the target (liking and interpersonal closeness). The type of manipulation (synchronous vs. asynchronous) and rubber hand ethnic identity (white vs. black) were entered in the model as repeated measure variables (first order autoregressive [AR1] covariance structure, assuming that residual errors within each subject are correlated but independent across subjects) and as categorical fixed effects. Individual variability was taken in account fitting the variable participants' id as random effect. The dependent variables treated with this LMM structure were the ones about the body illusion and social perception toward the person, the owner of the hand.

Body perception

Bodily illusion. A main effect of synchrony was found on the different facets of the body illusion, replicating the typical rubber hand illusion. Independently from the skin

colour of the hand showed in the movies, the synchronous (vs. asynchronous) visuo-tactile stimulation led to an illusory feeling of ownership of the hand shown in the movie (*ownership*, F (1, 33.73) = 25.66, $p < .001$, M_synch = .73, SEM = .30 α = .94, M_asynch = -.96, SEM = .30, α = .93), of confusion on the location (participant hand and rubber hand) of the tactile sensation (*location*, F (1, 36.51) = 8.66, p = .005, M_synch = .74, SEM = .33, α = .89, M_asynch = -.30, SEM = .33, α = .89) and of controlling the rubber hand (*agency*, F (1, 31.25) = 11.44, p = .002, M_synch = .35, SEM= .34, α = .94; M_asynch = -.88, SEM= .34, α = .92; see Figure 18A).

Pleasantness of the stimulation. Moreover, the synchronous experience was judged more pleasant (M = 2.23, SEM = .23, α = .90) than the asynchronous stimulation (M = 1.82, SEM = .23, α = .77), F (1, 33.41) = 8.35, p = .007.

Physical resemblance. An index of physical resemblance was created (average of the judgements of similarity of fingers, nails, wrist, shape of the hand, texture of the skin, size of the hand and generic resemblance (α_synch = .95, α_asynch = .94). The analysis yielded a main effect of synchrony, F (1, 35.19) = 10.42, p = .003. Interestingly a similar effect emerged also for the skin tone, F (1, 34.51) = 9.99, p = .003. The synchronous, in comparison with the asynchronous, visuo-tactile stimulation enhanced the perceived similarity between the rubber hand and the participants' hand both for the physical characteristics (M_synch = 4.84, SEM = .27, M_asynch = 4.00, SEM = .27) and the skin tone (M_synch = 4.91, SEM = .32, M_asynch = 3.89, SEM = .32; see Figure 18B). The identity of the hand influenced the judgement on the perception of physical similarity, as well. A main effect for the ethnic identity of the hand showed in the movie emerged for the judgements on the skin tone, F (1, 34.51) = 18.76, $p < .001$, and, as marginal significant, for the physical resemblance of the rubber hand, F (1, 35.19) = 3.89, p = .057. The hand in the movie was perceived as more resembling to the own hand in the shape, size and other features when it was white (M = 4.68, SEM = .27) rather than black (M = 4.16, SEM = .27). Obviously, the colour gradation of the hand was judged more similar for the white (M = 5.09, SEM = .32) than for the black hand (M = 3.71, SEM = .32).

Social perception

Interpersonal closeness. The visuo-tactile stimulation affected also the feeling of closeness toward the person whose hand was shown in the movie, F (1, 33.44) = 16.59, p < .001. Participants felt closer with the person who was stimulated on the hand in synchrony *(*M = 4.48, *SEM* = .32) rather than asynchrony (M = 3.34, *SEM* = .32; see Figure 18 C).

Pleasantness. A main effect of stimulation emerged also from the analysis on pleasantness of the person, F (1, 34.52) = 7.63, p = .009. The person was perceived more pleasant when stimulated in synchrony (M = 5.00, *SEM* = .25, α = .93) rather than in asynchrony (M = 4.52, *SEM* = .25, α = .93; see Figure 18D).

Data on group perception (closeness and attitude toward the in-group and the out-group) were also analysed with a Linear Mixed Model (LMM) by SPSS software. We were interested in attitudes toward Whites and Blacks people in general and whether sharing a synchronous experience with an out-group vs. an in-group member would reduce in-group bias. The hand ethnic identity (white and black) was treated as a repeated measure (AR1 covariance structure) and fitted as fixed effect. The other fixed factor was synchrony (synchrony shared with the in-group target vs. synchrony shared with the out-group target). Participants' id was fitted as random effect.

Closeness toward the in-group/out-group. White participants felt generally closer to their in-group (M = 5.54, *SEM* = .27) than the out-group (M = 4.31, *SEM* = .27), as shown by the main effect of group factor, F (1, 34.00) = 14.38, p = .001. More interestingly, the interaction between the synchrony shared with the white vs. black hand and the colour of the skin of the target was significant, showing that a synchronous (vs. asynchronous) stimulation had an effect on intergroup perception, F (1, 34.00) = 9.11, p = .005. When the synchronous touch was shared with an in-group member's hand (white hand) an in-group bias effect was observed: feelings of closeness are higher toward Whites (M = 5.95, *SEM*= .35) than Blacks (M = 3.75, *SEM* = .35), F (1, 34.00) = 26.08, p < .001. Watching a black hand being brushed in an exact spatio-temporal synchrony with the own's hand created a feeling of closeness toward Blacks in general (M = 4.88, *SEM* = .40) similar to

those experienced toward Whites as a group (M = 5.12, SEM = .40) and, F (1, 34.00) = .27, p = n.s. (see Figure 19A). Importantly, this effect is due to an increase in the closeness toward the Blacks, F (1, 63.74) = 4.50, p = .04, rather than a change in closeness toward Whites, F (1, 63.74) = 2.42, p = n.s..

Attitudes toward Blacks and Whites. A similar pattern of results emerged also for the attitudes toward Blacks and Whites. In general the attitudes were more positive for the in-group (M = 5.23, SEM = .20, α =.97) than the out-group (M = 4.70, SEM = .20, α = .91), as it was shown by a group factor main effect, F (1, 34.00) = 6.82, p = .013. The significant interaction, F (1, 34.00) = 5.79, p = .022, showed that this pattern was present only when a synchronous stimulation was shared with a white person (M_Whites = 5.30, M_Blacks = 4.28, SEM = .27, F (1, 34.00) = 14.16, p = .001). When the synchronous stimulation involved a black person, the attitudes toward the Blacks improved (M = 5.13, SEM = .30) becoming as positive as the attitude toward the Whites (M = 5.17, SEM = .30), F (1, 34.00) =.02, p = n.s.. Synchrony shared with a black person changed the attitude toward the Blacks, F (1, 54.63) = 4.36, p = .04, but not the attitudes toward the Whites F (1, 54.63) = .11, p = n.s. (see Figure 19B).

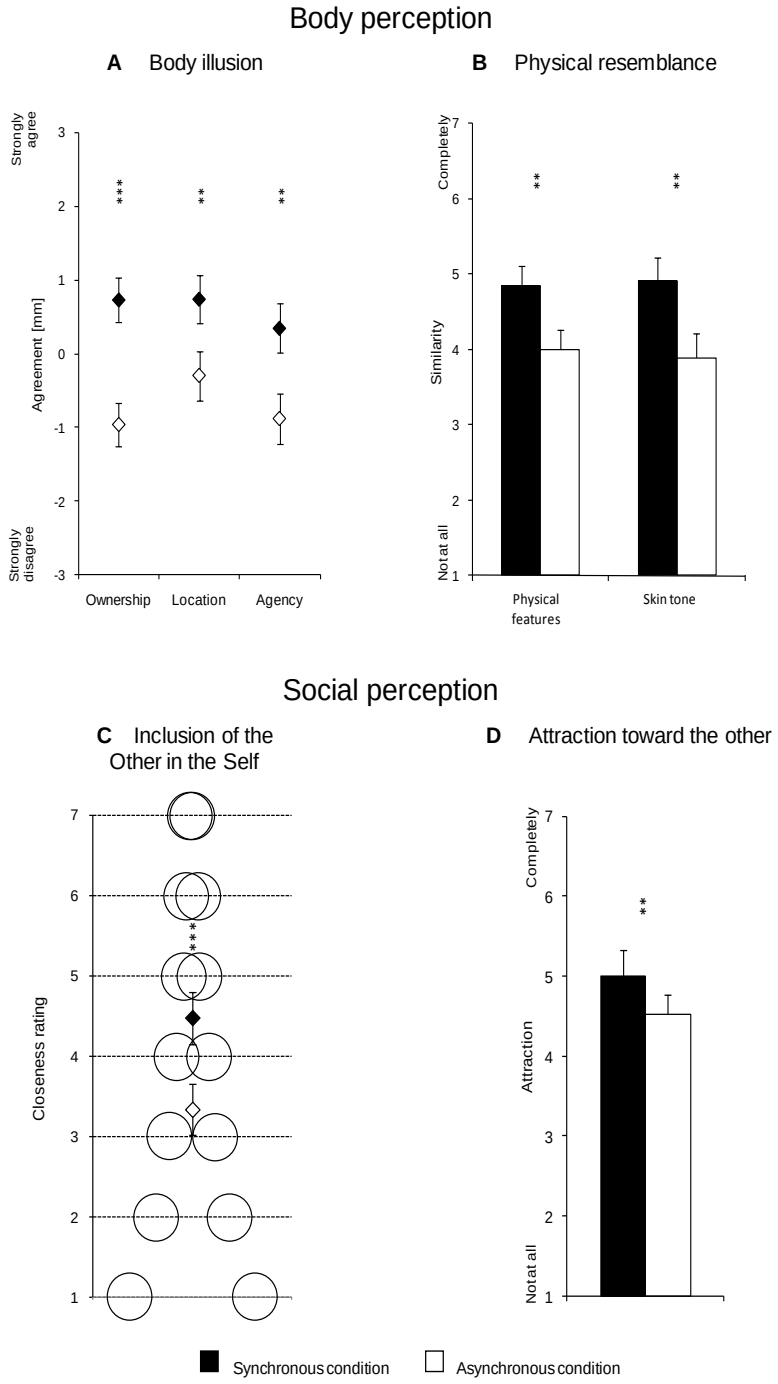


Figure 18. Effects of a synchronous (black) vs. asynchronous (white) visuo-tactile stimulations on: (A) the different facets of the body illusion (ownership, location and agency); (B) the physical resemblance on the feature of the hand and the skin color; (C) closeness toward the other (IOS scale); (D) attraction toward the other. Means and standard error of the mean (error bars) are reported. *** $p < .001$, ** $p < .01$ and * $p < .05$

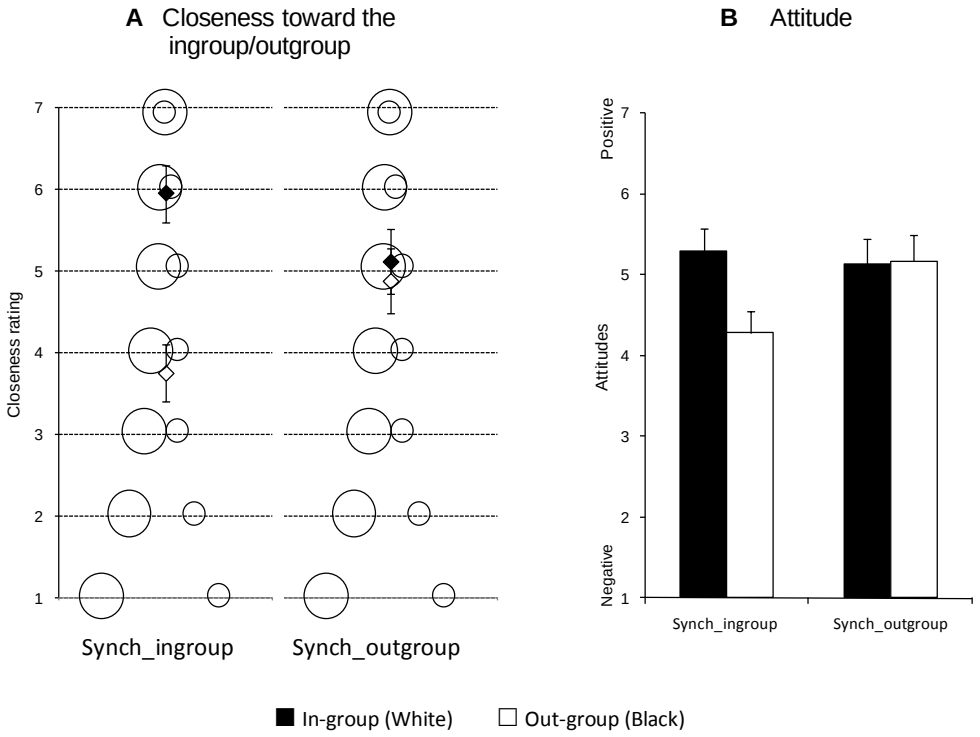


Figure 19. Effects of a synchronous visuo-tactile stimulation (shared with an in-group member vs. synchrony shared with an out-group member) on group perception: (A) closeness toward the in-group and the out-group (OSIO scale); (B) attitude toward the in-group and the out-group. Means and standard error of the mean (error bars) are reported. *** $p < .001$, ** $p < .01$ and * $p < .05$

Racism/ethnocentrism scale. Results on biological and cultural based racism questionnaire (Vala, Pereira & Costa-Lopez, 2009) were submitted to a Linear Mixed Model (LMM, by SPSS software) where synchrony shared with the white hand vs. synchrony shared with the black hand index was fitted as a fixed effect and participants' id as a random effect. Sharing synchrony with a white or a black person changed neither racial, F (1, 34.00) = .56, p = n.s., α = .63, nor the cultural beliefs, F (1, 34.00) = 1.96, p = n.s., α = .67.

The RHI was not affected by the ethnic identity of the hand showed in the movie. Independently from skin color, participants reported a greater illusory feeling of ownership and agency of the hand in the movie and a greater confusion about the location of the source of the tactile stimulation, in the synchronous, rather than the asynchronous stimulation. They also judged the synchronously stimulated hand in the

movie as more resembling to their own hand. Even if participants were perfectly aware of the different ethnicity of the two hands in the movies, synchrony enhanced a physical similarity. Besides body perception, the synchronous multisensory stimulation led also to a greater sense of closeness and attraction toward the person whose hand was stimulated in synchrony, replicating previous findings on social perception shown by Paladino and colleagues (2010, see Chapter 2). Interestingly, these positive social effects extended from the single person (the owner of the hand in the movie) to his/her group. In particular, sharing a synchronous experience with an out-group member reduced the favoritism for the in-group, measured trough inclusion of the other into the self and attitude thermometer. With a second study we aimed to replicate these findings in a different intergroup context: young and elderly people.

Study 2 - Age

Classifying people by age is as automatic as that by race or gender but, differently than race and gender, this kind of categorization is not static and changes during life time (Nelson, 2005). For a young person, the elderly are an out-group, but also a future in-group.

The experiment design and procedure was exactly the same of that of Study 1 (see Figure 17). One difference consisted of the hand shown in the video. In this study, the hand of a young and the hand of an elderly same sex person (all white) were shown. Items investigating closeness and attitudes toward the in-group and the out-group were also changed as they referred now to young (i.e., in-group) and elderly persons (i.e., out-group). After the experimental blocks an 8 items scale investigated the attitudes more directly toward elderly (e.g., "I really like to talk with elderly people", "I think that elderly are much more interesting than young people") (Braithwaite, Stevenson & Pigram, 1993). Participants indicated their agreement with each of the statements on a 7-point scales (from 1=totally disagree to 5=totally agree). At the end of the entire procedure, similar to the previous study, participants completed demographic variables (i.e., gender, age, ethnic belonging), responded to manipulation check questions about

perceived synchrony in the two different visuo-tactile stimulations ("In the first/second movie, how much was the brushing on your hand synchronized with the brushing shown in the movie? 5-point scale, from "at all" to "completely") and to questions on targets age ("Describe the person that you saw in the first/second movie". Different choices were possible, from 16 to older than 60 years old). Also in this case hand-size of the participants was taken. Participants were debriefed and thanked.

Participants.

37 students at the Lisbon University Institute (all white; 24 females, mean age 21.08, *SD* = 3.74) took part to the study in exchange of shop voucher of 5 Euros of value.

Results

As in Study 1 of this chapter, we used the same Linear Mixed Model (LMM) procedures, fitted by SPSS software (West, 2009; West, Welch, & Galecki, 2007). The type of manipulation (synchronous vs. asynchronous) and the hand identity (young vs. elderly) were entered in the model as repeated measure variables (first order autoregressive [AR1]) and as categorical fixed effects. Participants'id was fitted as random effect. This LMM structure was used for dependent variables about the body illusion and social perception toward the person whose hand was showed in the movie.

Body perception

Bodily illusion. Consistently with Study 1 and the rubber hand studies, we found a synchrony main effect on all the different parts of the body illusion. After the synchronous, rather than the asynchronous visuo-tactile stimulation, the participants reported a stronger illusory feeling of owning the hand in the movie (*ownership*, F (1, 35.03) = 14.03, p = .001, M_{synch} = .00, *SEM* = .29 α = .93, M_{asynch} = -1.05, *SEM* = .29, α = .95), confusing the source of the tactile stimulation between their real hand and the hand in the movie (*location*, F (1, 35.62) = 22.86, p < .001, M_{synch} = .63, *SEM* = .28 α = .64, M_{asynch} = -.47, *SEM* = .28, α = .81) and controlling the hand in the movie (*agency*, F (1, 34.80) = 12.97.86, p = .001, M_{synch} = -.23, *SEM* = .31 α = .84; M_{asynch} = -1.57, *SEM* = .31, α =

.96; see Figure 20A). These facets of the multisensory illusion were not influenced by the hand identity, except for the sense of ownership. In this case, a main effect of group was also found, F (1, 35.03) = 4.46, p = .04. The feeling of owning the hand shown in the video was stronger when that belonged to a young (M = .23, SEM = .29) rather than an elderly person (M = -.82, SEM = .29).

Pleasantness of the stimulation. The synchronous experience was judged as more pleasant (M = 1.97, SEM = .18, α = .82) than the asynchronous one (M = 1.60, SEM = .18, α = .77), F (1, 32.66) = 5.80, p = .02.

Physical resemblance. A score of physical resemblance was analyzed (average of the judgements on fingers, nails, wrist, colour and texture of the skin, shape and size of the hand and general resemblance, α_{synch} = .89, α_{asynch} = .93) Only a main effect of group emerged, F (1, 33.89) = 11.46, p = .002. The young person's hand was judged more similar (M = 4.10, SEM = .23) than the elderly person's hand (M = 3.27, SEM = .23).

Social perception

Interpersonal closeness. The type of visuo-tactile stimulation affected the feeling of closeness toward the person whose hand was shown in the movie, F (1, 33.42) = 5.45, p = .03. Participants felt closer with the synchronous (M = 2.86, SEM = .23) in comparison with asynchronous stimulated other (M = 2.37, SEM = .23). Also a main effect of the age of the person whose hand was shown in the movie emerged, F (1, 33.42) = 13.32, p = .001. They felt closer to the young (M = 3.00, SEM = .23) than the elderly person (M = 2.23, SEM = .23) (Figure 20B).

Liking of the target. A main effect of the target's age was found on the liking of the person, F (1, 35.14) = 6.63, p = .01 (α_synch= .88, α_asynch= .86). The young person was judged as more pleasant (M = 3.93, SEM = .19) than the elderly (M = 3.55, SEM = .19).

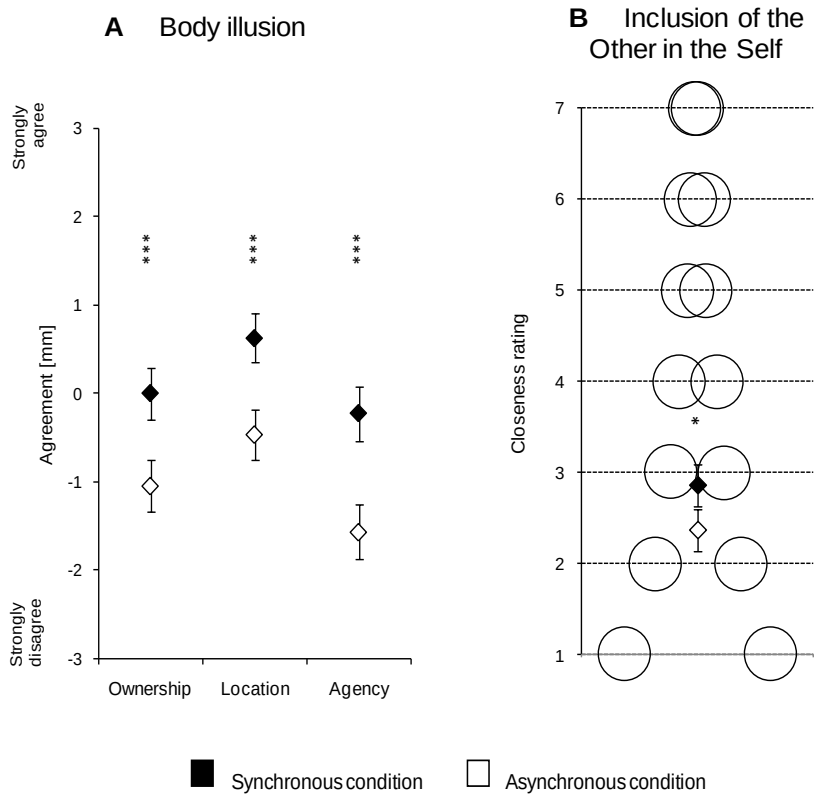


Figure 20. Effects of a synchronous (black) vs. asynchronous (white) visuo-tactile stimulations on: (A) the different facets of the body illusion (ownership, location and agency); (B) closeness toward the other (IOS scale). Means and standard error of the mean (error bars) are reported.
*** $p < .001$, ** $p < .01$ and * $p < .05$

As in the previous study, the group judgements (closeness and attitude toward the in-group and the out-group, namely young and elderly people) were analysed with a Linear Mixed Model (LMM) by SPSS software. We were interested in assessing whether sharing a synchronous experience with an out-group member (i.e., elderly) could reduce in-group bias. The age factor (young vs. elderly) was treated as a repeated measure (AR1 covariance structure) and fitted as fixed effect. The other fixed factor was synchrony (synchrony shared with the in-group target vs. synchrony shared with the out-group target). Participants' id was fitted as random effect.

Closeness toward the in-group/out-group. The group main effect showed that participants felt closer to the young ($M = 5.20$, $SEM = .24$) than elderly people in general ($M = 3.35$, $SEM = .24$), F (1, 35.00) = 49.97, $p < .001$. We found also an interaction effect

between the synchrony (shared with the in-group vs. shared with the out-group) and the group, F (1, 35.00) = 1.63, p = .04. When the synchronous experience was shared with the young the feeling of closeness was stronger for the young (M = 5.74, SEM = .33) than for the elderly (M = 3.32, SEM = .33), F (1, 35.00) = 41.36, p < .001. Being stimulated synchronously with an out-group member it did not affect the judgments of the out-group, F (1, 62.17) = .02, p=n.s, but it decreased the closeness toward the young F (1, 62.17) = 5.07, p = .03. This change, however, reduced, but did not eliminate an in-group bias. (M = 4.67, SEM = .34 and M = 3.39, SEM = .34, respectively for young and elderly people), F (1, 35.00) = 10.91, p =.002 (Figure 21).

Attitudes toward young and elderly. Differently from the previous experiment, no ingroup bias emerged. No differences were found in attitudes toward young (α = .91) and elderly people (α = .88) or effect of synchrony stimulation on them, all the $p > .05$.

Attitudes toward elderly. Results on the Braithwaite and colleagues (1993)'s attitude scale specific for elderly (α= .81) were analyzed by LMM by SPSS software in a model with the synchrony (shared with the young hand vs. synchrony shared with the elderly hand) fitted as a fixed effect, participants' variable as a random effect. Synchrony had a marginal main effect on opinion toward elderly people, F (1, 35.00) = 3.73, p = .06. Sharing a synchronous visuo-tactile experience with an elderly person enhanced the positivity of the attitude toward the elderly (M = 3.81, SEM = .15), in comparison when it was shared with a young person's hand (M = 3.41, SEM = .14).

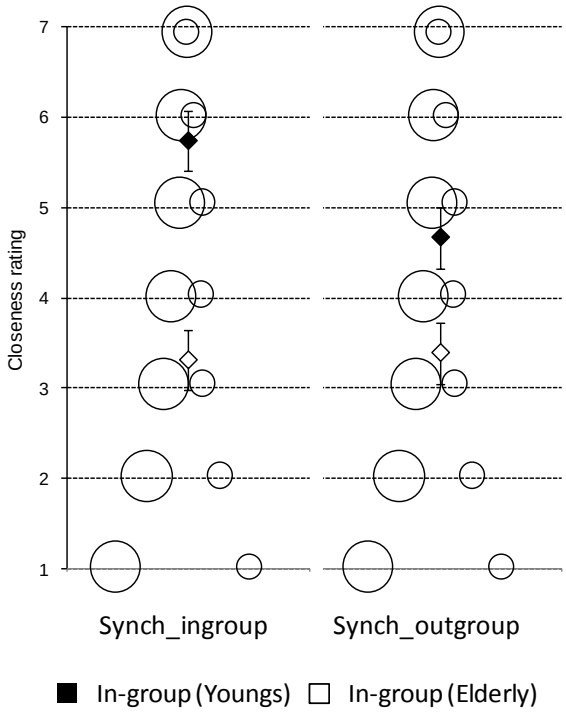


Figure 21. Effects of a synchronous visuo-tactile stimulation (shared with an in-group member vs. synchrony shared with an out-grup member) on group perception: closeness toward the in-group and the out-group (OSIO scale). Means and standard error of the mean (error bars) are reported. *** $p < .001$, ** $p < .01$ and * $p < .05$

Again we obtained a multisensory illusion independently from the features of the presented hand. Nevertheless, participants' agreement about the sense of ownership and agency were slightly lower in comparison with Study 1. The sense of ownership, in particular, was also affected by the group membership, indicating the incorporation in the body representation of the young hand was easier, in comparison with the elderly hand. This time synchrony did not succeed in influencing the perceived resemblance and attractiveness. Moving to social perception, also in a different group context, the multisensory illusion created a greater sense of closeness with the synchronous, in comparison with the asynchronous stimulated other. Importantly, sharing a synchronous experience with an out-group member reduced the in-group bias and enhanced a positive attitude toward elderly people in general. We thus replicated Study 1 findings on the positive effect of synchrony on group perception.

Conclusion

Taking advantage of the rubber hand illusion paradigm, we manipulated in two studies the social identity of the hand shown in a movie: the ethnic and the age group. Participants were all young, white Portuguese, university students. In Study 1 they received a synchronous (vs. asynchronous) tactile stimulation both with a white and a black's person hand, and in Study 2 with a young and an elderly person's hand. The differences in skin colour or texture between the participants' and the stimulated hand did not disrupt the occurrence of the typical multisensory illusion due to a synchronous visuo-tactile stimulation. In line with previous studies (Longo, Schüür, Kammers, Tsakiris & Haggard, 2009; Paladino, Mazzurega, Pavani & Schubert, 2010), that showed that the multisensory illusion affected the perceived resemblance, in Study 1 the physical features of the hand in the movie were judged more similar after the synchronous, in comparison to the asynchronous stimulation. Interesting, we obtained the same effect also for the skin colour resemblance. In Study 2, the perceived resemblance was influence by the identity of the other and not affected by the synchronous (vs. asynchronous) visuo-tactile manipulation. In this experiment, the strength of the illusion was weaker in comparison to the previous one. Presenting a young vs. elderly person's hand, we varied also the texture of the skin of the hand. While skin complexion (i.e., the colour) does not influence the rising of the illusion (see Longo, Schüür, Kammers, Tsakiris & Haggard, 2009; Holmes, Snijders & Spence, 2006), previous studies found that skin texture decreases the illusory perception of the rubber hand being part of the one's own body (Haans, IJsselsteijn & de Kort, 2008). The illusion experience could have not been strong enough to affect similarity. The perception of similarity could have been affected also by the pleasantness of the target. The elderly person's hand was seen as less pleasant in comparison with the young person hand, preventing similarity.

More importantly, besides more perceptual physical features as colour and texture, the hands shown in the movies clearly had characteristics indicating group membership. A synchronous multisensory stimulation leads to inclusion of the other in the body representation, even if an out-group member. The self-other merging at the bodily level extended also to the social perception, replicating our previous findings

(Chapter 2; Paladino, Mazzurega, Pavani & Schubert, 2010). Synchronous multisensory stimulation thus fostered social bonding even when the other is a member of the out-group. The novelty of these studies is the extension of the effect of synchronous multisensory stimulation also to the domain of intergroup relations. Sharing a synchronous stimulation with a black or an elderly person, not only created a tie with this specific individual, but also positively affected the perception of the group as whole. In particular, this multisensory experience decreased the in-group bias. The out-group member was included in the self through a mere bodily experience, reducing in-group bias (Aron, McLaughlin-Volpe, Mashek, Lewandowski, Wright & Aron, 2004). Though, this affective reaction did change more complex beliefs on the out-group as those revealed by the racism scale.

An interesting issue would be whether in a highly prejudiced context, the inclusion of an out-group member in the self-boundaries (both bodily and conceptual) would be impaired. In this case, inducing similarity with an out-group member by a synchronous multisensory stimulation would create a need for differentiation and rejection (Tajfel & Turner, 1979; Jetten, Spears & Postmes, 2004).

In these experiments we manipulated the visible features of group membership (i.e., the colour of the skin and the texture) and thus also the more perceptual (i.e., visual) part of the perception of the other. Future researches could investigate whether a shared synchronous multisensory stimulation can modulate the social perception of the other also when his/her group is not "visible" as, for instance the political affiliation. In this case, we would make salient the social categorization without manipulating the physical features of the hand.

The present research shows that the effect a multisensory synchronous (vs. asynchronous) stimulation in creating a bonding can go beyond the interpersonal level and be extended also to intergroup relations, enhancing positive affective reaction toward the out-group.

Chapter 6

It is a matter of time: Self-other bodily merging in the context of synchronous but arbitrary related multisensory inputs[9]

Our body representation is constantly updated starting from the integration of different sensory inputs (Holmes & Spence 2004; de Vignemont 2007). A paradigmatic example of this notion is the so-called rubber hand illusion (RHI). This illusion was first documented by Tastevin in 1937, and later described in more detail by Botvinick and Cohen (1998). In their experiment, participants sat at a table and looked at a prosthetic left hand laying on it, while their own left hand was concealed from view. Across blocks, the participant's left hand and the prosthetic hand were stroked repeatedly, either in synchrony or out of synchrony. When the seen and felt touches were synchronous, participants reported the illusory sensation of the rubber hand becoming part of their own body. In addition, they had the impression that the tactile input was located on the fake hand, rather than their own real hand. Finally, the process of integration of the synchronous visual and tactile stimulations led to a proprioceptive distortion of perceived hand position. After the synchronous manipulation, participants experienced a drift of the position of their own hand concealed from view toward the rubber hand. This classic study was among the first to suggest that an external object resembling a body part can be incorporated in the one's own body representation. Importantly, this effect does not occur when the visual-tactile stimulations are not delivered simultaneously. When asynchronous, the seen and felt touches of the paintbrush remain

[9] This chapter is based on:
Mazzurega, M., Pavani., F., Paladino, M.P., & Schubert, T.W. (submitted). It is a matter of time: Self-other bodily merging in the context of synchronous but arbitrary related multisensory inputs

independent sensory tracks that the brain does not appear to process and integrate them as parts of the same entity. As a consequence, no RHI is observed.

Since this first report, the RHI has been extensively investigated (for review see Makin, Holmes & Ehersson 2008) and it is now considered a useful paradigm to investigate body ownership, self-identification, or self-other merging. A few recent examples illustrate well the broader implications of this bodily illusion. The RHI illusion need not be restricted to the hand and can readily be adapted for stimulation on the entire body (Lenggenhager, Tadi, Metzinger & Blanke 2007) or the face (Tsakiris, 2008; Sforza, Bufalari, Haggard & Aglioti 2010; Paladino, Mazzurega, Pavani & Schubert 2010). When the RHI is created for stimuli delivered to the face, the participant receives a tactile stimulation on the cheek, while she is watching a video depicting the face of another person being touched in exact spatio-temporal synchrony. This variation of the RHI paradigm creates in the participant the sensations of being in front of a mirror. Furthermore, participants report the illusory sensation of being able to control the facial movements of the person in the video and perceive a resemblance between the face shown in the video and their own face (Tsakiris, 2008; Sforza, Bufalari, Haggard & Aglioti 2010; Paladino, Mazzurega, Pavani & Schubert 2010). As in the classic RHI phenomenon, these effects emerge selectively, or more strongly, in synchronous compared to asynchronous conditions. Finally, my colleagues and I (Paladino, Mazzurega, Pavani & Schubert, 2010, see also Chapter 2) recently showed that the perception of self-other similarity induced during synchronous stimulation of the participant's face and an actor face in a video can go beyond the physical body attributes, to affect also social perception and behavior toward the stranger in the video. Participants felt closer, and expected more psychological similarity (i.e., personality traits and inner states) toward the stranger stimulated in synchrony compared to a different stranger stimulated out of synchrony. Strikingly, participants were also more prone to rely on the stranger's judgments, as assessed by an implicit conformity task (Castelli, Vanzetto, Sherman & Arcuri 2001; Vaes, Paladino, Castelli, Leyens & Giovanazzi 2003). This suggests that multisensory integration can also affect processing

of social information and that the RHI phenomenon may be informative on how we create social bonds with the others.

One of the debated issues in the RHI literature, and the one we want to explore here further, concerns the relative contribution of bottom-up sensory components vs. top-down cognitive elaborations in contributing to the rise and persistency of this illusion. Armel and Ramachandran (2003) argued that the statistical correlation between visual and tactile inputs that characterizes the synchronous stimulation condition is necessary and sufficient to induce the illusion. In support of this account, they showed that even a non-corporeal object, such as the table in front of the participant, could be incorporated by participants in their own bodily representation when touched in synchrony with the participant's hand hidden from the view. However, this purely bottom-up view has been challenged in a number of studies, showing that the simultaneous and correlated presence of sensory inputs is necessary but not sufficient to induce the illusion. This claim is supported by the observation that changes in the position (aligned vs. misaligned; Tsakiris & Haggard 2005; Costantini & Haggard 2007; Pavani, Spence & Driver 2000), size (Pavani & Zampini 2007) or identity (hand/body part vs. object; Tsakiris & Haggard, 2005) of the external object stimulated in synchrony can change substantially the extent of the illusion. For example, when the rubber hand occupies a posture which is largely incongruent with respect to the body (e.g., it is rotated by 90° with respect to the participant's real hand) the RHI fades even if visuo-tactile stimulation is completely synchronous (e.g., Pavani, Spence & Driver 2000; Tsakiris & Haggard 2005). Similarly, no reliable proprioceptive drift (i.e., one of the effects of the RHI) has been measured when the visible object stimulated in synchrony was a wooden stick (Tsakiris & Haggard, 2005; see also Haans, Ijsselsteijn & de Kort, 2008), unlike the original observation of Armel and Ramachandran (2004). These findings suggest that the illusory merging of a rubber hand into the person's body representation can be disrupted either by stimulation asynchrony, or by plausibility mismatches between the stimulated object and the body.

But there is another top-down factor to consider. In most studies adopting the RHI paradigm, visual and tactile stimuli are delivered using the same ecological

stimulus: a paintbrush. Thus, in the synchronous condition, two concurrent factors can contribute to multisensory binding: first, the co-occurrence of multisensory events; second, the tactile expectation about tactile sensations resulting from a paintbrush on the skin. Tactile expectancy can be considered as a top-down factor (i.e., to what extent we expect a specific tactile sensation, given a specific visual stimulus approaching the fake hand). A few studies have recently examined whether changes in tactile expectancy can modulate the RHI. These studies violated tactile expectations by changing orientation congruency of the strokes on the participant's hand and on the fake hand (Costantini & Haggard, 2007) or by creating a mismatch between the tactile properties of the stimulus administered to the fake hand and that of the stimulus delivered to the participant's own hand (White, Aimola Davies, Halleen & Davies 2010; Schütz-Bosbach, Tausche & Weiss 2009; Ehrsson, Holmes & Passingham 2005). The overall finding is that changing orientation congruency did interfere with the RHI, whereas creating a mismatched between previously experienced visuo-tactile pairings did not. The latter finding appears to falsify some anecdotal reports about the RHI becoming weaker when a mismatch between expected and perceived touch existed (e.g., "the illusion was ruined when [my] hand was touched in an area of high hair density", Armel & Ramachandran, 2003, p. 1504). Note that these approaches to top-down factors are very dissimilar to those adopted in earlier studies (e.g., Tsakiris & Haggard 2005; Pavani & Zampini 2007), in which top-down components were manipulated by changing some attribute of the stimulated object (e.g., size, orientation or identity).

Violations of tactile expectation in the rubber hand illusion always entailed ecologically plausible pairs of stimuli, such as fingers, paintbrushes or fabrics. Thus, it remains an open question whether administering entirely arbitrary and non-ecological pairs of visual and tactile events could result in a conflict that can diminish the RHI to a larger extent. In addition, the role of tactile expectations has so far been examined exclusively for stimulation delivered to hands (fake and real), raising the issue of whether applying this manipulation to other body parts, such as the face or the entire body, could differently affect the RHI. Finally, our recent observation (Paladino, Mazzurega, Pavani & Schubert, 2010) suggests that the RHI adapted for the face can give

rise to conceptual as well as perceptual aspects of self-other merging. The synchronous multisensory inputs modified social perception and behavior toward the stranger in the video, in addition to creating bodily illusion.

The present study aims to address these issues, by replicating the experimental paradigm in which we (Paladino, Mazzurega, Pavani & Schubert, 2010) documented bodily as well as social consequences of the RHI illusion, but using visuo-tactile stimuli that have no previous multisensory association: an electrical stimulation on the participant's cheek and a dot of white light appearing on exactly the same location on a stranger's face. The electrical stimulation (i.e., the tactile stimulus) and the dot of light (i.e., the visual stimulus) were either synchronous or asynchronous. In both conditions the rhythm of presentation of the inputs was non cadenced and entirely unpredictable. We investigated the effect of this procedure on body perception, asking participants to rate their illusory perception of 'enfacement' (Sforza, Bufalari, Haggard & Aglioti 2010) on three components (ownership, location and agency) and to judge self-other face similarity. With an exploratory purpose, we tested also the effect on social perception (i.e., closeness, attraction and personality similarity) and behaviour (i.e., tendency to conform) toward the partner of the stimulation, to compare the consequence of our tactile expectancy manipulation on social and bodily effects of the illusion.

With our entirely non-ecologic and arbitrarily linked visuo-tactile events, the only potential multisensory binding factor is temporal synchrony. If merely exposure to temporally correlated signals is sufficient to induce an extension of the bodily borders, as originally proposed by Armel and Ramachandran (2003) and also suggested by some results on tactile expectancy for stimuli delivered at the hands, we should observe a fully-blown RHI illusion, or enfacement, also when stimuli are delivered to the face and when perceptual and conceptual effects are both measured. By contrast, if temporal synchrony is a necessary but not sufficient aspect of the illusion, we should not observe an enfacement effect.

Method

Participants

A total of 19 students at Faculty of Cognitive Science of the University of Trento took part in the study in exchange of course credits. One participant was excluded from the analysis because he/she was not a native speaker of Italian. The analysis were thus conducted on 18 participants (mean age 21.28, *SD* = 2.54; 16 females).

Material

Visual stimuli consisted of two movies of four minutes each. In each video, the photograph of a young woman's face appeared centered on the screen, with a sequence of white dots with blurred edges appearing on her left cheek. Dots were 1 cm in diameter and located 1 cm under the more external left-eye border. The women's hair and the entire background were covered by a white rectangular mask and were not visible. Two different woman's portraits were used in the two videos. A pre-test showed that the two faces were judged equally attractive (M = 5.01, SD = .99 and M = 5.11, SD = .86; $t < 1$). We will refer to the two faces as person A and person B. Tactile stimuli consisted of high-voltage pulses of brief duration, delivered using neurogical electrodes (Neuroline 700, AMBU) on participants' right cheek connected to a constant current stimulator devised for clinical use (DS7A, Digitimer®). For each participant, intensity of the electro-tactile stimuli was adjusted to a clear supra-threshold level, while also making sure that the stimulus was not perceived as painful. Tactile stimulation was always administered on the same hemispace as the visual stimulation on the face in the video. In other words, the spatial correspondence between visual and tactile stimulation mimicked what people normally see when they touch their face in front of mirror (see Figure 22).

Visual and tactile stimulation was controlled using the E-Prime® software. In the synchronous condition, tactile stimulation on participants' cheek was delivered in the exact temporal synchrony with the dot of light that appeared on the cheek of the person in the movie. In the asynchronous condition, the tactile stimulation was designed to be unrelated to the visual one. Stimulation sequences were generated using a Maximum

Length Sequence (MLS) algorithm, with a linear feedback shift register method (Brown 2002). This resulted in binary pseudo-random sequences, in which 1 corresponded to stimulation present and 0 corresponded to stimulation absent. Sequences were 255 bits long, with each bit lasting 1000 ms. The MLS algorithm produces a balanced proportion of 1 and 0 bits in each sequence, and low correlation between successive output sequences. In the synchronous condition, exactly the same stimulation sequence was used for visual and electro-tactile stimulation. In the asynchronous condition, tactile and visual stimulation were based on independently generated sequences, with an intersequence correlation ranging between .40 and .60. Note that zero correlation between the sequences would have meant having the two sequences in anti-phase (e.g., whenever a 0 was present in the visual sequence a 1 was present in the tactile sequence).

Procedure

Similarly to the study described in Chapter 2 (see also Paladino, Mazzurega, Pavani & Schubert, 2010), participants performed two experimental blocks[10]. In each block they saw a three minutes movie while they received synchronous or asynchronous visuo-tactile stimulation. Stimulation timing (synchronous or asynchronous) and target identity (person A or person B) were counterbalanced between participants. Immediately after each stimulation block, participants filled a questionnaire and performed a conformity task. The questionnaire concerned the different aspects of the bodily illusion of merging with the stranger shown in the movie, the perceived physical resemblance with her and the feeling of relational closeness and attraction. In the conformity task they were asked to provide an estimate about a large number of 'a' letters randomly distributed on the screen, while also seeing the estimate supposedly provided for the same set by either person A or person B. At the end of the two experimental blocks, participants completed also an inference task and answered

[10] As in Chapters 3 (Study 2) and 4, before starting the experimental session, participants completed the Italian version (Albiero, Ingoglia, & Lo Coco, 2006) of the Interpersonal Reactivity Index (IRI; Davis, 1983; see also Sforza, Bufalari, Haggard & Aglioti, 2010; see Chapter 3, footnote 5 for details about IRI scale). Table 8, at the end of this chapter, will display correlations between the different aspects of empathy, the bodily illusion (ownership, location and agency), the social outcomes.

manipulation check questions (see Figure 22 for a schematic representation of the procedure). Finally participants were debriefed and thanked for their participation. All measures used in the study are explained in detail in the next two paragraphs.

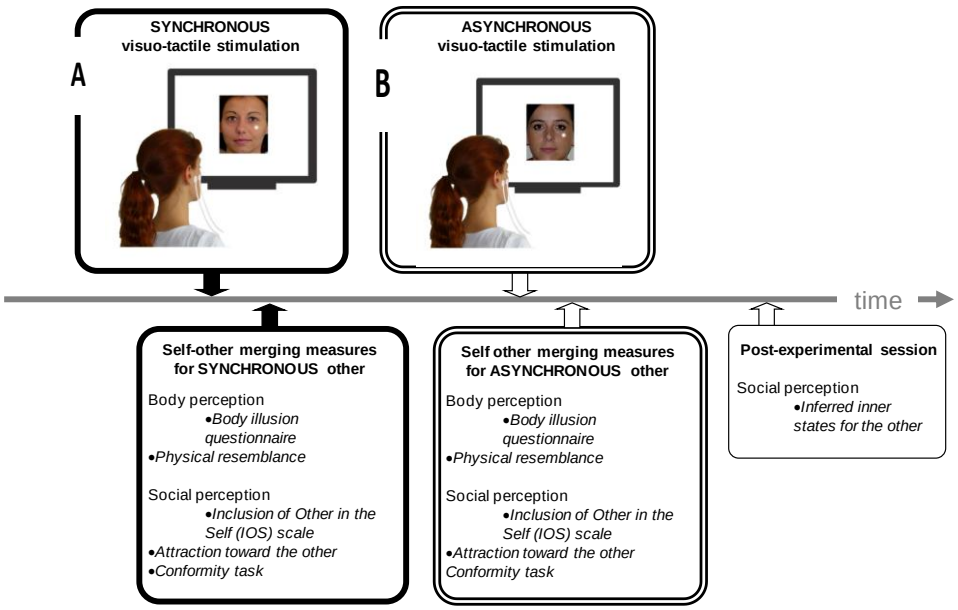


Figure 22. Schematic representation of the experimental procedure. Type of stimulation (synchronous vs. asynchronous) and identity of the other (person A and B) were fully counterbalanced between participants.

Body perception

Body illusion. The bodily illusion questionnaire aimed to assess, as in previous studies (Longo, Schüür, Kammers, Tsakiris, & Haggard, 2008; Paladino, Mazzurega, Pavani & Schubert 2010), the main facets of the illusory experience, i.e., the feeling of becoming the person in the movie (*ownership*; e.g., "It felt as if my face was turning into the face in the video", 4 items), the confusion in the source of the stimulation (*location*, e.g., "It seemed as if the touch I felt was caused by the paintbrush touching the face in the movie ", 3 items), the sensation of controlling the face in the movie (*agency*, e.g., "Sometimes I had the impression that if I had moved my eyes, the eyes of the person in

the video would have moved too", 2 items[11]). Three additional items assessed the pleasantness of the experience (*affect*, 3 items)[12].

Physical resemblance. Participants judged the resemblance they felt with the stranger on different facial areas. We compute an index for core (e.g., eyes, nose and mouth) and peripheral regions (e.g., cheeks, chin). Moreover they answered also about the general physical resemblance. All responses were given on a 7-point scale (1 = not at all; 7 = completely).

Social perception measures

Inclusion of the Other in the Self. Participants rated the degree of closeness felt with the stranger saw in the movie on the Schubert and Otten (2002)'s version of the Inclusion of the Other in the Self (Aron, Aron & Smollan, 1992). This graphic 7-point scale consists of a series of pictures of two circles representing the self and the other person with different degree of overlap, from two distant (1) to a completely overlaping circles (7).

Attraction toward the other. 3 items investigated the attraction toward the strangers in the movies. Responses were given on a 7-point scale (1 = not at all; 7 = completely).

Conformity behaviour. The implicit measure of conformity developed by Castelli and collegues (Castelli, Vanzetto, Sherman & Arcuri 2001; Vaes, Paladino, Castelli, Leyens & Giovanazzi 2003) was used. This task was presented as a numeric estimation

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[11] In this study, questions about the possibility to control the person shown in the photo, turned out to be inappropriate, if not constructed in a hypothetical way. Consequently, differently from the study described in Chapter 2 (Paladino, Mazzurega, Pavani & Schubert, 2010), here we dropped the item "It seemed that the face in the video had my same facial expressions". Moreover, deleting this item a larger internal consistency was reached: α = .67 and α = .93 in the synchronous and in the asynchronous stimulation condition. Only 2 of the 3 items used in our previous study (see Chapter 2) to assess the illusory perception of agency were retained ("Sometimes I had the impression that if I had moved my eyes, the eyes of the person in the video would have moved too", "It had the sensation that if I had moved my own face I would have seen movements of the face in the video")

[12] On the base of Durgin and colleagues (2007)' results about the warm feeling on participants' hand created by a "stroking" with a laser light on a rubber hand, we add a supplementary item in order to investigate a possible thermal sensation (warm vs. cold) due to a synchronous vs. asynchronous stimulation. Responses were given on a bipolar continuum of 100 mm (-50 mm = totally disagree, 50 mm = totally agree; thermal item -50 mm = cold, 50 mm = warm). Differently from Durgin and collegues (2007)'s study, the type of stimulation used in this paradigm did not induce a differential sensation of warmth, F (1, 17) = 1.87, p = n.s., η_p^2= .10.

task. 14 pages with different lay-out of letters 'a' agglomerates were presented, each one for few seconds. The number of the letters was always 200 but the different lay-outs on the page make them looking different numbers. On the top of the page we showed the estimations of the person participants just seen in the movie and who supposedly participated in the same task. This evaluation should be ignored by participants but works in fact as an anchor for their judgments. Conformity was operationalised as the absolute difference between the participants' estimates and the anchors that were given in each trial.

Inference of inner states. At the end of the whole procedure, after participants saw both the movies and received the two types of stimulations, an inference task was presented (Mitchell, Macrae & Banaji, 2006). Participants answered (yes/no) to 51 questions presented in a booklet, in a random order, about their habits and characteristics and about the synchronous and asynchronous stimulated others' same habits and characteristics. Therefore the same questions were repeated three times. To enhance the participants' feeling of being entitled to judge the actor, we told them that during the video they received some subliminal information about the actor (Yzerbyt, Schadron, Leyens & Rocher 1994). Obviously, no subliminal information was given. Within-participants correlations were computed between the self and the synchronous stimulated other ratings and between the self and the asynchronous stimulated other ratings. The *z*-transformed correlations formed an indirect index of self projection onto the other.

Manipulation check. Two questions for both synchronous and then asynchronous stimulations aimed to control if the participants perceived the type of synchrony ("I had the sensation that the tactile stimulation on my face and the light on the face of the person in the movie appeared at the same – synchronous- or at different moments – asynchronous- ") and felt the electric stimulation ("I felt clearly the tactile stimulation on my face"). Responses were given on a 7-point scale (respectively 1 = totally asynchronous; 7 = totally synchronous and 1 = not at all; 7 = completely).

Results

All dependent variables were submitted to a repeated measure ANOVA, with stimulation timing (synchronous or asynchronous) as variable.

Results on self-other merging in bodily and social perception are summarized in Figure 23. The manipulation check confirmed that participants perceived the differences in synchrony in the two experimental blocks, F (1, 17) = 114.90, $p < .001$ ($\eta_p^2 = .87$, $M = 6.56$, $SD = .71$, $M = 1.89$, $SD = 1.28$) and reported to have equally felt the tactile stimulation in both the conditions, F (1, 17) = 3.32, $p = .09$, $\eta_p^2 = .16$.

Body perception

Bodily illusion. The synchronous condition led to stronger bodily illusion compared to asynchronous stimulation. In particular, the illusory perception of *ownership* that is the sensation of being/becoming the face shown in the movie was higher after synchronous ($M = -8.94$, $SD = 16.85$, $\alpha = .83$) than asynchronous stimulation ($M = -25.02$, $SD = 17.96$, $\alpha = .85$), F (1, 17) = 9.12, $p = .008$, $\eta_p^2 = .35$. The confusion between the *location* source of the seen and the felt stimulation was also stronger after synchronous ($M = 2.08$, $SD = 16.35$, $\alpha = .61$) than asynchronous stimulation ($M = -16.93$, $SD = 17.70$, $\alpha = .66$), F (1, 17) = 18.25, $p = .001$, $\eta_p^2 = .52$. Finally, the illusory sensation of *agency* was stronger in the synchronous ($M = -21.29$, $SD = 15.21$, $\alpha = .67$) compared to the asynchronous condition ($M = -29.61$, $SD = 15.25$, $\alpha = .93$), F (1, 17) = 4.39, $p = .05$, $\eta_p^2 = .21$. In brief, we replicated all the main aspects of the illusion (see Figure 23A). Instead, evaluations of the pleasantness (*affect*) of the stimulation and the overall experience was comparable for the synchronous and asynchronous conditions ($M = 5.44$, $SD = 20.18$, $\alpha = .85$ and $M = 3.74$, $SD = 16.14$, $\alpha = .82$, respectively), $F < 1$, and did not differ from the midpoint of the scale (t (17) = 1.14, p = n.s., and $t < 1$).

Resemblance. Participants judged the face of the person stimulated in synchrony (vs. asynchrony) as more resembling to the self face on the peripheral, ($M = 3.78$, $SD = 1.05$ and $M = 3.41$, $SD = 1.00$, for the synchronous and the asynchronous stimulation condition respectively), F (1, 17) = 4.30, $p = .05$, $\eta_p^2 = .20$, but not on the core facial features (i.e., eyes, mouth and nose), $F < 1$. However, this perceived resemblance on the

peripheral features did not affect the general perception of physical similarity toward the partner of the stimulation, $F < 1$ (see Figure 23B).

Social perception

Inclusion of the Other in the Self On *social perception*, the analysis of responses to the IOS scale showed that participants felt closer toward the person in the video when the visual stimulation (dots of light) was synchronous ($M = 3.17$, $SD = 1.43$) rather than asynchronous to the tactile stimulation ($M = 2.50$, $SD = 1.82$), F (1, 17) = 6.18, $p = .02$, $\eta_p^2 = .27$ (see Figure 23C).

Inferences of inner states. Evidence for an overlap between the self and the synchronously stimulated other was found also in the responses to the self-projection task. The within-correlations between the self and the other was in fact positive and significantly different from zero only in the synchronous stimulation condition ($M = .14$, $SD = .28$), $t\ (17) = 2.13$, $p = .048$, but not in the asynchronous stimulated condition ($M = .06$, $SD = .45$), $t < 1$. This shows that the self was used to make inference only when judging the personality and the inner states of the synchronous stimulated other (see Figure 23D). However, the difference between the correlations in the two conditions was not significant, $F < 1$.

Attraction and conformity. The analysis of the other social perception variables, attraction toward the other and conformity behavior, yielded no significant effect, for attraction (F (1, 17) = 1.27, p = n.s., $\eta_p^2 = .07$) and conformity behavior (F (1, 17) = 2.86, p = n.s., $\eta_p^2 = .14$).

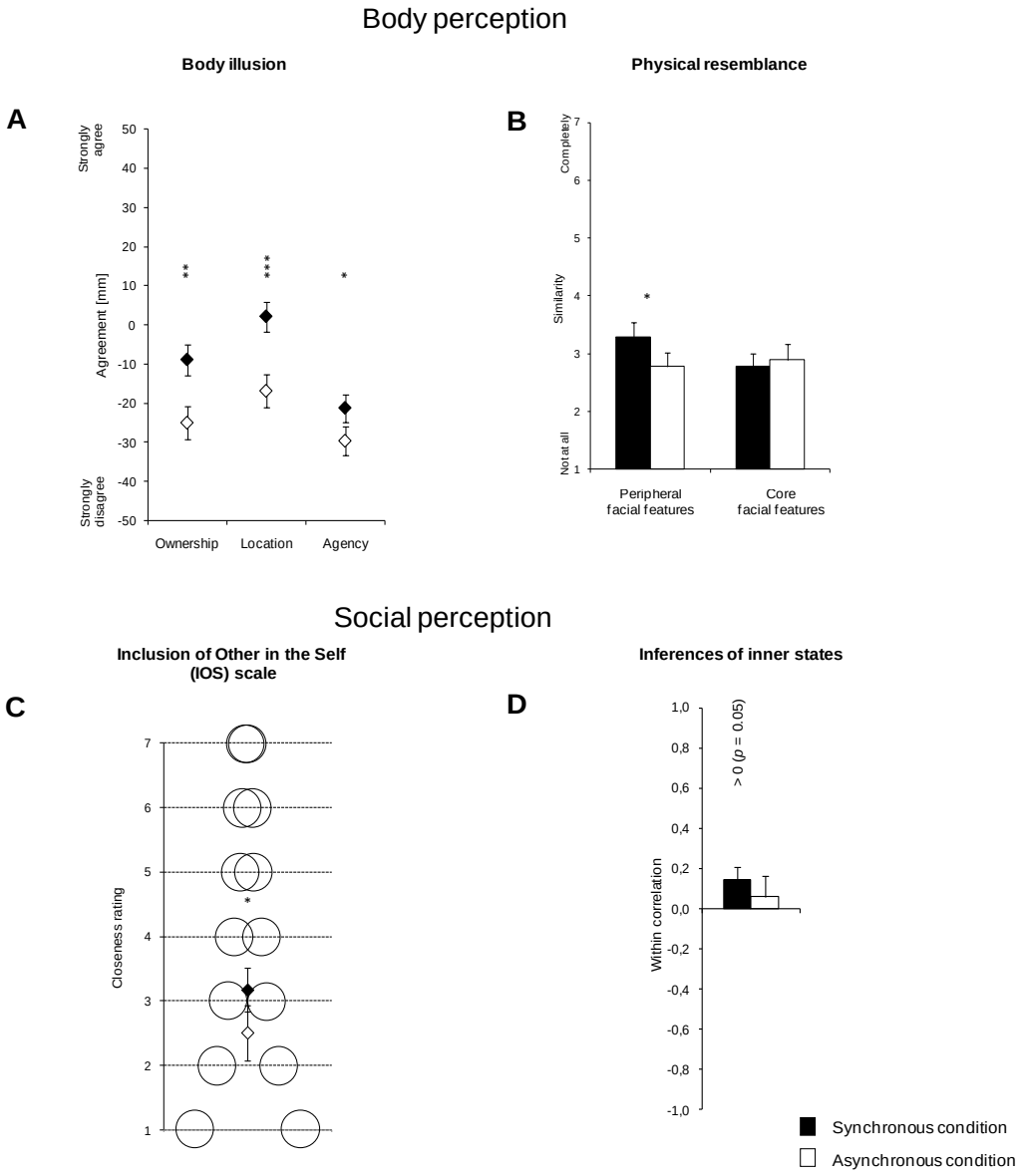

Figure 23. Effects of a multisensory synchronous (black) (vs. asynchronous - white) stimulations on: (A) the different aspects (ownership, location and agency) of the bodily illusion; (B) physical resemblance on the core and peripheral facial features; (C) closeness with stranger, rated on the Inclusion of Other in the Self (IOS) scale; finally, (D) self projection, operazionalized as within correlation between the self and the synchronous stimulated other and the self and the asynchronous stimulated other. Means and standard error of the mean (error bar) are reported. *** $p < .001$, ** $p < .01$ and * $p < .05$.

Conclusion

In the present study we aimed to investigate whether tactile expectancy plays a role in the RHI adapted for stimulation at the face. Unlike previous studies on tactile expectancy, that manipulated the congruency between seen and felt touches using ecological stimuli (e.g., a paintbrush touch paired with a finger touch; e.g., White, Aimola Davies, Halleen & Davies 2010), here we adopted entirely non-ecologic stimulations. Participants received a series of electro-tactile stimuli on the cheek, while watching a movie in which a discontinuous sequence of dot of white light appeared on the cheek of a stranger. These stimulations were either synchronous or asynchronous, resulting in a series of multisensory events that could be associated on the basis of temporal synchrony but not on the basis of previous experience.

The main result of the present study is that synchronous sensorial stimulations affected body perception leading to a blurring in self-other bodily boundaries, despite their arbitrary link. Compared to the asynchronous conditions, when the stimulation was synchronous participants tended to report touches in the location where they saw the visual stimulation. Furthermore, they experienced the illusory perception of being the person in the video and being able to control eye and facial movements of the person in the video. Consistent with these illusory effects, participants also tended to see some resemblance between the peripheral facial features of the stimulated partner and their own ones. These findings suggest that a previously learned association between the visual and tactile stimulation delivered in the RHI paradigm is not a necessary condition for experiencing the bodily aspects of the illusion, even when stimulation is delivered to the face. This result supports and extends recent work on the role of tactile expectancy on the RHI phenomenon (e.g., White, Aimola Davies, Halleen & Davies 2010; Schütz-Bosbach, Tausche & Weiss 2009) by showing that even an extreme violation of tactile expectancy (such as the one evoked here by entirely arbitrary non-ecological stimuli) can induce self-other merging at the bodily level.

To what extent is the illusory effect evoked here with arbitrary stimuli comparable with the illusory body effects evoked when the same paradigm is adopted using paintbrush stimulation? To answer this question we conducted a meta-analytic

comparison between the effect size of bodily illusion measures obtained in the present study, and the average effect size found on the same measures in other studies (N=3, in total 73 participants; average N= 24) we previously conducted (Chapter 2, 4 and another study conducted in our lab but not part of this thesis). In these comparison studies, participants were touched by a paintbrush on the cheek while watching a person being touched on a cheek by a paintbrush (either in synchrony or asynchrony). Thus visuo and tactile events were both temporally related and matched on the basis of previous tactile expectations (i.e., feeling associated with the bristles touch). Bodily illusion was measured along the ownership, agency and location dimension, as well as in terms of perceived physical similarities on the facial features. In all these 3 studies, the effect of synchrony of stimulation was significant and in the same direction for the 3 facets of the bodily illusion and the resemblance on peripheral facial features. Following Rosenthal's (1991) indications, the effect sizes were combined into a single index. The results of the meta-analytic procedure indicated that the illusory perception of being the person in the video (i.e., ownership), controlling her facial movement (i.e., agency) and a sensation of confusion between the felt and the seen touch experience (i.e., location), as the perceived physical resemblance, were experienced equally strongly in the present and the comparison studies (all Z's < 1)[13]. This suggests that the experience of bodily illusion and the perception of a certain physical similarity are not reduced when introducing an arbitrary link between the visual and the tactile stimulations.

Unlike these bodily aspects of the illusion, in the present study we only partially replicated our findings on social perception an behavior (Chapter 2, see also Paladino,

[13] Following Rosenthal's (1991) indication for each variable of interest, the combined effect size (z_1) was compared to the effect size obtained in the present (z_2) study using the following formula:

$$Z = \frac{z1 - z2}{\sqrt{\frac{1}{N1-3} + \frac{1}{N2-3}}}$$

where N_1 = 24 (average sample) and N_2 = 18.

	z_1	z_2	Z
Ownership	.71	.68	0,08
Location	.88	.91	-0,09
Agency	.65	.49	0,48
Similarity on peripheral feature	.49	.48	0,00

Mazzurega, Pavani & Schubert, 2010). Although the person stimulated in synchrony (vs. asynchrony) was judged as closer to the self (IOS scale; Aron, Aron & Smollan 1992; Schubert & Otten, 2002) and more similar in terms of personality (projection of inner states), synchrony did not influence attraction toward the partner of the stimulation nor induced conformity behavior. Inclusion of the other in the self typically characterizes the relationship with close other and the extent to which we rely on the self to infer personality traits of the other may precisely reflect this self-other merging. Attraction and conformity, instead, can be influenced by self-other merging but can also reflect other factors such as the sociability and the influenceability of the person. In this respect, synchronous pairing of arbitrary multisensory inputs appears sufficient to induce a blurring in self-other body boundaries, but insufficient to affect other socio-affective responses toward the partner of the stimulation.

Another potential explanation of the results should also be acknowledged. In addition to violating tactile expectancy, by using carefully randomized sequence of stimuli we also made the stimulation rhythms entirely unpredictable. This differs from the stimulation conditions adopted in the study described in Chapter 2 (Paladino, Mazzurega, Pavani & Schubert, 2010) and, to our knowledge, in most previous studies on the RHI phenomenon. We cannot exclude that this additional difference could have somehow interfered with social perception measures. In partial support of this account of the results on the social measures, moving in synchrony following an easy and predictable rhythm (e.g., Wiltermuth & Heath 2009; Miles Nind & Macrae 2009) leads to a series of social and affective outcomes very similar to those showed by us (Chapter 2, Paladino, Mazzurega, Pavani & Schubert, 2010), whereas trying to tap in synchrony a not predictable rhythm does not lead to these effects (see Kurzban, 2001).

Whatever the explanation for the absence of self-other merging in the social domain, the present findings demonstrate that bodily illusion phenomena in the RHI paradigm can be elicited even when participants are exposed to stimuli that can be bound exclusively on the basis of temporal synchrony. This finding underlines the role of temporal synchrony in multisensory integration and is consistent with the so-called "unity assumption" (Welch & Warren, 1980). The unity assumption suggests that

whenever two or more sensory inputs are highly consistent in one or more dimension (for example time as in the present study, but it could also be a semantic content), observers are likely to treat them as referring to the same underlying multisensory event and consequently bind them into a single unified percept. Interestingly the present study suggests that time is more important than previously experienced links between visual and tactile inputs in bodily illusion induced by multisensory integration. This conclusion is also compatible with the Bayesian account put forward by Armel and Ramachandran (1993) in their work.

In addition, this account matches findings in the multisensory literature concerning, for instance, audio-visual integration and the ventriloquism effect . In a ventriloquist show, the auditory (ventriloquist's voice) and visual signals (the synchronous movement of the mouth of the puppet) come from different locations. The ventriloquist effect is the perceived shifted of the auditory source toward the visual stimulus (Howard & Templeton, 1966; Recanzone 2009). It has long been established that the ventriloquist effect emerges reliably with ecological connected stimuli (i.e., stimuli associated in our daily-life experience) such as heard words and lip movements as in the actual ventriloquist show or a whistling sound and a puff of steam coming from a kettle. It is also clear that non-related stimulate, such as bells sounds and flashes of light can also produce this audio-visual capture (Jackson, 1957). In the latter case, however, the tolerance of spatial discrepancies between the auditory and visual signals that our perceptual system accepts before the ventriloquist illusion breaks down is smaller (e.g., Jackson, 1957). Thus, prior knowledge about the multisensory link is not a pre-requisite for the emergence of multisensory illusions, but may modulate their strength.

In conclusion, extending the role of tactile expectancy top-down factor to the RHI applied to the face, in the present experiment, we showed that correlated but arbitrary linked inputs delivered on the participant and a stranger's face did induce a bodily illusion and a certain physical similarity and connectedness. Moreover, comparisons of the effect size to previous studies suggest that it did not have a less strong effect than to ecological, congruently shared stimulations (i.e., a paintbrush touch) in inducing a blurring in self-other bodily boundaries. Given face relevance in representation of

identity and also self-other recognition, in our paradigm the only unifying link between the self and the stranger remained a temporal stimuli concurrence. This suggests that, in an interpersonal interaction, synchrony seems to be sufficient in inducing the feeling to look at the other as looking at the self in a mirror.

Chapter 6 endnote

In Table 8, correlations between different dimensions of the empathy scale and the bodily and social perception measures (computed as the difference between rates after the synchronous and asynchronous condition) are showed. The links between the different empathic dimensions and the multisensory illusion different facets and the social aspects will be discussed.

Fantasy scale shows a positive correlation with agency, r (18) = .64, p = .004, while *empathic concern* dimension with the pleasantness of the stimulation, r (18) = .51, p = .03.

	1. PT	2. FS	3. EC	4. PD
1. Perspective taking	-			
2. Fantasy scale	-,035	-		
3. Empathic concern	-,088	,420	-	
4. Personal distress	-,096	,230	,080	-
5. Ownership	-,334	,285	,113	,364
6. Location	-,309	,442	,412	-,047
7. Agency	-,232	,639**	,404	,340
8 Pleasantness of the stimulation	-,216	,347	,511*	-,234
9. General resemblance	-,353	-,019	-,191	,281
10. Resemblance on the peripheral facial features	-,153	-,304	-,014	-,088
11. Resemblance on the core facial features	-,129	-,136	,130	-,024
12. IOS	-,232	,202	,194	,261
13. Attraction	-,276	,024	-,109	,014
14. Conformity	,169	-,373	,138	-,136
15. Inference of inner states of the other	-,007	,085	,427	,030

* p< .05, ** p< .01

Table 8. Correlations between empathy (four dimensions), bodily illusion (ownership, location and agency), the social outcomes (computed as the difference between rates after the synchronous and asynchronous condition).

Capitolo 7

Discussione e conclusioni

Tra le molteplici manifestazioni della socialità umana, i comportamenti sincroni si riscontrano in una grande varietà di situazioni. Contesti e significati possono essere diversi (e.g., una marcia in una protesta, una preghiera in un rituale religioso, un ballo ad una festa) ma l'effetto dell'agire all'unisono rimane quello di aumentare il senso di unità tra le persone coinvolte e comunicare che esse abbiamo qualcosa di importante da condividere, un'identità o appartenenza comune (Fiske, 2004). La psicologia sociale ha portato svariate evidenze sperimentali riguardo la percezione di entatività creata dalla sincronia (Lakens, 2010; Lakens & Stel, in stampa), la sua potenzialità nel creare un legame tra le persone (e.g., Hove & Risen, 2009; Valdesolo & DeSteno, in stampa), nell'aumentare la cooperazione (Wiltermuth & Heath, 2009) ma anche i comportamenti conformisti (Wiltermuth, in revisione; Valdesolo & Winter, in revisione). Poche però sono le ricerche che, fino ad oggi, si sono occupate di quali siano i processi sottostanti a questi effetti sociali dovuti alla sincronia e la sua potenzialità nel dare il via ad un legame di tipo relazionale (per un'eccezione in questo senso vedi Lakens 2010). La presente tesi ha il merito di aver contribuito nel colmare questa lacuna, proponendo e testando come uno dei possibili meccanismi l'*integrazione multisensoriale*.

Secondo le neuroscienze cognitive, le informazioni provenienti simultaneamente da canali sensoriali diversi vengono integrate e organizzate in un'unità coerente (Welch & Warren, 1980). Questo processo ha un ruolo importante nel costruire e aggiornare la rappresentazione corporea. Diversi studi hanno mostrato come sia possibile, giocando con i processi di integrazione multisensoriale, allargare i confini corporei fino ad includere nella rappresentazione del proprio corpo un oggetto esterno, come una mano finta (Botvinick & Cohen, 1998; Tsakiris & Haggard, 2005) ma anche un volto (Tsakiris, 2008; Sforza, Bufalari, Haggard & Agliotti, 2010; Paladino, Mazzurega, Pavani & Schubert, 2010), e l'intero corpo (Ehrsson, 2007; Leggenhager, Tadi, Metzinger & Blanke,

2007). Si tratta per lo più di una percezione illusoria e relativa, in quanto i partecipanti di questi studi riportano la sensazione che l'oggetto esterno (i.e., la mano, il volto o il corpo) sia parte del proprio corpo quando stimolato in sincronia piuttosto che in modo asincrono. Ci siamo chiesti se questo effetto illusorio dato da una stimolazione visuo-tattile sincrona (vs. asincrona) di includere l'altro nel sé potesse estendersi da un livello corporeo ad uno socio-affettivo. Una sovrapposizione concettuale tra sé e altro avviene tipicamente nelle relazioni intime e di lunga durata (Aron, McLaughlin-Volpe, Mashek, Lewandowski, Wright & Aron, 2004). In questa tesi, abbiamo mostrato come una stimolazione visuo-tattile sincrona, di tipo strettamente fisico e difficilmente riconducibile ad aspetti affettivi, riesca ad instaurare un legame relazionale tra le persone che condividono l'esperienza. Gli studi da noi condotti, nel loro insieme, portano un'evidenza di tipo sperimentale di come il corpo (i.e., manifestazioni sincrone) influenzi la nascita di relazioni anche tramite processi per lo più automatici che coinvolgono l'integrazione delle informazioni sensoriali.

Rifacendoci al paradigma di Tsakiris (2008) che ha riadattato l'illusione della mano di gomma al viso, in tre esperimenti (Capitolo 2, Studio 1 del Capitolo 3, Capitolo 4; vedi anche Paladino, Mazzurega, Pavani & Schubert, 2010) i partecipanti venivano toccati con un pennello sul viso mentre vedevano due video dove una sconosciuta veniva toccata a sua volta nella stesso modo, in maniera sincrona o asincrona. Abbiamo riscontrato che una stimolazione visuo-tattile sincrona, in confronto ad una asincrona, induce la percezione illusoria di diventare la persona mostrata nel video. Questa alterazione del sé corporeo, oltre che ad una maggiore somiglianza fisica, si accompagna anche una maggiore vicinanza tra sé e altro, e a giudizi di piacevolezza e similarità nei termini di tratti di personalità e stati mentali nel confronti dell'altra persona stimolata sincronicamente. I partecipanti ai nostri studi hanno utilizzato le conoscenze su loro stessi per inferire le caratteristiche della persona con cui condividevano la stimolazione sincrona ma sono anche stati capaci di prendere su di sé il suo punto di vista, ancorandosi alle sue valutazioni in un compito implicito di conformismo (Capitolo 2). L'analisi mediazionale mostra il ruolo di mediatore dell'illusione multisensoriale (e in particolare la sensazione di diventare l'altro, *ownership*, insieme a quella di poter

controllare il suo viso, *agency*), nella fusione sé-altro, rilevata attraverso una serie di misure di percezione sociale (Capitolo 2; vedi anche Paladino, Mazzurega, Pavani & Schubert, 2010). Nel Capitolo 4, inoltre, abbiamo manipolato la competenza in un gioco di anagrammi delle due sconosciute mostrate nei video e con cui i partecipanti condividevano la stimolazione sincrona e asincrona e verificato la percezione di sé. Quando la persona stimolata in sincronia veniva descritta come molto brava nel gioco, nei partecipanti si verificava un l'effetto di contrasto nell'auto-valutazione delle proprie capacità nel compito, che quindi riportavano una minore fiducia nelle loro capacità. Questa reazione viene tipicamente osservata quando il paragone avviene nel contesto di una relazione importante, ed è funzionale a mantenere un equilibrio fondato sulla complementarietà nel legame (Stapel & Van der Zee, 2006; Tesser, 1988; Guay, Boivin & Hodges, 1999; Summers, Schallert & Ritter, 2001). Questo studio è importante perché mostra come l'inclusione dell'altro non sia solamente un fenomeno di assimilazione percettiva ma un legame relazionale.

L'analisi dei movimenti oculari nelle due diverse condizioni sperimentali, durante quindi la stimolazione visuo-tattile sincrona e asincrona, hanno messo in luce alcune differenze nell'esplorazione del volto (Capitolo 3). In particolare, durante la manipolazione sincrona il focus era su occhi, naso e bocca, mentre l'asincronia distoglieva l'attenzione dalle zone centrali per spostarla sulla fonte della discordanza cioè la zona toccata dal pennello. Pure essendo l'esplorazione del viso, e in particolare della zona degli occhi, un'importante fonte di informazioni di tipo sociale, abbiamo mostrato come il pattern registrato non possa essere considerato, in aggiunta all'illusione indotta dalla stimolazione multisensoriale sincrona (vs. asincrona), un'altra possibile causa degli effetti sociali misurati. Ad ulteriore conferma, la stessa tendenza nell'esplorazione visiva del volto è stata trovata a conseguenza di una manipolazione audio-visiva sincrona e asincrona (Capitolo 3, Studio 2). Non comprendendo il corpo del partecipante questa stimolazione non ha ricreato l'illusione multisensoriale, ma nemmeno nessun effetto di inclusione dell'altro a livello relazionale. Sembra quindi che la sincronia, visiva e tattile o auditiva e visiva, influenzi il pattern di esplorazione del

volto ma che per ottenere dei cambiamenti nella percezione sociale sia necessaria l'induzione di una percezione illusoria di diventare l'altro.

Un ulteriore possibile mediatore degli effetti sociali riportati nei nostri esperimenti potrebbe essere la risposta piacevole data da un particolare tipo di recettori, cioè le fibre C afferenti. Tranne il caso della stimolazione elettro-tattile data nello studio presentato nel Capitolo 6, il tipo di tocco dato durante la stimolazione visuo-tattile sul volto (Capitoli 2, nello Studio 1 del Capitolo 3 e Capitolo 4) e sulla mano (Capitolo 5) dei partecipanti è sempre stato dato con un pennello morbido, tipo una carezza. Le fibre C, presenti anche sul viso, sembrano rispondere specificatamente a questo tipo di input tattile, lento e gentile, dando una percezione piacevole (Vallbo, Olausson & Wessberg, 1999; Björnsdotter, Morrison & Olausson, 2010). E' possibile che questi recettori giochino un ruolo nell'originare l'assimilazione relazionale osservata nei nostri studi? Applicare una stimolazione visuo-tattile sul palmo della mano, dove queste fibre non sono presenti, potrebbe essere un modo per meglio differenziare l'effetto dell'illusione multisensoriale dalla risposta a valenza positiva di questi recettori sull'inclusione dell'altro nel sé. Vorremmo comunque sottolineare che, ad esempio, anche attraverso una stimolazione meno piacevole che quella del pennello, cioè un leggero impulso elettrico (Capitolo 6), abbiamo ottenuto un certo grado di fusione tra il sé e la sconosciuta con cui i partecipanti hanno condiviso una stimolazione sincrona (vs. asincrona).

Continuando la discussione sugli studi presentati in questa tesi, il legame relazionale che illusione multisensoriale legata alla sincronia di input sensoriali visivi e tattili induce avviene anche se la persona con cui si condivide l'esperienza è un membro di un gruppo esterno al proprio (Capitolo 5). La parte innovativa degli studi presentati nel Capitolo 5, è che questa connessione a livello corporeo porta ad una maggiore vicinanza con la persona ma anche con il suo gruppo sociale di appartenenza. In due esperimenti, utilizzando questa volta il classico paradigma della mano di gomma, abbiamo manipolato l'appartenenza etnica (i.e., colore della pelle, mano di una persona bianca vs. nera; Studio 1) o l'età (i.e., mano di una persona giovane vs. anziana; Studio 2) di una mano mostrata in un video. Condividere una stimolazione sincrona (vs. asincrona) con un membro dell'out-group riduce la classica tendenza a favorire l'in-

group (i.e., in questo caso i Bianchi e i giovani). Questa risposta però si limita alla parte più affettiva del fenomeno, cioè il senso di vicinanza provato e l'atteggiamento generico verso il gruppo, ma non invece le credenze più complesse come, ad esempio, il pregiudizio razziale. E' opportuno sottolineare che questi studi sono stati condotti in un contesto multiculturale, quale un'università di Lisbona, dove i contatti interetnici, soprattutto con persone di origini africane o sud-americane, sono frequenti. In una situazione con elevato pregiudizio, l'illusione percettiva che la mano nera faccia parte del proprio corpo avverrebbe comunque? Potremmo aspettarci che indurre similarità tramite una stimolazione multisensoriale sincrona con un membro dell'out-group porti, nel volersi differenziare, a rigettare la sua inclusione nel sé (Tajfel & Turner, 1979; Jetten, Spears & Postmes, 2004).

Un ultimo studio (Capitolo 6) si è interessato ai fattori di tipo cognitivo, top-down, che giocano un ruolo, oltre alla sincronia tra gli input sensoriali o fattori bottom-up, nel verificarsi dell'illusione. Un nuovo paradigma è stato proposto, dove la stimolazione tattile sulla guancia del partecipante consisteva in un leggero impulso elettrico, mentre quella visiva era un punto di luce bianca sul viso della sconosciuta nel video. In questa maniera, le due stimolazioni non erano relate dal punto di vista concettuale ed associativo, ma connesse solo dalla sincronia temporale. La sincronia è risultata essere condizione sufficiente per far si che l'altro venisse incluso nel sé, sia ad un livello corporeo e, seppur in maniera meno completa rispetto ai precedenti studi, anche sociale. Le misure che, anche in questo caso, hanno registrato un effetto della stimolazione in sincronia piuttosto che asincronia, sono state la scala di Inclusione dell'Altro nel Sé (IOS, Aron, Aron & Smollan, 1992; Schubert & Otten, 2002) e l'inferenza delle caratteristiche e stati mentali dell'altro basate sul sé. Queste misure, a differenza di quella di conformismo e di attrazione, sono indicatori dell'inclusione dell'altro nel sé come mostrato negli studi sulle relazioni intime (Aron, Aron, Tudor & Nelson, 1991; Aron, Aron & Smollan, 1992). Ciò lascia supporre che la stimolazione multisensoriale sincrona susciti un'inclusione dell'altro nel sé, ma non necessariamente maggiore fiducia e attrazione verso l'altro. Questo ultimo studio pone la questione di quali siano le

condizioni entro le quali, al seguito di un'illusione corporea, si registrino i diversi aspetti delle conseguenze socio-affettive e relazionali.

Come precedentemente sottolineato, l'effetto della stimolazione sincrona (vs. asincrona) nell'indurre una vicinanza tra il sé e l'altro misurata sulla scala di IOS (Aron, Aron & Smollan, 1992; Schubert & Otten, 2002) e l'inferenza delle caratteristiche dell'altro sono risultati replicati in tutti gli studi presentati in questa tesi in cui questa variabili venivano effettivamente misurate. Per i giudizi di attrattività delle sconosciute invece, non sempre abbiamo riscontrato un effetto di modulazione dalla stimolazione multisensoriale sincrona, in confronto all'asincrona (nell'esperimento presentato nel Capitolo 2 e nello Studio 1 del Capitolo 5 l'altro con cui si condivide la stimolazione sincrona – vs. asincrona - viene giudicato più piacevole, mentre nello Studio1 presentato nel Capitolo 3, quello del Capitolo 4 o lo Studio 2 del Capitolo 5, non c'è è un effetto significativo). Perché questa inconsistenza? Questa domanda richiede una spiegazione in quanto studi riguardanti le azioni sincrone e i suoi effetti sociali, come ad esempio la ricerca di Hove e Risen (2009), hanno riscontrato anche l'aumento della piacevolezza dell'altro a seguito di un'azione sincrona (vedi anche Valdesolo & DeSteno, in stampa). La piacevolezza dell'altro potrebbe quindi non essere un effetto diretto della stimolazione sincrona, in quanto influenzato da altri aspetti come, ad esempio, la bellezza/piacevolezza effettiva delle attrici o, nel caso specifico di uno degli item utilizzati per misurare la piacevolezza, la propensione personale del partecipante ad incontrare uno sconosciuto. Un'ulteriore possibilità è che qualche altro aspetto legato al tipo di manipolazione della sincrona alimenti un senso di affiliazione. Diversamente dai nostri studi, dove i partecipanti ricevevano passivamente una stimolazione, negli esperimenti di Hove e Risen (2009) e di Valdesolo e DeSteno (in stampa), dovevano imparare a battere un ritmo. Nell'agire attivamente in sincronia, rispetto all'induzione di un processo di integrazione multisensoriale, altri fattori possono entrare in gioco, come la soddisfazione per la riuscita nel compito o la gradevolezza di un'azione sincrona in sé, nel favorire un senso di affiliazione con l'altro.

In recente studio, Sforza e colleghi (2010) hanno trovato che l'empatia, e in particolare la capacità di prendere la prospettiva dell'altro e condividerne emozioni e

sentimenti, correla con l'effetto dell'illusione di inclusione delle caratteristiche del volto nel proprio (i.e., *enfacement*). Nello stesso studio viene dimostrato che anche l'attrattività del compagno facilità il sorgere dell'illusione. Ispirandoci a questi risultati, in alcuni dei nostri esperimenti (vedi Studio 2 del Capitolo 3, Capitoli 4 e 6), abbiamo inserito, prima della manipolazione sperimentale, l'indice di Reattività Interpersonale (Interpersonal Reactivity Index, Davis, 1980, 1983; versione italiana di Albeiro, Ingoglia & LoCoco, 2006) usato da Sforza e colleghi (2010) per valutare eventuali connessioni tra le diverse caratteristiche individuali di risposte empatiche, misurate da questa scala nei termini di capacità di prendere il punto di vista dell'altro (i.e., presa di prospettiva, *Perspective Taking*), di immedesimarsi nel personaggi di romanzi e film (i.e., fantasia, *Fantasy Scale*), il sentire le emozioni dell'altro (i.e., considerazione empatica, *Empathic Concern*), la reazione nelle situazioni d'emergenza (i.e., disagio personale, *Personal Distress*) da un lato e l'illusione corporea così come i diversi effetti di similarità sé-altro sia a livello corporeo che concettuale e sociale. Negli studi dove abbiamo preso in considerazione questa variabile individuale, a differenza dei risultati di Sforza e colleghi (2010), non abbiamo osservato un legame tra l'empatia verso altro (presa di prospettiva o considerazione empatica) e illusione multisensoriale. La considerazione empatica correla con la piacevolezza della stimolazione (Capitolo 6). A parte questo caso, la capacità immaginativa e il disagio personale per le situazioni critiche per gli altri, quindi reazioni empatiche basate sul proprio stato emotivo piuttosto che focalizzate su quello dell'altro, risultavano correlate rispettivamente con la sensazione di controllare l'altro (Capitolo 6) e il senso di la vicinanza (Capitolo 3, Studio 2). La differenza tra i nostri risultati e quelli ottenuti da Sforza e colleghi (2010) potrebbe essere dovuta a d una sostanziale differenza nella procedura sperimentale. Nelle nostre ricerche la persona con cui i partecipanti condividevano la stimolazione visuo-tattile era una sconosciuta e veniva mostrata in un video, nel caso di Sforza e colleghi (2010) la stimolazione avveniva faccia a faccia con una persona reale e conosciuta (i.e., coppie di amici). L'empatia giocherebbe quindi un ruolo nell'illusione corporea unicamente quando l'altro è un amico.

L'effetto di un processo di integrazione multisensoriale sincrono di creare l'illusione di includere l'altro nella rappresentazione del sé corporeo, fino ad influenzare

anche la percezione affettivo-relazionale che si ha di lui, è stato replicato nei vari studi sperimentali qui presentati. Pensiamo che questo meccanismo possa essere anche responsabile del senso di unità provato durante la messa in atto di azioni sincrone e dei vari effetti sociali osservati in relazione alla sincronia (e.g., cooperazione, affiliazione; per una rassegna si veda il Capitolo 1). Una prova più convincente in tal senso richiederebbe di testare l'effetto dell'integrazione multisensoriale sulla percezione sociale in una situazione più ecologica. Ad esempio, quando i soldati marciano al passo d'oca hanno l'impressione di confondere il proprio corpo con quello dei compagni? Un'ulteriore questione interessante da esaminare è il ruolo delle risorse cognitive. Affinché l'integrazione multisensoriale e di conseguenza l'illusione, possa avvenire è necessario dedicare risorse attentive all'evento. Un ambiente più naturale, come una marcia in un manifestazione, in questo senso, e ovviamente più complesso di una situazione di laboratorio per la presenza di informazioni in conflitto o ulteriori compiti da svolgere. D'altra parte, nelle manifestazioni sincrone osservabili sul campo (e.g., danzare o marciare in sincrono), una serie di altre variabili entreranno in gioco, tra cui il fatto di essere un'esperienza emotivamente connotata, di condividere uno scopo comune, l'aver deciso volontariamente o meno di compiere l'azione (e.g., marciare su ordine di un superiore o spontaneamente in una manifestazione d protesta), o per la presenza di legami già esistenti, tutti fattori che potrebbero moderare e/o contribuire, oltre all'integrazione multisensoriale, agli effetti di tipo sociale e relazionale.

Come dimostrato in precedenti studi, all'effetto legante dell'integrazione multisensoriale si potrebbero aggiungere altri processi, come la percezione di essere parte coerente di un tutto più ampio (e.g., Lakens, 2010) o, nel caso di esperienze a valenza positiva o anche fisicamente intense, il senso di benessere dato dalla produzione di endorfine (Cohen, Ejsmond-Frey, Knight & Dunbar, 2010).

I rituali o le danze in sincronia seguono, solitamente, un ritmo cadenzato, ripetuto e prevedibile (e.g., una marcia, mantra, in un rave party), rendendo più semplice la simultaneità e la coordinazione interpersonale. In alcuni casi estremi, la cadenza del ritmo arriva ad indurre stati alterati di coscienza e trance (e.g., riti sciamanici, danza rotatoria dei Dervisci turchi). Il poter facilmente prevedere

l'andamento di un ritmo sembra essere importante anche rispetto all'innescare effetti di tipo sociali. Kurzban (2001) ad esempio, al seguito di un compito in cui i partecipanti dovevano battere in gruppo un ritmo rivelatosi troppo complicato, non ha trovato conseguenze sulla cooperazione (vedi anche Capitolo 6).

Gli studi presentati in questa tesi contribuiscono alle attuali conoscenze sui processi di integrazione multisensoriali in più modi. Sono stati esaminati il ruolo di alcuni fattori top-down dell'illusione multisensoriale quali il legame concettuale e causale tra le stimolazioni (vedi Capitolo 6) e l'etnia e l'età della mano di gomma (Capitolo 5). La parte più innovativa degli studi qui presentati è nell'aver dimostrato, a nostra conoscenza per la prima volta, che l'integrazione multisensoriale, oltre a creare una serie di illusioni corporee, possa anche modulare le nostre risposte e vissuti affettivi e relazionali verso l'altro, anche quando questo è uno sconosciuto. L'incontro di due diverse aree come le neuroscienze cognitive e la psicologia sociale ha messo in luce come il corpo e le esperienze corporee vadano ad incidere anche sulla percezione del mondo sociale, connettendo e completando le prospettive di queste due discipline.

Oltre alle illusioni sensoriali utilizzate nei nostri studi, che prevedono una stimolazione sul viso o la mano, Le illusioni multisensoriali possono però comprendere anche tutto il corpo, creando l'illusione di osservare sé stessi dall'esterno, attraverso un'esperienza extra-corporea (i.e., *out of body experience*, Ehrsson, 2007; Lenggenhager, Tadi, Metzinger, & Blanke, 2007) o, con un drammatico cambio di prospettiva, di entrare nel corpo dell'altro (i.e., *body swapping*, Petkova & Ehrsson, 2008). Interessante sarebbe studiare se vedersi dall'esterno o essere letteralmente nei panni dell'altro possa influenzare aspetti diversi della percezione del concetto di sé e il rapporto sociale con gli altri. Ad esempio, il focus sul sé dato dal vedersi dall'esterno, creando uno stato di autoconsapevolezza oggettiva, può attivare processi di auto-regolazione di pensieri pregiudiziali? Inducendo l'illusione di entrare nel corpo di un membro dell'in-group o dell'out-group, a conseguenza di una minaccia a questo corpo (e.g., viene tagliato con un coltello), si avrà la stessa risposta di arousal fisiologico?

In conclusione, la presente tesi contribuisce, alle nostre conoscenze sui processi *embodied*[14] in cognizione sociale (i.e., radicati nel corpo, che trattano il ruolo delle esperienze fisiche nel pensiero e nelle relazioni umane) individuando nei processi di integrazione multisensoriale il meccanismo responsabile degli effetti sociali e affettivi dell'agire in sincrono.

[14] Altri esempi di indizi corporei presi in considerazione recentemente dalla psicologia sociale per la loro caratteristica di connettere le persone tra loro, sono il contatto (Gallace & Spence, 2008), la vicinanza fisica (Williams & Bargh, 2008b), un'azione motoria di approccio (Nussinson, Seibt, Hafner & Strack, 2010) o la percezione del calore (Ijzerman & Semin, 2009; Williams & Bargh, 2008a; Zhong & Leonardelli, 2008).

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RINGRAZIAMENTI

In questi tre anni ho avuto la fortuna di incontrare molte persone splendide che hanno reso quest'avventura del dottorato un'esperienza positiva ed arricchente e a cui sono molto grata. I miei non saranno ringraziamenti formali e forse nemmeno molto eleganti ma senza dubbio molto sinceri e sentiti.

Prima di tutto, un grazie di cuore va a Maria Paola per essere stata una guida ispirante, sempre presente, per i buoni consigli (sulla ricerca ma non solo!) e per il suo contagioso entusiasmo.

Grazie a Francesco per il tempo che mi ha dedicato e perché è stato molto interessante (e divertente) scoprire questo meraviglioso mondo fatto di illusioni, mani di gomma e altre cose bizzarre.

I am grateful to Thomas because he gave me the possibility of an interesting collaboration and because it was always pleasant to work with him (and he could patiently stand my "not really fluent" english).

Thanks also to Alessandro Farnè, the Gcir group, Sven, Alan Fiske (it was an honor to meet you!) and all the RMT lab members.

Non potevo mancare l'occasione di ringraziare per l'ennesima volta Massimo Vescovi per il suo impareggiabile aiuto. Una colonna portante del mio dottorato! Grazie anche a Nicola Chistè per aver montato tutti miei video, agli studenti che hanno collaborato in questo progetto, come Mauro, Paolo, Miriam e Immacolata, alle "attrici" dei video, Elisa, Irene e Federica, e a Daniele, Michèle, Anto e Marco per aver riletto alcune parti della mia tesi.

Grazie anche a Massimiliano per le consulenze ferroviarie, la buona compagnia e per le leccornie che si mangiano a casa sua.

Anto! It was great to live with you in our little cozy flat in Traversa dos Mastros. Thank you for your friendship and your daily FORZA in this last period. Grazie Mauro per il tempo passato insieme, le confidenze e le fantastiche cene a casa Bianchi-Loff. Thanks also to the other members of the running team P., Claire and Allard, and all the people that I met in terra lusa: Beate & Charlie, Clàudia, Mariline, Ana, Sofia, Silvia, Rui, Paulo, Taketo, Hugo, Hans, Cèsar…

Un grazie particolare va ai miei colleghi ed amici, membri della "setta" e non, Fabio, Elisa, Selena, Doris e James, per aver condiviso ed esserci sostenuti e motivati a vicenda durante questo periodo della tesi e semplicemente perché si sta così bene in vostra compagnia!

E ancora, grazie: ad Alessandra, a Gerhard per essere stato Georg per un giorno, al popolo di R, Simone, Daniele (Didì) e Daniele (Paniz) per l'aiuto con i linear mixed models. Sull'analisi dei movimenti oculari mi sono venuti in soccorso Daniele e Lisandro che hanno inoltre il merito, l'uno di avermi anticipato, con dimostrazione pratica, cosa voleva dire essere in tesi, l'altro di essere il mio uomo-party preferito.

Infine, ringrazio i miei genitori, Norma e Giorgio, che per me ci sono sempre. E Marco che crede sempre in me e che mi ha stoicamente sopportata e supportata in questo ultimo periodo.

Sperando di non aver dimenticato nessuno, ancora GRAZIE! THANK YOU! OBRIGADA!