The Role of Fluency in Oral Approach and Avoidance

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Summary

Names of, for instance, children or companies are often chosen very carefully. They should sound and feel good. Therefore, many companies try to choose artificially created names that can easily be pronounced in various languages (e.g., *Zalando, Skype, Ansons*, and *Caleido*). A wide range of psychological research has demonstrated that easy processing (in other words, high *processing fluency*) is intrinsically experienced as positive (e.g., Diener, Larsen, Levine & Emmons, 1985; Reber, Schwarz & Winkielman, 2004; Topolinski & Strack, 2009a, 2009b, 2009c, 2009d, 2010; Whittlesea & Williams, 1998; Winkielman & Cacioppo, 2001). Due to this positive feeling, easy processing (e.g., easy pronunciation) can have profound influences on preferences for names (e.g., Laham, Koval, & Alter, 2012; Song & Schwarz, 2009).

Topolinski, Maschmann, Pecher, and Winkielman (2014) have introduced a different mechanism that influences the perception of words. Due to the fact that consonants are articulated on distinct spots on the sagittal plane of the mouth (e.g., K is articulated in the back and B in the front), it is possible to construct words that feature peristaltic wanderings of articulation spots from the front to the back (inward dynamics) or from the back to front (outward dynamics) of the mouth. Across several experiments Topolinski et al. (2014) found that words featuring consonantal inward wanderings (inward words) were preferred over words featuring consonantal outward wanderings (outward words). They argued that this was due to the fact that approach and avoidance motivations are activated by articulating inward and outward words, because the pronunciation resembles approach and avoidance behaviors of swallowing and spitting, respectively. Generally, we tend to approach objects we like, and to avoid objects that we do not like (for an overview, see Elliot, 2008). Topolinski et al. (2014) suggested this close link as an underlying mechanism for the effect that we prefer inward words over outward words (in-out effect), but did not test this assumption directly.

In the current work, I tested an alternative fluency account of the in-out effect introduced by Topolinski et al. (2014). Specifically, I hypothesized that processing fluency might play a critical role instead of motivational states of approach and avoidance being necessarily activated.

In Chapter 1, I introduce the general topic of my dissertation, followed by a detailed introduction of the research area of approach and avoidance motivations in Chapter 2. In Chapter 3, I narrow the topic of approach and avoidance motivations

down to orally induced approach and avoidance motivations introduced by Topolinski et al. (2014), which is the main topic of my dissertation. In Chapter 4, I introduce the research area of ecological influences on psychological processes. This chapter builds the base for the idea that human language might serve as a source of processing fluency in the in-out effect. In the following Chapter 5, I elaborate the research area of processing fluency, for which I examined whether it plays a role in the in-out effect.

After an overview of my empirical work in Chapter 6, the empirical part starts with Study 1a and Study 1b (Chapter 7) that aimed to show that two languages (English & German) in which the in-out effect has originally been found might feature a source of higher processing fluency for inward over outward words. The results showed that higher frequencies of inward dynamics compared to outward dynamics were found in both languages. This can lead to higher pronunciation fluency for inward compared to outward words which might in turn lay the ground for higher preferences found for inward over outward words.

In Chapter 8, the assumption that inward compared to outward dynamics might be more efficient to process was tested directly in experiments that examined objective as well as subjective processing fluency of artificially constructed non-words featuring pure inward or outward dynamics. In Studies 2a and 2b, participants were indeed faster in initiating an overt articulation of inward than of outward words. In Study 3, a second objective fluency measure of silent reading durations also found a processing advantage for inward over outward words. In Studies 4a and 4b subjectively experienced pronunciation fluency was found to be higher for inward compared to outward words.

In Chapter 9, the causal role of objective and subjective pronunciation fluency in the effect of consonantal inward and outward dynamics on word preferences was examined. In Study 5 mediational analyses on item-level and across studies were conducted using objective and subjective fluency as possible mediating variables. For subjective fluency, the mediation analysis could not be conducted, because a statistical precondition was not met by the data, which was probably due to low statistical power. For objective processing fluency, the results were not in line with the hypothesized mediating role of objective fluency. In Study 6 mediation analyses were conducted with data on subject- and trial-level from a within-subject design. A partial mediation of experienced ease of pronunciation on the influence of consonantal stricture dynamics on explicit word preferences was found on subject- as well as on trial-level. Overall, the data of the item-based, subject-based and trial-based mediation analyses provide rather mixed results. Therefore, an experimental manipulation of fluency was implemented in the last two studies.

In Chapter 10, Study 7 and Study 8 demonstrate that manipulating fluency experimentally does indeed modulate the attitudinal impact of consonantal articulation direction. Articulation ease was induced by letting participants train inward or outward kinematics before the actual evaluation phase by simply rehearsing either inward or outward words in a short-term memory task. Additionally, the simulation training was intensified in Study 8 in order to examine whether a stronger modulation of the in-out effect could be found. Training outward articulation kinematics led to an attenuation (Study 7) and, after more extensive training, even to a reversal (Study 8) of the in-out effect, whereas training inward articulation kinematics led to an enhancement of the classic in-out effect. This hints at my overall hypothesis that the explicit preferences of inward and outward words are, at least partially, driven by processing fluency.

Almost all studies (Studies 1a, 1b, 2a, 2b, 3, 4a, 4b, 6, 7, 8) of my dissertation, except for one analysis of the item-based mediation study (objective fluency in Study 5), speak in favor of the hypothesis that inward words compared to outward words are objectively and subjectively easier to articulate. This possibly contributes partially to a higher preference of inward over outward words. The results are discussed in Chapter 11 with respect to conclusions for processing fluency as an underlying mechanism compared to approach and avoidance motivations and with respect to the role of language as an ecological factor. Finally, future research ideas are elaborated.

Zusammenfassung

Die Namensgebung von beispielsweise Kindern oder Firmen ist meist sehr sorgfältig bedacht. Ein Name sollte sich möglichst gut anfühlen und schön klingen. So wählen weltweit agierende Firmen oft künstlich kreierte Namen, die in mehreren Sprachen leicht aussprechbar sind (z.B. *Zalando, Skype, Ansons* und *Caleido*).

Psychologische Forschung hat vielfach gezeigt, dass eine leichte Verarbeitung (hohe *Verarbeitungsflüssigkeit* oder *fluency*), beispielsweise von Wörtern, implizit als positiv wahrgenommen wird (z.B. Diener, Larsen, Levine & Emmons, 1985; Reber, Schwarz & Winkielman, 2004; Topolinski & Strack, 2009a, 2010; Whittlesea & Williams, 1998; Winkielman & Cacioppo, 2001). Aufgrund dieses positiven Gefühls, kann eine leichte Verarbeitung (z.B. leichte Aussprache) starken Einfluss auf die Präferenzen für Namen haben (z.B. Laham, Koval, & Alter, 2012; Song & Schwarz, 2009).

Topolinski, Maschmann, Pecher und Winkielman (2014) stellten einen anderen Mechanismus vor, der die Wahrnehmung von Wörtern beeinflussen kann. Aufgrund der Tatsache, dass Konsonanten an einem distinkten Punkt auf der sagittalen Ebene des Mundes artikuliert werden (z.B. wird *K* hinten artikuliert und *B* vorne), können künstliche Wörter konstruiert werden, die peristaltisch wandernde Artikulationspunkte aufweisen, welche von vorne nach hinten (Reindynamiken) oder von hinten nach vorne (Rausdynamiken) wandern. Topolinski und Kollegen (2014) konnten in mehreren Experimente hinweg zeigen, dass Wörter mit einer konsonantischen rein-Wanderung (Reinwörter) gegenüber Wörtern mit einer konsonantischen raus-Wanderung (Rauswörter) präferiert wurden. Die Autoren postulieren, dass dies durch Annäherungs- und Vermeidungsmotivationen zustände käme, die durch die Artikulation von Rein- und Rauswörtern ausgelöst wurden, da das Aussprechen von Rein- und Rauswörtern jeweils dem Annäherungs- und Vermeidungsverhalten im Sinne von schlucken (sich einverleiben) und spucken (von sich geben) ähneln. Gestützt wird die Annahme dadurch, dass wir im Allgemeinen dazu neigen, uns Dingen zu nähern, die wir mögen und Dinge, die wir nicht mögen, zu vermeiden (siehe Elliot, 2008 für einen Überblick). Topolinski und Kollegen (2014) nehmen an, dass diese enge Verknüpfung von Merkmalen der Aussprache mit Annäherungs-/Vermeidungsverhalten der zugrundeliegende Mechanismus dafür ist, dass wir Reinwörter gegenüber Rauswörtern präferieren (Rein-Raus Effekt). Jedoch wurde diese Annahme bislang nicht direkt empirisch überprüft.

In der vorliegenden Arbeit untersuche ich eine alternative fluency-Darstellung des von Topolinski und Kollegen (2014) beschriebenen Rein-Raus Effekts. Genauer ge-

sagt, stelle ich die Hypothese auf, dass die Verarbeitungsflüssigkeit unabhängig davon, ob Annäherungs- und Vermeidungsmotivationen aktiviert werden, eine entscheidende Rolle für die Entstehung des Rein-Raus Effektes spielen könnte.

In Kapitel 1 führe ich das allgemeine Thema meiner Dissertation ein, gefolgt von einer detaillierten Vorstellung des Forschungsbereichs der Annäherungs- und Vermeidungsmotivationen (Kapitel 2). In Kapitel 3 grenze ich das Thema auf oral induzierte Annäherungs- und Vermeidungsmotivationen ein (Topolinski et al., 2014), die das Hauptthema meiner Dissertation darstellen. In Kapitel 4 stelle ich den Forschungsbereich vor, der ökologische Einflüsse (z.B. Sprache) auf psychologische Prozesse untersucht. Dieses Kapitel bildet die Grundlage für meine These, dass die menschliche Sprache selbst als eine Quelle der Verarbeitungsflüssigkeit im Rein-Rauseffekt fungieren könnte. Im darauffolgenden Kapitel 5 führe ich den Forschungsbereich zur Verarbeitungsflüssigkeit näher aus, da dessen Rolle bei der Entstehung des Rein-Rauseffekts in meiner Arbeit untersucht wird.

Nach einem Überblick über meine empirische Arbeit in Kapitel 6, beginnt der empirische Teil mit den Studien 1a und 1b (Kapitel 7). Diese haben das Ziel zu untersuchen, ob die zwei Sprachen (Englisch und Deutsch), in denen der Rein-Raus Effekt bislang gefunden wurde, eine Quelle der höheren Verarbeitungsflüssigkeit für Rein- im Vergleich zu Rauswörtern darstellen können. Die Ergebnisse zeigen in beiden Sprachen ein häufigeres Vorkommen von konsonantischen Reindynamiken gegenüber Rausdynamiken. Diese Ungleichverteilung der Häufigkeiten könnte eine höhere Aussprechflüssigkeit von Reinwörtern gegenüber Rauswörtern zur Folge haben, was wiederum die Grundlage dafür sein könnte, dass Reinwörter gegenüber Rauswörtern präferiert werden.

In Kapitel 8 wurde die Annahme überprüft, ob Reinwörter verglichen mit Rauswörtern eine höhere Verarbeitungsflüssigkeit haben. In mehreren Experimenten wurde die objektive und subjektive Verarbeitungsflüssigkeit von künstlich konstruierten Non-Wörtern untersucht, die reine konsonantische Rein- oder Rausdynamiken enthielten. In den Studien 2a und 2b sind Probanden tatsächlich schneller darin, eine offene Artikulation von Reinwörtern verglichen mit Rauswörtern zu initiieren. In Studie 3 erfasst ein zweites objektives Verarbeitungsflüssigkeitsmaß durch die stumme Lesedauer, dass Reinwörter gegenüber Rauswörtern auch stumm schneller gelesen werden. Neben der objektiven Verarbeitungsflüssigkeit ist auch die subjektive Verarbeitungsflüssigkeit von Reinwörtern höher als die von Rauswörtern (Studien 4a und 4b).

In Kapitel 9 wurde die mögliche kausale Rolle von objektiver und subjektiver Verarbeitungsflüssigkeit für den Einfluss von konsonantischen Rein- und Rausdynamiken auf Wort-Präferenzen untersucht. In Studie 5 wurden diesbezüglich Mediationsanalysen auf Item-Ebene mit objektiver und subjektiver Verarbeitungsflüssigkeit als mögliche mediierende Variablen berechnet. Für subjektive Verarbeitungsflüssigkeit konnte die Mediation nicht vollständig berechnet werden, da, wahrscheinlich auf Grund niedriger statistischer Teststärke, eine Voraussetzung für die Analyse nicht gegeben war. Für die objektive Verarbeitungsflüssigkeit stimmen die Daten nicht mit der erwarteten Mediation überein. In Studie 6 wurden Mediationsanalysen für subjektive Verarbeitungsflüssigkeit auf Probanden- und Trial-Ebene mit Daten aus einem Within-Subjects Design durchgeführt. Eine partielle Mediation von subjektiver Verarbeitungsflüssigkeit wurde auf Probanden- und Trial-Ebene gefunden. Insgesamt zeigen die Mediationen aus beiden Studien keine eindeutigen Befunde. Daher wurde in den letzten beiden Studien eine experimentelle Manipulation von Verarbeitungsflüssigkeit realisiert.

Die in Kapitel 10 berichteten Studien 7 und 8 zeigen, dass eine experimentelle Manipulation der Verarbeitungsflüssigkeit tatsächlich Auswirkungen von konsonantischen Rein- und Rausdynamiken auf Wort-Präferenzen moduliert. Die Artikulationsleichtigkeit wurde vor der Evaluationsphase induziert, indem Probanden Rein- oder Rausdynamiken durch Wiederholung in einer Kurzzeitgedächtnis-Aufgabe trainierten. Zusätzlich wurde dieses Simulationstraining in Studie 8 intensiviert, um festzustellen, ob man eine stärkere Modulation des Rein-Raus Effektes finden kann. Das Trainieren von Rausdynamiken führte zu einer Abschwächung des Rein-Raus Effektes (Studie 7) und nach dem intensiveren Training sogar zu einer Umkehrung des Effektes (Studie 8). Das Trainieren von Reindynamiken hingegen führte zu einer Verstärkung des Rein-Raus Effektes. Diese Ergebnisse deuten auf die Gültigkeit meiner Hypothese, dass Präferenzen für Rein- und Rauswörter - zumindest partiell - durch die Verarbeitungsflüssigkeit von Rein- und Rauswörtern beeinflusst sind.

Nahezu alle Studien meiner Arbeit (Studien 1a, 1b, 2a, 2b, 3, 4a, 4b, 6, 7, 8), außer der item-basierten Mediation aus Studie 5 (zur objektiven Verarbeitungsflüssigkeit), sprechen für meine Hypothese, dass Reinwörter gegenüber Rauswörtern sowohl subjektiv als auch objektiv leichter artikulierbar sind und möglicherweise teilweise aus diesem Grund auch präferiert werden. Die Ergebnisse werden in Kapitel 11 mit Bezug auf Konklusionen für Verarbeitungsflüssigkeit und Annäherungs- und Vermeidungsmotivationen als zugrundeliegende Mechanismen und mit Bezug auf die Rolle der Sprache als einen ökologischen Einfluss diskutiert. Zum Abschluss wird ein Ausblick auf mögliche Folgestudien gegeben.

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You made me achieve this.

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CHAPTER 1 - General Introduction

Everyone who has felt the responsibility of choosing names for children knows that this can be preceded by a very difficult decision-making process. You always want the best for your children and therefore, you also want perfect names for them. A name should sound and feel good and maybe should even remind you of a special person, but also leave a wide scope for their own development of identity. You do not want your children to be bullied in school, because their names sound funny. You do not want them not to be taken seriously as future managers of respectable companies, because their names sound cute. Lots of aspects can be pondered on.

Also for global trade names or brand names, name-giving is often preceded by a difficult decision-making process. Many companies try to choose artificially created names that can easily be pronounced in various languages. For instance, the company-names *Zalando, Skype, Ansons*, and *Caleido* can easily be pronounced in German, English and French. In contrast, when my brother and his wife started their own company 20 years ago, they chose a terribly long and complicated name that included our Persian surname *Bakhtiari* which rarely is pronounced correctly by their average German customers who mostly do not speak Persian. I tried to convince them that changing the company name to a more fluent one (i.e., easier to pronounce) could be beneficial for the success of their company. My dissertation basically shows how important the ease of pronunciation for a name-giving decision can be.

A broad range of psychological research has found that easy processing is intrinsically experienced as positive (e.g., Diener, Larsen, Levine & Emmons, 1985; Reber, Schwarz & Winkielman, 2004; Topolinski & Strack, 2009a, 2010; Whittlesea & Williams, 1998; Winkielman & Cacioppo, 2001), which has been shown with physiological measures (e.g., EEG, EMG; Harmon-Jones & Allen, 1996, 2001; Topolinski, Likowski, Weyers, & Strack, 2009; Topolinski & Strack, 2015; Winkielman & Cacioppo, 2001) as well as with explicit self-reports (e.g., Monahan, Murphy, & Zajonc, 2000; Zajonc, 1968). Due to this positive feeling, easy processing (e.g., easy pronunciation) can have profound influences on preferences for names (e.g., Laham, Koval, & Alter, 2012; Song & Schwarz, 2009). For instance, English speaking participants prefer the surname *Sherman* over *Leszczynska*.

Topolinski, Maschmann, Pecher, and Winkielman (2014) have proposed another mechanism that also influences word perception. Given the fact that consonants are articulated on distinct spots on the sagittal plane of the mouth (e.g., K is articulated in the back and B in the front), it is possible to construct words that feature peristaltic wanderings of articulation spots from the front to back or from the back to front of the mouth. Across several experiments Topolinski et al. (2014) found that words featuring consonantal inward wanderings (inward words) were preferred over words featuring consonantal outward wanderings (outward words). They argued that this was due to the fact that approach and avoidance motivations are activated by articulating inward and outward words, respectively. Specifically, approach or avoidance motivations could be evoked by mere pronunciation of words featuring consonantal inward or outward wanderings, because the pronunciation resembles approach and avoidance behaviors of swallowing and spitting, respectively. We tend to approach objects we like, and avoid objects that we do not like (for an overview, see Elliot, 2008). Topolinski et al. (2014) suggested this close link as an underlying mechanism for the effect that we prefer inward words over outward words (in-out effect), but did not test this directly.

However, I propose an alternative account for this finding. Specifically, I argue in my dissertation that the previously introduced ease or pronunciation may play a crucial role in the in-out effect described above. There are several reasons why inward words might be easier to pronounce than outward words. If this can be found to be true, then processing ease can provide completely different explanation of the in-out effect.

Therefore, in the current work I investigated systematically the role of processing ease in the in-out effect reported by Topolinski et al. (2014). In eight studies I tested whether consonantal inward wanderings are more fluently processed than consonantal outward wanderings. Moreover, I examined where this fluency might originate from, and what role it plays for the underlying mechanisms of the in-out effect.

First, a potential linguistic source of fluency was examined in the two languages where the in-out effect has been found originally, namely English and German. I expected to find in both corpora, for English and German, that there are more consonantal inward than outward kinematics. Second, I tested experimentally whether inward words are overtly as well as silently easier to articulate than outward words. I hypothesized inward words to be easier to be articulated than outward words. Third, I examined whether subjective fluency might also differ in inwards and outward words. I hypothesized that inward words would also be subjectively experienced as being easier to pronounce than outward words. Fourth, I planned to test by means of mediational analyses whether processing fluency in the form of subjective processing fluency as well as objective processing fluency would partially or completely mediate the influence of consonantal inward and outward kinematics on preference for inward and outward words. For all mediational analyses I expected that objective as well as subjective fluency would mediate the effect of consonantal inward and outward kinematics on preference for inward and outward words. Finally, because of advantages of interaction testing over mediation testing, I tested whether higher preferences of inward words over outward words can be influenced by fluency gains. I hypothesized that fluency gains for outward words would result in more positive evaluations of outward words than inward words, whereas fluency gains for inward words would result in a stronger classic in-out effect.

In the following chapters, a theoretical basis for the empirical work is created by introducing the concept of approach and avoidance motivations in general, as well as oral approach and avoidance as a specific instantiation. Thereafter, the role of language and processing ease are elaborated for an alternative account of the in-out effect. After the empirical chapters, the results are discussed, compared to the previously introduced theoretical concepts and then discussed with respect to future research on that topic.

Coming back to my examples, I can fortunately tell a happy end. After years of talking insistently to my brother and his wife, they finally changed the name of their company into an easy-to-pronounce name. For the name-giving of their daughter, no advice was necessary because they made the best decision they could have made. *Sara* is not only an inward wandering word, but is also easily pronounced in all languages that are spoken in her family, namely German as well as Persian and Portuguese (even though, these might not be the most important reasons she is loved endlessly by her family).

CHAPTER 2 - Approach & Avoidance

One of the most fundamental and widely researched concepts in the study of human emotion, cognition, and behavior is that of approach and avoidance motivation. An interdisciplinary field of biological, cognitive, personality and social psychology explores these motivational states and has developed various viewpoints on this field of study.

From the literature one can deduct concordantly, for instance, that stimuli can elicit two different motivations: appetitive stimuli induce approach and aversive stimuli induce avoidance motivation, respectively (e.g., Cacioppo, Priester, & Bernston, 1993; Carver & Scheier, 1990; Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Gray, 1987; Higgins, 1997; Lang, Bradley, & Cuthbert, 1990; Miller, 1944; Neumann, Förster, & Strack, 2003; Strack & Deutsch, 2004; Young, 1959; for an overview see Elliot, 2008). Approach can be defined as moving toward or keep a positively valenced object, whereas avoidance can be defined as moving or staying away from a negatively valenced object. This can involve changing actual physical distance (e.g., stepping back from a dangerous looking person) or psychological distance (e.g., ending a bad relationship). Discriminating when to approach and when to avoid a stimulus is one of the primary and most elemental responses of an organism to its environment (e.g., Zajonc, 1998). In order to survive, an adaptive functioning organism needs to orient itself according to these two basic principles - towards rewards and incentives, and away from punishments and threats.

Approach and avoidance motivational states can be examined from various viewpoints. On the one hand, there is research focusing on spontaneous reactions proposing that the valence of a perceived stimulus automatically determines the motivational orientation without any higher intentional mechanisms (Gray, 1987; Lang et al., 1990; Neumann et al., 2003; Strack & Deutsch, 2004). Here, motivation orientations can switch dynamically between approach and avoidance depending on changes in the environment and the focus of attention. This mechanism enables an organism to adapt to a rapidly changing environment and thereby promotes survival. On the other hand, research that focused on goal-directed behavior proposes that currently activated goals determine which motivational system will be activated (Carver & Scheier, 1990, 1998; Higgins, 1997, 1998). Then, the activated system will prevail throughout the whole episode of goal pursuit (towards incentives, away from threats) and meanwhile influence emotion, cognition, and behavior.

Two other lines of research that can be identified in the literature show the bidirectionality of the link between the valence of a stimulus and the bodily state of approach and avoidance responses. On the one hand there are studies demonstrating that the valence of a stimulus (positive versus negative) has an influence on behavioral tendencies of approach and avoidance (e.g., Solarz, 1960). Therefore, in the following sections the biological basis of motivational orientations is introduced, its relation to evaluative processes as well as some experimental support for facilitated behavioral tendencies. On the other hand there are studies showing that approach and avoidance body movements influence the experienced valence of a concurrently presented stimulus (e.g., Cacioppo et al., 1993). Therefore, in the following there will be an excursus on the embodied cognition theory and according experimental operationalizations of approach and avoidance. However, there are also studies claiming that evaluative processes are not strictly tied to the bodily feedback about approach and avoidance behaviors but rather to the valence labels of the movement (e.g., Eder Rothermund, 2008; Seibt, Neumann, Nussinson, & Strack, 2008).

The current work is about a specific instantiation of an approach and avoidance response, namely oral approach avoidance. To be able to integrate it into the general field of approach and avoidance motivation, these different accounts of approach and avoidance motivation are elaborated more specifically in the following sections.

2.1 Neurophysiology and Neurobiology of Approach & Avoidance

From a neurophysiological point of view, there is an ongoing debate whether approach and avoidance behaviors can be associated with frontal cerebral asymmetry. There is a broad range of studies suggesting that there may be a neurological basis of approach and avoidance motivation. The first studies suggesting this were observations in patients with right or left frontal cortex lesions (e.g., Gainotti, 1972, 1989). Patients with left frontal cortex lesions showed more depressive symptoms, whereas patients with right frontal cortex lesions showed more manic symptoms. This led to the conclusion that left and right frontal cortex regions are associated with specific emotional processes that should lead to differing cerebral activation in healthy participants. This hypothesis has been predominantly studied with EEG measurements because they have been shown to be a useful noninvasive technique with a high temporal resolution. Therefore, there is a huge amount of EEG studies suggesting that avoidance behavior and negative affect may predominantly be associated with right prefrontal brain activity and that approach and positive affect may be associated with left prefrontal activity (e.g., Davidson, 1992, 2002; Davidson & Irwin, 1999; Davidson, Marshall, Tomarken, & Henriques, 2000; Davidson et al., 1990; Harmon-Jones, 2003; Murphy, Nimmo-Smityh, & Lawrence, 2003; Pizzagalli, Sherwood, Henriques, & Davidson, 2005; Sobotka, Davidson, & Senulis, 1992; Sutton & Davidson, 1997).

However, a more complex case is that of the emotion of anger, because it cannot be classified within the category of either negativity and avoidance behavior, or within that of positivity and approach behavior. It is partially related to both, specifically, negativity and approach behavior, and seems to be associated to left prefrontal activity (Harmon-Jones, 2003, 2004; Harmon-Jones & Allen, 1998; Harmon-Jones & Sigelman, 2001). Therefore, some researchers suggested that frontal cerebral asymmetry might not reflect valence categories of positivity and negativity but rather motivations of approach and avoidance. However, it should also be noted that initial approach behavior in the case of anger is mostly intended to enable an avoidance behavior subsequently (e.g., Krieglmeyer & Deutsch, 2013).

In contrast, other studies suggest that cerebral asymmetry might reflect neither valence categories nor motivational orientations but rather motivational *intensity* (Gray & McNaughton, 2000). In this vein, behavioral activation seems to be associated with activation in the left anterior brain region and behavioral inhibition seems to be associated with activation in the right anterior brain region.

Concluding, there is a high amount of research on cerebral asymmetry and on the neurological basis of approach and avoidance behavior. Taken together they provide rather mixed results about the cerebral asymmetry of approach and avoidance. Therefore, future research is needed to elaborate a more conclusive framework.

2.2 Reflex-like Functions of Approach & Avoidance

Automatic approach and avoidance behavior tendencies are crucial for human survival because they facilitate avoiding threats as well as approaching and securing rewards. Early information processing about the nature of a perceived stimulus enables the perceiver to prepare to react quickly in an adaptive manner. For instance, Konorski (1967) assumed that motivations and emotions share a reflex-like basis and that there are reflex-like behavioral tendencies that play a crucial role in human survival. He suggested a two-system organization of preservative and protective motivational and emotional states. Accordingly, there are approach-associated *preservative emotions* like, for instance, joy, sexual passion, and nurturance, and according *preservative motivations* like ingestion, copulation, nurture and progeny. Moreover, there are avoidance-associated *protective emotions* as, for instance, fear, and *protective motivations* like the withdrawal from pain and rejection of noxious agents. Consistent with this notion that approach and avoidance motivations are adaptive and crucial for survival, human beings show reflex-like behaviors that can be considered as manifestations of approach and avoidance behaviors.

One of most prominent behaviors that is often studied as a measure of avoidance behavior is the so called *startle reflex* (e.g., Lang et al., 1990). The startle reflex is an eye-blink response that is involuntarily activated within 30-50ms of a very intense stimulus onset (e.g., electric shock, loud noise). It serves as the function of defending against eye injuries as well as facilitating escape responses. Generally, studies have demonstrated that the blink magnitude of the startle reflex is increased when participants are presented unpleasant stimuli whereas it is reduced when pleasant stimuli are presented (e.g., Bradley, Cuthbert, & Lang, 1999; Dichter, Tomarken, Shelton, & Sutton, 2004). Moreover, it has been shown that arousal modulates this effect. Specifically, the magnitude of the startle reflex is higher the more arousing negative stimuli are, whereas the magnitude gets lower the more arousing positive stimuli are.

Hence, approach and avoidance motivational states seem to affect basal processes that evoke reflex-like behaviors like, for instance, withdrawing ones' hand from a hot cooking plate or the well-studied startle reflex.

2.3 The Link of Approach & Avoidance to Evaluations

In line with the notion that approach and avoidance motivations are crucial for survival, studies have shown that automatic positive or negative evaluations of probably every stimulus that is encountered occur immediately and without intention, awareness, or much effort being executed (e.g., Bargh, 1997; Bargh, Chaiken, Raymond, & Hymes, 1996; Fazio, 2001; Zajonc, 1998). That is, the mere perception of a stimulus may automatically evoke an evaluation ranging from positive to negative.

For example, even perceiving positively or negatively valenced human facial expressions for only 10ms automatically evokes an accurate evaluation process (e.g., Murphy and Zajonc, 1993; Niedenthal, 1990). Thus, perceiving valenced stimuli even under circumstances which do not allow elaborate conscious processing leads to a nonspecific but often correct feeling. Aside from its immediate and effortless character, automatic positive or negative evaluations are closely linked to a tendency of approaching or avoiding the evaluated stimuli (e.g., Chen & Bargh, 1999; Damasio, 1999; Duckworth, Bargh, Garcia, & Chaiken, 2002; Fazio, 1989; Roskos-Ewoldsen & Fazio, 1992). This connection can also be regarded as valid for slow and reflective evaluations (e.g., Ajzen, 1991; Bandura, 1986; Deci & Ryan, 1985), as long as participants have no other motivation to withhold true preferences or behavioral motivations (e.g., because of social desirability). Overall, there is a broad range of research showing that what is openly expressed to be liked or disliked often is tightly related to what the relevant motivational behavior tendencies toward that objects are.

Mostly, positive evaluations lead to positive emotions that facilitate approach behaviors, whereas negative evaluations lead to negative emotions that facilitate avoidance. However, as mentioned previously, there is a specific emotion where this connection is the exact opposite to what is described above. In the case of anger the close associations of negativity and avoidance as well as of positivity and approach are violated. Anger is a negative emotion that can be described with adjectives like being angry, annoyed or enraged. It is often a consequence of an unpleasant situation that triggers a fight response (e.g., due to missing escape option) and an emotion of anger in contrast to a flight response (e.g., due to possible escape option) and an emotion of fear. That is, instead of causing avoidance, anger often leads to an approach motivation which in turn results in reducing distance towards a threat (e.g., Ekman & Friesen, 1975). Not only attacking behavior (Berkowitz, 1993) but also increased task engagement (Lewis, Sullivan, Ramsey, & Allessandri, 1992) can result from anger and can both be considered as initial approaching behavior.

However, it is crucial to note that this can also vary. For instance, Krieglmeyer and Deutsch (2013) demonstrated that angry faces evoke directly an avoidance response when aggression is not an available response option. Moreover, they showed that that angry faces elicit approach when the behavior is interpreted as aggression, whereas they trigger avoidance when it is interpreted otherwise (e.g., affiliation). They conclude that both responses serve the goal to increase distance to an angry opponent. Thus, one might conclude that anger and approach are linked for the initial short-term reaction. The initial distance reduction (fight response) is usually intended to enable an increase of distance subsequently (flight response).

Furthermore, Krieglmeyer, Wittstadt and Strack (2009) have demonstrated that when unintentionality plays a role, behavioral aggressive approach tendencies can be controlled whereas implicit anger still persisted. This is in line with the assumption that anger is evoked by unpleasant experiences independent from the appraisal of the situation (e.g., Berkowitz, 1993); and nicely demonstrates that rational processes mainly influence behavior, whereas impulsive processes stay unaffected (e.g., Strack & Deutsch, 2004).

To conclude, automatic as well as reflective evaluations are closely connected to relevant emotions and motivational behavior tendencies of approaching positively evaluated stimuli and avoiding negatively evaluated stimuli (except for anger).

2.4 Affect Elicits Approach & Avoidance Motor-Responses

The first experimental support for behavioral approach and avoidance tendencies being evoked by the valence of a stimulus has been provided by Solarz in 1960. In a pioneering experiment he studied congruency between movement tendencies and valence. He showed that automatic arm flexion (approach) and arm extension (avoidance) responses to positively and negatively valenced stimuli differed in speed. Participants' task was to evaluate positively and negatively valenced words presented on cards on a movable stage by means of pushing or pulling a lever on the stage. Reaction times of those movements indicated that participants were faster at pulling positive words towards themselves and pushing negative words away (cf. Chen & Bargh, 1999; Duckworth et al., 2002; Rotteveel & Phaf, 2004). Thus, compatibility of movements and valence regarding an object led to faster reaction times.

Here, it was shown for the first time that the response time of the movement itself can be used as an indicator of compatibility of a movement in relation to an object and the valence that is inherent to the object. Today, this method is still a common method used in experimental psychology. For instance, Chen and Bargh (1999) replicated this finding in a similar paradigm where participants had to pull or push a lever toward or away from themselves in order to evaluate words that were presented on a computer screen. In line with Solarz's (1960) findings, push movements with the lever were relatively faster when negative words were presented, whereas pull movements were relatively faster when positive words were presented. Thus, participants' reaction times were faster in compatible than in incompatible situations.

Overall, these studies suggest that the positive or negative valence of a stimulus can facilitate approach or avoidance movements, respectively. In contrast, there is also another line of research studying the reverse causal relation (movements evoking affect) which is elaborated in more detail in Chapter 2.7. After these very first studies mentioned in the current chapter, a huge amount of studies on the motivational orientations of approach and avoidance have been conducted. In that process discussions and disagreement within contrary accounts evolved that are briefly introduced in the following sections.

2.5 Discussions of Approach & Avoidance Accounts

The broad range of studies that has been conducted to get insight about the nature of approach and avoidance behavioral tendencies can be roughly divided into three possible views (for a review see, Krieglmeyer, De Houwer, & Deutsch, 2013), namely the *specific-muscle-activation account* (e.g., Cacioppo et al., 1993), the *distance-change account* (e.g., Seibt et al., 2008), and the *evaluative response coding account* (Eder & Rothermund, 2008). All three accounts are explained and contrasted in the following.

First, there is the *specific-muscle-activation account*, which proposes that the bodily feedback of specifics muscle movements of arm extensions (i.e., avoidance) are directly associated to negative stimuli evaluations, whereas specific muscle movements of an arm flexions (i.e., approach) are specifically associated to positive stimuli evaluations (e.g., Cacioppo et al., 1993; Centerbar & Clore, 2006; Chen & Bargh, 1999; Cretenet & Dru, 2004; Neumann & Strack, 2000; Rotteveel & Phaf, 2004; Solarz, 1960). Accordingly, it is proposed that positively evaluated stimuli generally facilitate arm flexions, whereas negatively evaluated stimuli generally facilitate arm extensions. For instance, Rotteveel and Phaf (2004) demonstrated in an evaluation task that independent of whether a movement changed the distance between the perceiver and the stimulus, participants were faster to respond with an arm flexion to positive stimuli and faster to respond with an arm extension to negative stimuli. However, these specific movement-facilitation effects cannot be assumed to be completely automatic, as it has been suggested by some prior studies (e.g., Chen & Bargh, 1999), because they only occurred when participants had the goal to evaluate the valence of presented stimuli (Rotteveel and Phaf, 2004).

Second, there is the *distance-change account*, which proposes that the valence of stimuli can cause a facilitation of movements that decrease (i.e., approach) or increase (i.e., avoidance) distance between the evaluated object and the perceiver (e.g., Markman & Brendl, 2005; Schneirla, 1959; Seibt et al., 2008; Strack & Deutsch, 2004). Accordingly, it is proposed that positively evaluated stimuli generally facilitate any movement that will decrease distance to them, whereas negatively evaluated stimuli generally facilitate any movement that will increase distance to them. In line with that, Seibt et al. (2008) demonstrated that independent from arm flexion or extension, participants were faster to respond with a movement that decreased distance to a positive stimulus, and were faster to respond with a movement that increased distance to a negative stimulus (for arbitrary key responses evoking distance change see, De Houwer, Crombez, Baeyens, & Hermans, 2001). Importantly, in contrast to movement-facilitation effects the distance-change facilitation effects seem to occur automatically, given the fact that they can be found even when participants do not have the goal to evaluate the valence of presented stimuli (Krieglmeyer & Deutsch, 2010), or to change distance to an object (Krieglmeyer, Deutsch, De Houwer, & De Raedt, 2010). Moreover, Krieglmeyer, De Houwer, and Deutsch (2011) have demonstrated that the ultimate distance change is more important than the immediate direction of distance change.

Finally, there is the *evaluative response coding account* by Eder and Rothermund (2008), who argue that that evaluations are neither restricted to particular movements (e.g., arm-flexion and positivity) nor to specific functions of a movement (e.g., distance regulation). They propose that the modulation of behavior by valence can be found in all kinds of behaviors that are ascribed evaluative codes (see also, Lavender & Hommel, 2007). This means that dependent on the evaluative coding, one and the same movement can be highly positive in the one condition but also highly negative under different circumstances. In a series of experiments they demonstrated that classic approach avoidance operationalizations (e.g., lever movements) can lead to opposite results when response labels within instructions were of opposite valence (e.g., towards turned into downwards and away into upwards). Thus, their results support their assumption that the valence implicated by an action instruction and its specific goal led to valenced codes ascribed on movements on a representational level. Therefore, a movement is facilitated when the valence of the movement matches the valences of the stimulus.

Interestingly, Krieglmeyer et al. (2010) contrasted the distance-change account to the evaluative response coding account in a study, in which the direction of distance change and the evaluative coding of the respective response were manipulated independently from each other. Accordingly, both positively as well as negatively coded responses could imply approach or avoidance responses, respectively. The results nicely demonstrated that, in line with the distance-change account, positive stimuli facilitated distance decreasing responses, whereas negative stimuli facilitated distance increasing responses, irrespective of whether an evaluation goal was active or not. However, in line with the evaluative response coding account, it was shown that positive stimuli facilitated positively labeled responses, whereas negative stimuli facilitated negatively labeled responses. Moreover, the latter influence vanished when there was no evaluation goal active. Drawing on these findings, Krieglmeyer et al. (2010) conclude that the valence of a stimulus can automatically elicit approach and avoidance behavioral tendencies, whereas this automaticity cannot be assumed for the effect of valenced stimuli on affectively labeled responses.

Overall, it is to conclude that positive and negative stimuli automatically but also flexibly elicit approach and avoidance behaviors, speaking in favor of the distance-change account as well as the evaluative response coding account. This is in line with the notion that emotions have an adaptively value because they can cause behavioral tendencies that might be crucial for promoting survival (e.g., Zajonc, 1998).

2.6 Excursus on Embodied Cognition

In contrast to the notion that the positive or negative valence of a stimulus can evoke a specific motor-response of approach or avoidance, there also the notion that a motor-response of approach or avoidance can evoke positive or negative affect, respectively. To introduce the latter line of research in Chapter 2.7, it is valuable to first make an excursus into embodied cognition theory. Therefore, in the following section, the embodied cognition theory is explained with examples from various domains.

There is a long history of the notion that in general bodily states can influence cognition and emotion. In his classic work, William James (1884) already claimed that "*bodily changes follow directly the perception of the exciting fact, and that our feeling of the same changes as they occur IS the emotion. … We feel sorry because we cry, angry because we strike, afraid because we tremble…*". Today, more recent accounts with similar notions of bodily states are still prevailing. There is an enormous amount of embodied cognition research supporting the notion that bodily states affect cognitive and emotional states in various ways (e.g., Barsalou, 1999, 2005, 2008; Niedenthal, 2007; Damasio, 1989; Glenberg, 1997; Körner & Strack, 2015; Körner, Topolinski, & Strack, 2015; Semin & Smith, 2004; Smith & Semin, 2008). This theory is crucial for understanding the influence of motor actions on affect, which is the assumed basic mechanism in the current work. Therefore, several examples are provided in the following, which are not directly related to approach and avoidance motivations, but instead help to understand the theory of embodied cognition in general.

For instance, Mussweiler (2006) showed, similar to William James' idea, that stereotypic movements can activate the corresponding stereotypes. Participants who were unobtrusively prompted to move in the stereotypic manner of overweight people ascribed in a following task more characteristics that are stereotypic to overweight people to a target person than did participants in the control condition. Specifically, he showed that participants who were unobtrusively prompted to move in a stereotypic slow manner of elderly people ascribed in a following task more characteristics that are stereotypic to elderly people to a target person than did participants in the control condition and were faster than control participants in responding to elderly-stereotypic words in a lexical decision task. Thus, the body movement itself changed semantic activation of movement-related stereotype information.

Another prominent example comes from Stepper and Strack (1993), who showed that body postures can change emotional and nonemotional feelings. Participants who received positive feedback on their task performance in an upright body posture reported greater feelings of pride than participants who received the same feedback in a slumped posture. This means that merely the upright vs. slumped positioning of their torso together with the positive vs. negative feedback could influence their emotional experiences. Moreover, Stepper and Strack showed that experienced effort of a task as well as self-judgment of self-assurance was a function of facial muscle contractions of the corrugator (furrowing the brow) vs. the zygomaticus (light smile). Thus, the mere facial expression of participants together with the self-judgment made them feel more or less exhausted. In their explanation they refer to Darwin's (1872/1965) claim that the erectness of posture might be closely connected to the feeling of pride. Overall and in line with an embodied view of cognition, it was shown that bodily feedback had an influence on emotional and nonemotional feelings.

One of the most groundbreaking studies in that line of research was probably the classic pen study by Strack, Martin, and Stepper (1988). Participants were asked to and hold a pen either between their teeth (activating the zygomaticus major muscle) or between their lips (inhibiting the zygomaticus major muscle), ostensibly to study substitution processes in physically impaired people. Then they were asked to fill out a paper pencil questionnaire with the pen in their mouth. One of the tasks was to rate the funniness of four cartoons. The results indicated that holding the pen between their teeth led to higher funniness ratings than holding the pen between their lips. The suggested underlying mechanism is that an automatic smiling simulation has been triggered resulting in respective affective ratings. In their argumentation they refer to Darwin's (1872) notion that "*in the presence of an eliciting emotional stimulus a person's emotional experience can be either strengthened or attenuated, depending on whether it is or is not accompanied by the appropriate muscular activity*" (Strack et al., 1988; p. 768). Thus, the bodily sensation of smiling made participants experience more positivity with respect to the evaluated stimuli.

Other studies have shown that the bodily feedback about the physical weight of an object (light vs. heavy) can influence the psychological weight, this is, the perceived significance of an object (Jostmann, Lakens, & Schubert, 2009; Schneider, Rutjens, Jostmann, & Lakens, 2011). For instance, when participants had to hold a heavy clip-board while making judgments of the value of an object, their judgments were higher than while holding a light clipboard. They also found that a heavy weight caused more elaborate thinking than a light weight, suggesting that participants invested more cognitive effort in dealing with the heavy object than with the light object. In line with embodied cognition theory, the authors explain these phenomena by the close link to the fact that people have to exert more physical effort to deal with physically heavy objects than with physically light objects. Also here, bodily feedback had an influence on mental processes.

There are also studies investigating different modalities. For instance, Lee and Schwarz (2012) showed that a slight smell of fish induced suspicion and undermined cooperation in social interactions. Additionally, they showed that there is also a bidirectional link between the olfactory sensation of a fishy smell and suspicion. Induced social suspicion increased the correct categorization of a fishy smell in comparison to other smells. This link was mediated by the accessibility of the metaphorical concept of fishy smells referring to social suspicion; and moderated by the applicability of that concept. Again, it was demonstrated that bodily sensations like smelling have an impact on social cognition as well as the other way round, social cognition can have an impact on the sensitivity of our senses.

In sum, one can conclude that there is a long history of the notion that various bodily sensations can influence human cognition and emotion, and also that there is huge amount of recent studies supporting the theory of embodied cognition. Research on approach and avoidance bodily states has also supported this theory profoundly, which is introduced in the following section.

2.7 Motor-Responses of Approach & Avoidance Elicit Affect

More than a hundred years after the theory of William James (1884) crucial work indicating an influence of approach and avoidance motor-responses on affect has been provided by Cacioppo et al. (1993). While looking at neutral Chinese ideographs, participants had to press their hands either on top of a table board (extending the arm – avoidance posture) or underneath it (flexing the arm – approach posture). The results showed that the evaluation of the Chinese ideographs afterward was dependent on the arm posture that was executed while perceiving it earlier. Ideographs that were accompanied with an arm extension were liked less than ideographs that were accompanied with an arm flexion. Thus, the bodily state affected the evaluation of the perceived stimuli.

There is a broad range of research showing that there is a bidirectional link between affective states of the mind and physical states of diverse bodily parts. Mostly, the emphasis has been placed on arm-, hand-, and finger-movements (e.g., Chen & Bargh, 1999; Caciopppo et al., 1993; Eder & Rothermund, 2008; Foroni & Semin, 2012; Krieglmeyer & Deutsch, 2010; Marsh, Ambady, & Kleck, 2005; Neumann, Hulsenbeck, & Seibt, 2004; Rinck & Becker, 2007; Seibt et al., 2008; Solarz, 1960; van Dantzig, Pecher, & Zwaan, 2008). But also eye movements, facial muscle movements (e.g., Lang et al., 1990; Niedenthal, Winkielman, Mondillon, & Vermeulen, 2009) and whole body movements have been investigated (Koch, Holland, Hengstler, & van Knippenberg, 2009).

For instance, Koch et al. (2009) found that stepping forward (approach) and stepping backward (avoidance) led to similar effects as previous approach and avoidance studies (e.g., Koch, Holland, & van Knippenberg, 2008). Specifically, they showed that stepping backward elicited higher cognitive control than stepping forward or sideward. It is assumed that cognitive control is recruited when stepping backwards because an avoidance motor-response elicits negative affect which signals that the situation may be problematic. To keep track of the potentially problematic situation and to be able to respond properly, cognitive control is enhanced (cf. Schwarz, 2002).

Interestingly, Neumann and Strack (2000) showed that body movements are not necessarily needed for triggering approach or avoidance motivational orientations. They demonstrated that merely by perceiving movements towards (away from) an object approach (avoidance) motivations are triggered leading to facilitated processing of positivity (negativity). Positive or negative word categorizations and lexical decisions were faster for participants who had the impression that they were moving toward or away from the computer screen, respectively. Thus, even the mere observation of the movement could induce motivational orientations.

Recently, a study introduced a novel bodily manipulation of approach and avoidance motivation (Topolinski et al., 2014) that is explained extensively in the following section.

CHAPTER 3 - Oral Approach & Avoidance

In the following part a novel bodily manipulation of approach and avoidance is introduced, which lays the ground for my current work.

Topolinski et al. (2014) argued that approach and avoidance motivations could be induced by mere oral motor kinematics. Until then, no such attempt had been published in the literature. The authors claimed that by means of oral motor kinematics approach or avoidance states can be evoked. The theoretical rationale behind that uses the fact that the mouth serves the functions of both ingestion and articulation (Rozin, 1999). Before explaining how the link between ingestion and articulation was used by Topolinski et al. (2014) as an explanation for oral motor kinematics evoking approach and avoidance states, the functions themselves (ingestion and articulation) are introduced in the next two following paragraphs.

3.1. Ingestion

Ingestion implies the consumption of substances via the mouth, such as eating and drinking (Rozin, 1999). Although there are also organisms that transport nutrients from the environment via a tissue interface (e.g., amoeba), in more complex organisms (e.g., mammals), nutrients mostly enter the body via a digestive system capable of transporting them through the organism (Miller, 1982). Rozin (1999) considers ingestion as part of the "*food system*", one of the evolutionary earliest and most fundamental functions of an organism. Rozin defines the body as "*a sheath of skin, penetrated by seven holes. The sheath and holes are a veritable playground of pleasure and pain*". Most of them are involved in material exchange between the body and the environment. The food system consists of several of those holes, whose interplay can be described as in the following.

The primary purpose of the food system is supplying the body with energy needed to survive and function (e.g., Pocock, Richards, & Richards, 2013; Rozin, 1999). To supply the body with energy, food and liquids are put into one hole (mouth) and passed along the esophagus to the stomach and intestines. There, the food is broken down to partially absorb nutrients into the body. As a consequence of this digestion procedure, energy is delivered to the body in the form of lipids, amino acids and glucose. A functioning body continuously consumes energy but cannot eat continuously without interruption. Therefore, it is crucial to store energy within the body for intervals between the supplies of energy. Most of the energy is stored as fats because fat has a relatively high energy storage capacity. The leftovers after the food breakdown are segregated from excretory holes at the other end (anus and urethra). For the current work the oral processes of ingestion is relevant, therefore, in the following the focus lays on them.

Ingestion involves two basic oral behaviors that promote survival, namely the intake of nutritive substances by means of deglutition and the ejection of harmful substances by means of expectoration (Heinjol & Martindale, 2008; Pocock et al., 2013; Rosenthal, 1999; Rozin, 1996, 1999; Troland, 1928). Both behaviors are crucial for organisms to survive. As described above, feeding the body with nutritive substances is crucial because organisms need energy to function, whereas protecting the body from harmful substances is equally crucial because they can undermine the functioning of a body. The oral processes of both behaviors are explained more precisely in the following.

Deglutition of substances features voluntary as well as involuntary sequential muscle movements wandering from the front to the rear of the mouth (Goyal & Mashimo, 2006). The deglutition process can be divided into three phases. First, there is an oral phase that is voluntary and involves moistening the food by saliva, masticating it and forming a bolus out of it (Duffy, 2007). In the final stage of the oral phase, the bolus is readily prepared to be moved forward into the pharynx by intrinsic muscles of tongue. Then, the pharyngeal phase begins, which is involuntary and in which other behaviors involving the pharynx are inhibited (e.g., breathing, coughing, vomiting). Other ducts (e.g., nasopharynx) are closed to prevent the bolus, for instance, from being aspirated. By means of peristaltic muscle contractions (pharyngeal stylopharyngeus, salpingopharyngeus and palatopharyngeus muscles) the bolus is moved forward into the esophagus. Finally, in the esophageal phase, which is involuntary as well, again via sequentially tensed and relaxed muscles (lower esophageal sphincter and superior, middle and inferior pharyngeal constrictor) the bolus is slowly pushed forward into the stomach.

In contrast, ejection of substances features involuntary sequential muscle movements wandering from the rear to the front of the mouth (Cummins, 1958; Goyal & Mashimo, 2006; Tintinalli, Cameron, & Holliman, 2010; Watcha & White, 1992). The ejection process can be divided into two phases. First, there is a phase called the retching phase, which can also be confused with spasmodic hiccups. Here, the abdominal muscles, the diaphragm and the muscles used in inhalation involuntarily contract in repetitive phases. Next, there is the expulsive phase in which strong and long lasting muscle contractions of the diaphragm and the abdomen cause severe pressure that is experienced in the stomach. As soon as the esophageal sphincter releases tension and the contractions of the diaphragm and the abdomen end abruptly the gastric content is ejected via the mouth or sometimes the nose. The last stage of latter phase can also be accompanied by voluntary mouth movements (e.g., spitting) involving, for instance, the buccinators muscle (also involved in puffing, sucking, whistling) as well as the tongue and the lips propelling out the gastric content (e.g., Fontana & Lavorini, 2006; Perkins, Blanton, & Biggs, 1977). This ejection process can also be enforced by the pharyngeal reflex (gag reflex) which can, for instance, be evoked by touching the back of the tongue, throat or tonsils or by trying to swallow objects that are too large (e.g., Davies, Stone, Kidd, & MacMahon, 1995). There are large interindividual differences regarding the sensitivity of this reflex ranging from individuals completely lacking the pharyngeal reflex to individuals who suffer from hypersensitivity. The pharyngeal reflex is known to protect from asphyxiation or accidental swallowing of objects. After the act of vomiting, in the so-called post-ejection phase, by means of autonomic and visceral processes the whole body turns into a rather passive and relaxing resting state (e.g., Watcha & White, 1992).

Both behaviors, deglutition and expectoration, are clearly linked to valence. Deglutition is mostly universally linked to positivity and expectoration mostly to negativity (Rozin, 1996).

The link between deglutition and positivity is also reflected by the fact that incorporation of substances is usually a voluntary and volitional act. Specifically, our body does not have to force us to incorporate substances because we mostly enjoy incorporation. Therefore, already newborns tend to ingest substances that they like and refuse to ingest substances that they do not like (e.g., pure water; Desor, Maller, & Andrews, 1975; Johnson & Harris, 1998). Rozin (1996) argues that although the pleasure that is experienced while eating or drinking is qualitatively different from pleasure that is experienced when perceiving aesthetic stimuli (e.g., music), the feeling conveys into the same subjective system. Across many cultures and eras, food intake is a crucial part of celebrating positive events. Whether during meaningful ceremonies mentioned in the Bible (e.g., The Last Supper), or the old Romans and Greeks celebrating with wine and various precious edibles, or wedding parties and anniversaries nowadays, food intake played and still plays a major role in the ceremony of special occasions. Of course, under specific circumstances the link between food and positivity might not be that obvious. The funeral feast, for instance, takes place after an extremely negative event, the funeral itself. It is integral part of the funeral ritual in various cultures and already in prehistoric times (e.g., Engels, 1998; Freybe, 1909; Reiz, 1796). Usually, the family members of the deceased person invite the funeral guests to a joint meal. However, the funeral feast itself still plays a rather positive role in the whole funeral ceremony. It provides the possibility to exchange good memories about the deceased person in an informal way and can promote alleviating the pain about the experienced loss. It can support strengthening social bonds and signalizes the bereaved that life will go on normally. Thus, the funeral feast might take place at very negative occasion but still plays a rather positive role, whereas in the following example the act of eating itself is rather negative.

In contrast, for patients suffering from eating disorders, like anorexia nervosa, food seems to be related to negative emotional arousal (e.g., Drewnowski, Pierce, & Halmi, 1988; Sunday & Halmi, 1990; for a review see Zhu et al., 2012). Patients suffering from anorexia nervosa have a distorted body image (heavier than they are) and typically restrict their food intake severely. Sometimes, their bodies are such undernourished that is leads to death (globally around 600 incidents in 2013; Ärnlöv & Larsson, 2014). They are intensely afraid of gaining weight and therefore, food intake poses a serious threat to their obsession of continuous weight loss.

The link between expectoration and negativity, on the other hand, is also supported by the fact that expectoration of substances is usually a non-voluntary act (but sometimes also voluntary after intake of emetics, touching the pharyngolaryngeal region; e.g., Decker, 1971). Specifically, our body needs to force us to expectorate substances because we generally detest expectoration. After emesis there is usually an unpleasant burning feeling in the esophagus and mouth, caused by the high concentration of acid that vomit contains. The phase before the act of emesis is also often accompanied by a negative anticipatory feeling of nausea. Vomiting can be caused, for instance, by the ingestion of emetics for medical reasons, alcohol intoxication, gastric inflammation, food allergies, overeating, or migraine, but also by simply observing or hearing that another person is vomiting. From an evolutionary perspective this seems to be an adaptive mechanism, because if one member of a group got intoxicated by food that was usually shared within a group, it might have been advantageous for the other members to vomit as well. Not only the act of vomiting bears clearly negative experiences, but also the product of vomiting, this is, vomit itself consists of substances (e.g., gastric secretions, acid, sometimes blood and fecal substances) that should be avoided to prevent diseases. Therefore, it is highly adaptive that there is a specific emotion that moderates between deglutition and expectoration of food, namely *disgust* (Rozin, 1999; Rozin, Haidt, McCauley, & Imada, 1997; for an overview, see Rozin, Haidt, & McCauley, 2000). Rozin (1996) even states that "*disgust began, both phyloge-*

netically and ontogenetically, as part of a food rejection system". Today, there the range of disgust elicitors (e.g., sensory, social, moral) has broadened beyond food rejection dependent on individual and cultural experiences.

Thus, also for expectoration accompanied by the feeling of nausea, one can say that across many cultures it is negatively associated. However, there are also specific circumstances under which the subsequent consequences of expectoration can be linked to positivity. In ancient Rome, for instance, Seneca described that intended vomiting was a recurring behavior performed in the higher elite during extravagant banquets in order to be able to eat more (e.g., Lowenberg, Todhunter, Wilson, Feeney, & Savage, 1968). Beyond this, at that time seemingly common practice, there is a pathological example, where induced vomiting is a mean to achieve a feeling of relief from anxieties and feelings of guilt (e.g., Rosen & Leitenberg, 1982; Stice, 1994). Individuals suffering from eating disorders, like bulimia nervosa, engage in regular binge-eating (eating huge amounts of food in short time). As a consequence they often feel disgusted about themselves, depressed, guilty or anxious about gaining weight. Vomiting after overeating is a means to feel relieved and disenthralled from the negative feelings (e.g., anxiety, feeling of guilt, disgust). Also, as mentioned above, physiological processes cause the body to relax after vomiting (e.g., Watcha & White, 1992). Beyond pathological conditions, emesis can also part of ritual ceremonies. In spiritual *ayahuasca ceremonies* vomiting is a mean to achieve a feeling of physical and psychological cleansing (e.g., Shanon, 2010). Natives of Amazonian Peru use ayahuasca (psychedelic brew), for example, to experience insights about the nature of the universe and spiritual revelation about the purpose of life. Intended vomiting elicited by the ayahuasca brew is part of the rite and stands for the release of negative emotions/energies that have accumulated in the past, thus reaching catharsis.

The importance of ingestion and its consequences is mirrored in diverse examples from wide-ranging domains (Rozin, 1999). For instance, human culture and development has always been largely concerned with the task of food supply. Food supply is managed by the specifically devoted emotion of disgust and the modality of taste. The corresponding behaviors (e.g., eating, drinking) are executed relatively frequently in comparison to other adaptive behaviors such as, for example, reproduction behaviors. Also, plenty of food-related metaphors in various languages reflect the crucial role of food in our lives (e.g., English: *to swallow a bitter pill;* German: *to eruct sourly;* Dutch: *to have a honey-sweet voice*; Farsi: *raw/uncooked/tasteful/tasteless words;* French: *not to be the end of string beans*; Chinese: *to eat bitter*).

To conclude, ingestion with its two contrary behavioral functions of deglutition and expectoration is fundamental for human survival. The importance is also reflected in omnipresent cultural practices and metaphorical expression in various languages. Crucial for the present work, the two behaviors of deglutition and expectoration involve automatic peristaltic movements that in their respective oral phases wander from the front to the back of the mouth or from the back to front, and are both linked to strong valence.

3.2. Articulation

After having introduced the evolutionary older function of the mouth – ingestion, in the following, the second most important function of the mouth is described that is also relevant for the proposed mechanism behind the in-out effect by Topolinski et al. (2014), namely articulation.

Articulation is the production of speech by movements of the speech organs including the tongue, the lips, and the jaw (e.g., Titze, 1994; 2008). By means of breathing in and then breathing the air out from the lungs various sounds are produced. In order to vary the to-be-generated sound certain oral muscle movements are exerted that obstruct the airflow. These movements leading to obstruction can occur on various so-called *points of articulation* (e.g., bilabial: P, B, M; labiodental: F, V; alveolar: T, D, N, L; International Phonetic Association, 1999). These are the locations where an *active articulator* (e.g., various parts of tongue, lower lip) presses against a *passive articulator* (e.g., soft and hard palate, upper lip, upper teeth) and thereby modulates or even obstructs the airflow. These movements can result in clear sounds of consonants. The way in which these air-flow modulating muscle strictures are performed (e.g., how close they converge) is called the *manner of articulation* (e.g., stops: T, D, P, B, K; fricatives: F, V, S; approximants: R, Y, W, H).

The primary purpose of articulation is producing speech sounds to communicate with the environment. The oral articulation of language is only one of various ways of communication (see e.g., also body language, sign language, eye contact). Technically, the symbols and sounds that are used to create a message can be seen as completely independent from the meaning they are thought to convey (e.g., de Saussure, 1959). Whether this claim is true has been a debate for a very long time. In Cratylus by Plato (1892), the dialogue between Socrates and two men (Cratylus and Hermogenes) concerns the question whether language consists of arbitrary symbols and sounds or whether they have already an intrinsic meaning (for more recent philosophical considerations see, e.g., Humboldt, 1836/1967; Nietzsche, 1876/1983).

In contrast to the view of Hermogenes, who argued that symbols and sounds are not related to their meaning, the alternative is constituted by *onomatopoeia.* Onomatopoeia refers to a word that phonetically resembles the properties of the denoted object (e.g., Bredin, 1996). The word onomatopoeia originates from the Greek words for "name" and "I make", which already indicates the meaning of the word itself. For instance, the English verb "croak" refers to the sound that a frog produces and itself already imitates the sound of a frog. The in-out effect by Topolinski et al. (2014) that is studied in the current work is not about onomatopoeic words in the strict sense, because according to the authors inward and outwords do not convey a meaning by its sounds but rather convey valence by the articulation movement being linked to positivity or negativity. However, I regard an introduction of this line of research as valuable for illustrating how general properties of words can influence their meaning.

There is a long history of phonetic symbolism research showing that the sound of a word can already convey a meaning, independent from the actual semantics of a word. For example, different vowels seem to have distinct associations with various rather concrete characteristics regarding the denoted objects (e.g., how small/tall, light/heavy, hard/soft, fast/slow and angular/round an object might be; e.g., Johnson, 1967; Johnson, Suzuki, & Olds, 1964; Newman, 1933; Sapir, 1929). Sapir was probably one of the first who demonstrated that back (e.g., A) and front vowels (e.g., I) in nonsense words would convey a meaning. In his study, participants were more likely to categorize a table as big when it had the name "MAL" than when it was called "MIL". The "A" in "MAL" connoted the meaning of largeness, whereas the "I" in "MIL" connoted the meaning of smallness.

In line with that, Lowrey and Shrum (2007) show that the sound of vowels being categorized as front vs. back vowels had an influence on brand name preferences. They demonstrate that participants preferred brand names for products when the vowels in the brand names conveyed the characteristics of the product. This is, a "two-seater convertible" was preferably named with, for instance, the brand name "GIMMEL", because the "I" connoted characteristics like small, light, fast, whereas, a "SUV" was preferably named with, for instance, the brand name "GOMMEL", because the "O" connoted characteristics like big, heavy, slow.

There is also research showing that meaningless articulation can also have a rather abstract connotation, like valence (*articulatory feedback hypothesis;* Rummer, Schweppe, Schlegelmilch, & Grice, 2014; for previous accounts see Zajonc, Murphy, & Inglehart, 1989). Also the in-out effect (Topolinski et al., 2014) that is the basis of the current work, fits into this line of research, because it causes a rather unspecific feeling of positivity/negative (induced by motivational states of approach/avoidance) than a rather concrete meaning as in onomatopoeia. In two studies Rummer et al. (2014) showed that vowels can not only connote rather concrete semantics, as in previously described studies, small/large, light/heavy or fast/slow, but also the rather abstract attributes of positive/negative. Moreover, they offer an underlying mechanism that is grounded in muscular activation feedback (zygomaticus = smiling), similar to the more indirect motor-affect account of simulated muscular activation dynamics by Topolinski et al. (2014), for the in-out effect.

Rummer et al. (2014) demonstrated that there is a bidirectional influence between vowel identity and emotional states. In the first study, participants were exposed to a positive or negative mood manipulation and subsequently were asked to invent novel words that should not have been present in their native language (only German native speakers participated). The results showed that after inducing positive mood, participants invented more words with the letter "i" (in German pronounced like "e" in English) than with the letter "o", whereas after inducing negative mood they invented more words with the letter "o" than with the letter "i". In contrast to the notion that meaning is independent from the form of communication, these data show that the letters "i" and "o" themselves are clearly associated to valence. Specifically, a negative or positive emotional state has an influence on the probability of using the vowels "i" and "o", respectively. The authors' explanation was adopted from the facial feedback hypothesis initially tested by Strack et al. (1988) and therefore, they applied a similar task in their second study.

In that study, besides the conditions of the holding a pen with the teeth or the lips, participants had to rate cartoons while articulating either the vowel "i" or "o" once per second. The results indicated that holding the pen with the teeth had the same effect as articulating the vowel "i" and holding the pen with the lips had the same effect as articulating the vowel "o". The articulation of "i" or "o" involves the activation of facial muscles that are also activated when holding a pen with the teeth (activating zygomaticus major muscle) or the lips (activating orbicularis oris muscle), respectively. Thus, similar to the facial feedback hypothesis, the *articulatory feedback hypothesis* maintains that contractions of facial muscles evoked by articulation can influence affective ratings. Also, bidirectionality has been shown by the fact that mood influenced the choice of vowels and that articulation of vowels affected emotional evaluations.

Probably because of the low number of vowels that exist and the consequential facility of inspection, vowels have been studied quite intensely in comparison to consonants. But also consonants have been studied with respect to the inherent non-semantic meaning they convey. As already mentioned, articulation involves the exertion of certain oral muscle movements (e.g., Arnold & Hansen, 1967; Steklis & Harnad, 1976; Titze, 1994; 2008). Particularly for consonants, these oral muscle contractions occur on well-defined *places of articulation* varying on the oral sagittal plane (e.g., front: B, back: K). Thus, like vowels, also consonants can be classified in front and back categories. Front consonants have been shown to be associated with weakness and pleasantness whereas back consonants have been shown to be associated with strength and unpleasantness (e.g., Folkins & Lenrow 1966; Miron, 1961). However, other categorizations of consonants are more common in this line of research. For instance, consonants are often categorized one the one hand as *fricative consonants* (e.g., S, F), when the articulation affords the airflow to pass the lips, teeth, or tongue and is partially blocked. On the other hand, consonants are categorized as *stops* (e.g., P, K), namely when the airflow is completely blocked by the lips, teeth, or tongue. Various other fine-grained consonant categorizations exist. However, I am not aware of any research is known that studies the effect that the order of consonantal articulation spots can have.

Overall, language articulation as a means of communication has long been seen as arbitrarily evolved without any relation between the meaning of a word and the sound of it. However, there are more recent views that suggest aspects of language that are non-arbitrary (e.g., Berlin, 1994; de Roder, 2003; Ertel, 1969; Ramachandran & Hubbard, 2001). The phenomenon by Topolinski et al. (2014) explained in the following part, also pertains to this line of research.

3.3. In-out Effect as the Interplay between Ingestion & Articulation

Topolinski et al. (2014) argued that the shared muscular dynamics between ingestion and articulation allow the possibility that motivational states associated with ingestion and expectoration can be induced by the mere articulation of words that contain inward and outward consonantal kinematics. In the following, this chain of reasoning is explained more elaborately.

The basis of this theoretical rationale is the biomechanical fact that the two functions of the mouth, ingestion and articulation, both use the same oral musculature in an analogical way. For both functions, similar peristaltic oral muscle strictures are produced to cause variable effects for either ingestion or articulation. These peristaltic movements can wander either from the front of the mouth to back (inwards) or conversely from the back of the mouth to the front (outwards), for ingestion as well as for articulation. Because of this shared muscular dynamics, it is conceivable that a movement involving such oral muscle strictures is linked to motivational and affective consequences of both functions. Thus, a movement can elicit motivational and affective consequences that were initially linked to a different movement that shares the same muscular dynamics. This is, for instance, that an articulation movement might at the same time evoke motivational and affective consequences initially associated to an ingestion movement because the movements are very similar to each other.

More precisely, Topolinski et al. (2014) propose that a peristaltic articulation movement that wanders inwards (outwards) can elicit a motivational state of approach (avoidance) that was initially linked to the evolutionary older movement of deglutition (expectoration). As a consequence of the activated motivational state of approach or avoidance, positive or negative affect is evoked, respectively. This notion is identical to other approach and avoidance literature described already in Chapter 2 where affective consequences are caused by the link between specific body movements and motivational states of approach and avoidance (Chen & Bargh, 1999; Higgins, 1997; Russell, 2003; Strack & Deutsch, 2004). The most prominent example is that executing an arm flexion is mostly linked to behavioral approach and therefore evokes positive affect, whereas executing an arm extension is mostly linked to behavioral avoidance and therefore evokes negative affect (e.g., Cacioppo et al., 1993).

Thus, also for the oral domain Topolinski et al. (2014) argue that motivational states of approach and avoidance that are associated with ingestion and expectoration, respectively, would be evoked by the articulation of words (exact operationalization explained in the following chapter) that afford movements that resemble oral ingestion (inward words) or expectoration movements (outward words; see Figure 1). Then, the activated motivational state of approach or avoidance would lead positive or negative affect, respectively. This experienced positive or negative affect spills over to the to-be-evaluated target words (inward and outward words). Thus, articulating an inward (outward) word leads to a motivational state of approach (avoidance) which in turn leads to positive (negative) affect, which in turn spills over to the evaluation of inward (outward) words. According to Topolinski et al., this explains why participants show higher preferences for inward than for outward words.

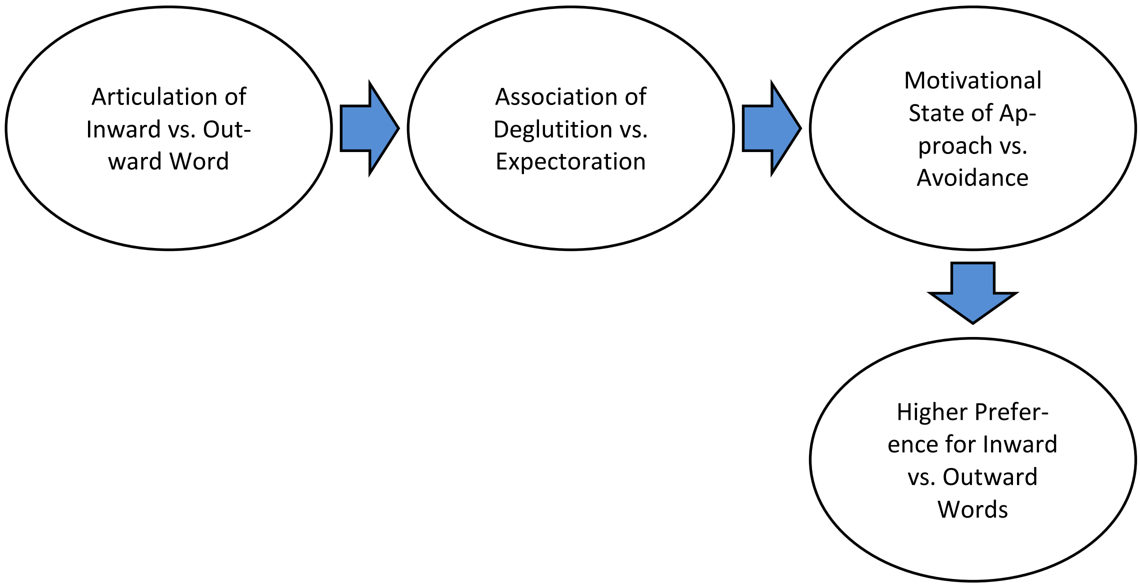

Figure 1. Underlying mechanism behind the in-out effect as postulated by Topolinski et al. (2014).

Moreover, according to the authors, no overt vocalization would be necessary since merely perceiving verbal stimuli leads to covert simulation of articulation kinematics (Topolinski & Strack, 2009a, 2010; for *simulations* in embodied cognition theory see Barsalou, 1999; Barsalou, Santos, Simmons, and Wilson, 2008; Körner, Topolinski, & Strack, 2015; Niedenthal et al. 2005; Schubert & Semin, 2009; Semin & Smith, 2008). Thus, simply perceiving an inward (outward) wandering word without articulating it aloud would induce a motivational state of approach (avoidance) that is reflected by positive (negative) affect being attributed on the perceived inward (outward) wandering word. And indeed, they found that merely perceiving the target stimuli led to inward wandering words being evaluated more positively than outward wandering words across several experimental set-ups, for both English and German speaking samples (see Table 1).

Table 1

Table adopted from Topolinski et al. (2014) with Samples, Materials, and Results of Experiments 1-6 (Standard Errors in Parentheses).

Exp.	Sample[1]	Target label	Consonantal stricture direction			Statistics for the pairwise-comparison between inward and outward
			Inward	Outward	Baseline	
1	*N* = 171 German psychology undergraduates 118 female, 50 male, 3 unknown Mean age 24, *SD* = 5	Nonsense words	4.56 (0.09)	4.24 (0.09)		$t(170) = 5.20$, $p < .001$ $d = 0.27$ 95% CI [0.20, 0.44]
2	*N* = 110 German psychology undergraduates 88 female, 22 male Mean age 23, *SD* = 4	Names of gourmet food companies	5.72 (0.12)	5.46 (0.13)		$t(109) = 3.00$, $p = .003$ $d = 0.20$ 95% CI [0.09, 0.44]
3	*N* = 150 German volunteers from various backgrounds 65 female, 85 male Mean age 41, *SD* = 19	Surnames of foreign politicians	5.53 (0.09)	5.22 (0.09)		$t(149) = 3.89$, $p < .001$ $d = 0.28$ 95% CI [0.15, 0.46]
4	*N* = 86 German volunteers from various backgrounds 60 female, 26 male Mean age 23, *SD* = 5	Nonsense words	5.14 (0.14)	4.70 (0.13)		$t(85) = 4.88$, $p < .001$ $d = 0.35$ 95% CI [0.26, 0.61]
5	*N* = 40 German volunteers from various backgrounds 28 female, 12 male Mean age 22, *SD* = 3	Nonsense words	4.83 (0.15)	4.12 (0.17)	4.42 (0.14)	$t(39) = 4.88$, $p < .001$ $d = 0.69$ 95% CI [0.41, 1.00]
6	*N* = 36 US undergraduates 31 female, 5 male Mean age 21, *SD* = 2	Nonsense words	4.46 (0.16)	4.21 (0.16)		$t(35) = 2.66$, $p = .012$ $d = 0.26$ 95% CI [0.06, 0.44] [2]

Notes. [1] The German samples were individuals from the university or city area of Würzburg. The US sample in Experiment 6 was from the University of California San Diego.

[2] Confidence Interval was corrected from 0.6 in the original paper to 0.06 in the current table (S. Topolinski, personal communication, April, 2015).

3.4. Experimental Operationalization of Oral Approach & Avoidance

The method used by Topolinski et al. (2014) has the advantage of being very subtle. Without having heard of the in-out effect, on the first sight probably nobody would recognize that inward and outward wandering words were different with regard to any specific pattern (see Table 2).

Table 2
Examples of inward and outward wandering words that were used as stimuli by Topolinski et al. (2014). Consonants are presented in blue.

Inward	Outward
MENIKA	KENIMA
BALUGOR	RAGULOB
PANOKARE	RAKONAPE
MESUKIRO	REKUSIMO
BULEKA	KULEBA
PATUGI	GATUPI
MADOGU	GADOMU
BATIKERO	RAKITEBO
PODAKERI	ROKADEPI

The exact stimulus material was constructed the following way. As explained above, the articulation of consonants involves the exertion of oral muscle movements on well-defined *places of articulation* along the oral sagittal plane. For instance, M, B, and P are articulated in the front of the mouth (the lips), D, T, and L are articulated right behind the front of the mouth (with the tongue on back of the upper teeth), and K is articulated in the back of the mouth (rear back of the tongue; e.g., Arnold & Hansen, 1967; Steklis & Harnad, 1976; Titze, 1994; 2008). By creating nonsense words that contain consonants in a certain sequence of articulation spots (see Table 2), oral muscle contractions can be generated by articulatory means that wander from the front the rear (e.g., MENIKA), or from the rear to the front (e.g., KENIMA), similar to the muscle dynamics in deglutition and expectoration, respectively. Every single stimulus consisted of alternating consonants and vowels. The latter have been chosen randomly (no iteration within a word), but their sequence within both stimulus categories have been hold constant. The authors focused on consonantal patterns, because consonants in contrast to vowels feature rather specific stricture spots. Thus, articulating the word MENIKA vs. KENIMA does not differ regarding the vowels, but only regarding the consonants. For the articulation of the word MENIKA, one starts at the front of the mouth by pressing the lips together (for the letter M), then presses the tip of tongue against the back of the upper teeth (for the letter N), and finally presses the back of the tongue is against the soft palate.

According to the theory of Topolinski et al. (2014), because of the shared muscular system, the articulation of an inward word like MENIKA leads the activation of the association with the behavior of deglutition. Then, this activated association leads to a motivational state of approach, which in turn leads to higher preference ratings for the word MENIKA (see Figure 2). The current work investigates the role of fluency in this process, which has not been addressed in the literature so far and which is introduced in the following chapter.

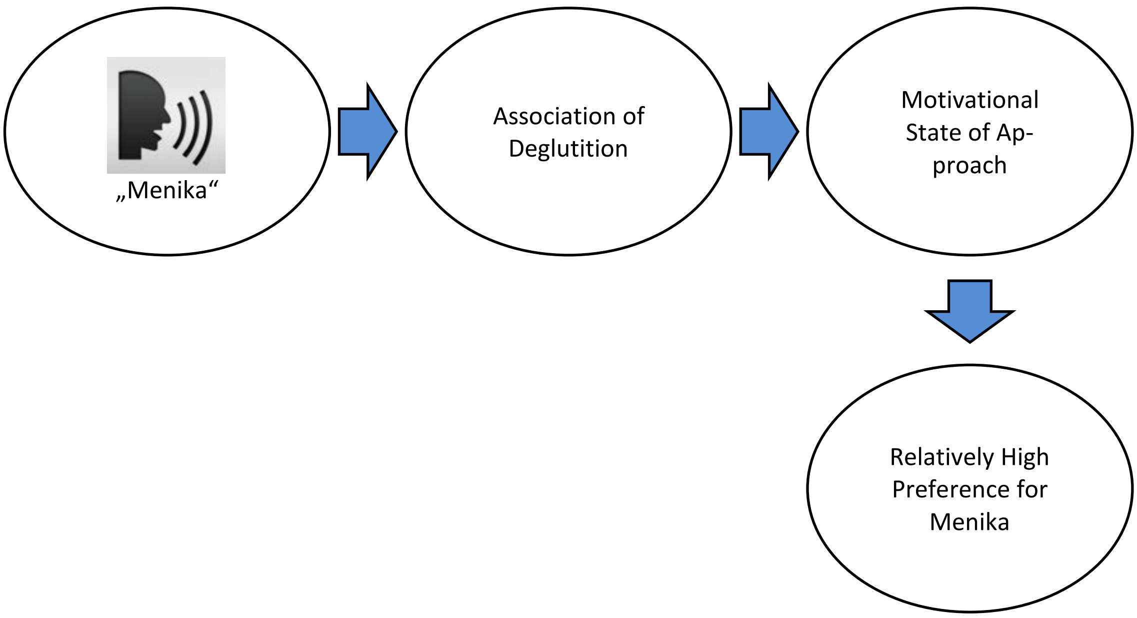

Figure 2. Example for causal relationship postulated by Topolinski et al. (2014) from articulation of the inward word “Menika” leading to a relatively high preference rating for that inward word.

3.5. Further Experimental Studies on

Oral Approach & Avoidance

Beyond the basic demonstration by Topolinski et al. (2014), there are several recent further studies on the in-out effect. For example, Topolinski and Bakhtiari (2015) found a similar effect comparable to the original finding for more complex consonantal patterns. Specifically, they found that words for which consonantal articulation spots wandered first-outward-then-inward (e.g., AKESUMUSEKA; avoidance-then-approach) were preferred over words that wandered first-inward-then-outward (e.g., AMENUKUNEMA; approach-then-avoidance; see Figure 3).

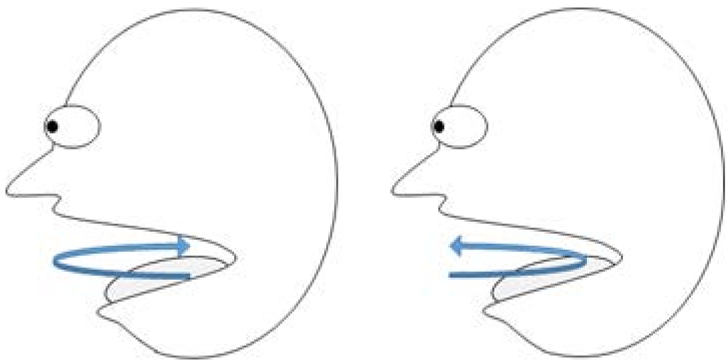

Figure 3. Schematic depictions of oral events in Experiment 1 by Topolinski and Bakhtiari (2015). Left: outward-then-inward, right: inward-then-outward.

Over several experiments involving English as well as German speaking participants, they found that avoidance-then-approach sequences were evaluated more positively than approach-then-avoidance sequences. To rule out a mere recency effect (e.g., Richter & Kruglanski, 1998), or an end-state comfort effect (Rosenbaum, van Heugten, & Caldwell, 1996), which would suggest that only the last movement determines the elicited affect, target words that featured neutral consonantal patterns as first words have been tested. The neutral parts of the stimulus words have been adopted from Topolinski et al. (2014, Experiment 5), where they have been generated by flipping two consonants within in- and out words (e.g., KILOBE (outward) turned into LIKOBE (neutral)). The neutral-then-avoidance and approach-then-avoidance sequences did not differ in preference ratings from baseline stimuli (unsystematic consonantal sequences). Only avoidance-then-approach sequences were preferred over the baseline stimuli. Ruling out a mere recency effect, it was shown that neutral-then-approach sequences were even preferred over avoidance-then-approach sequences. Hence, it was shown that affect, caused by subsequent oral approach and avoidance movements, is not only a sum of both affective consequences, thus leveling each other out, but rather is jointly influenced by the specific sequences.

Furthermore, Topolinski, Zürn and Schneider (2015) generalized this in-out effect as a marketing strategy to product attitudes and willingness-to-pay for products. They showed that for English as well as German speaking participants, inward compared to outward brand names led to higher product preferences, stronger purchase intentions, and higher amounts of money participants were willing to pay for a product. Thus, the subtle manipulation of brand names featuring either inward or outward kinematics had not only an impact on preferences but also on behavioral intentions.

Finally, Topolinski, Boecker, Erle, Bakhtiari, and Pecher (2015) even found a modulation of the basic in-out effect by edibility of the denoted object. They used inward and outward words as brand names for ingestion and expectoration related products, namely lemonades and chemical, respectively. While inward names were preferred over outward names when they denoted brands of lemonades, this effect vanished when they denoted brands of toxic chemicals.

Overall, it is to say that the in-out effect as introduced by Topolinski et al. (2014) is a completely novel phenomenon that nonetheless seems to be very robust and exerts various influences on attitudes and behavioral intentions. The current work tests an alternative to the proposed underlying mechanism for the in-out effect. Specifically, the processing ease of inward and outward words is examined. In the following chapter, the influence of ecology on psychological processes is explained to build a base for the introduction of processing ease as alternative mechanism of the in-out effect.

CHAPTER 4 - Influence of Ecology on Psychological Processes

In the study of human behavior there is a long history of the position that studying the properties of an organisms' environment is at least as important as studying the organism itself (e.g., Brunswik, 1956). For the current work this is a relevant aspect of psychological research that will be explained in more depth in the following, because I suggest that the in-out effect by Topolinski et al. (2014) should be considered in relation to ecological roots. Therefore, the classic lens-model by Brunswik is introduced as a model of the relation between an organism and its environment. Then a process model on the influence of processing ease is introduced that was inspired the Brunswik's lens-model. Finally, language is introduced as an environmental factor that shapes psychological processes.

4.1 Brunswik's Lens-Model

Brunswik's lens model (1956) describes the relations between an environment and an organism behaving in that environment (see Figure 4). He advocated that psychology should focus more on the characteristics of an organism's environment in order to understand the organism itself. Accordingly, he introduced the term *ecological validity* and described it as

> *"a statistical concept based on the principles of contingency or correlation and requiring the coolheaded gathering of a representative array of information. In the general case it involves the integration of both positive and negative, confirming and disconfirming (misleading) instances of concomitance of the distal variable with the cue variable. Small wonder, then, that in the discovery of the limitations of ecological validity the more casuistic study of 'exceptions' to the rule comes first; among those exceptions that can be produced artificially have exerted particular attraction"* (Brunswik, 1957, p. 16).

Specifically, he introduced the distinction of *proximal cues* referring to the organism's perceptions and *distal criterion* referring to properties in environments (see

Figure 4). He assumes that an organism perceives proximal cues and thereby infers properties of a distal criterion that is not directly perceivable for the organism.) Brunswik illustrated this with the example of depth perception (e.g., Brunswik, 1944, 1953, 1955; see also Unkelbach & Greifeneder, 2013). Generally, our retina is not able to perceive depth directly. Depth seems to be a distal criterion that we infer from various proximal cues like, for instance, overlap of objects (objects overlapping other objects are closer to the perceiver than the covered objects; e.g., a tree partially overlapping a house is closer to the perceiver than the house covered by that tree), motion parallax (a moving perceiver experiences closer objects to be moving faster than distant objects; e.g., pigeons infer depth by constantly moving their heads; Garzia, 2000), and gradient of texture (close objects have a clearer texture than distant objects). Thus, human organisms infer the distal criterion of depth from proximal cues.

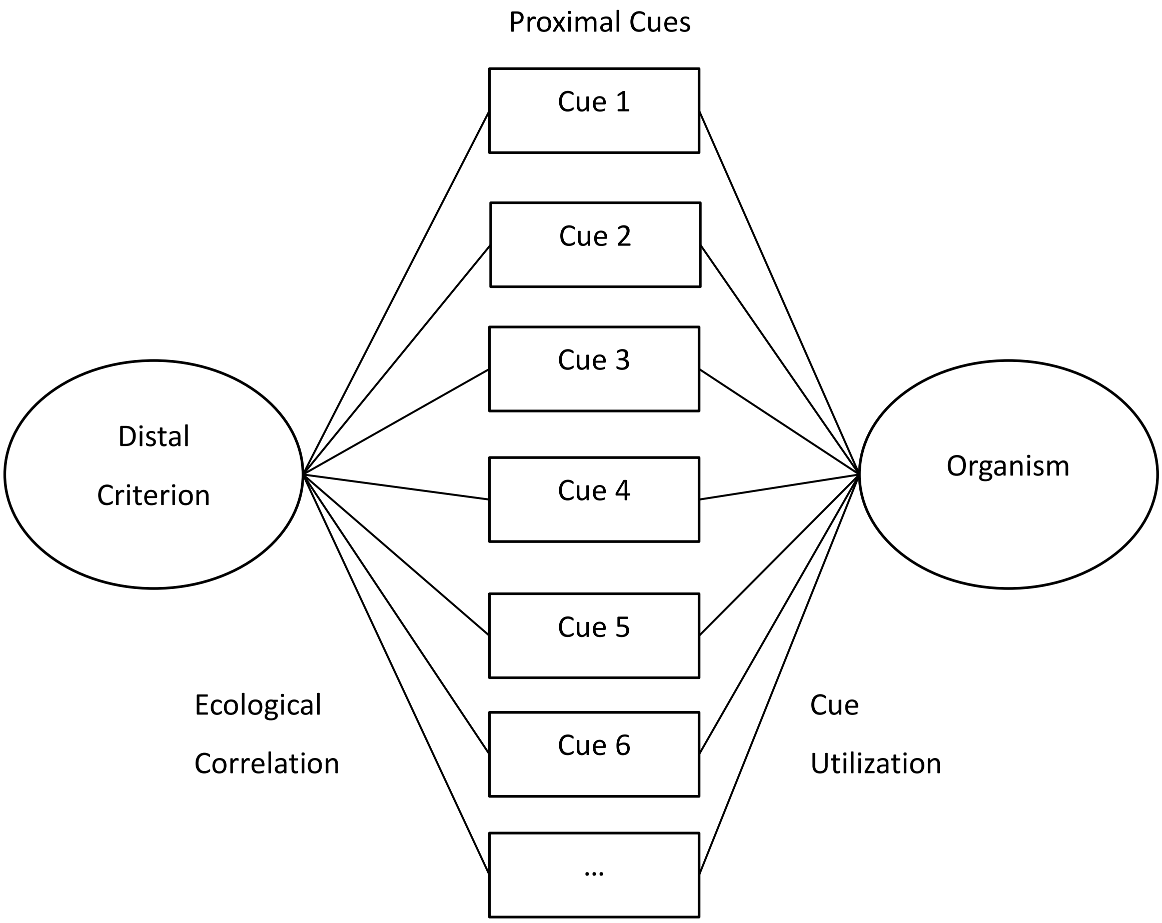

Figure 4. Schematic illustrations of Brunswik's lens-model demonstrating how an organism judges a distal criterion in the environment by distal cues.

As depicted in the model (see Figure 4), *cue utilization* is the link between the organism to the proximal cue, thus, the use of a cue in a given judgment, and refers to the fact that an organism can weigh proximal cues differently. As an example for depth vision, one can say that when a perceiver is sitting in a fast moving vehicle, depth perception is more strongly inferred from motion parallax than gradients of texture, because the latter is also a consequence of other factors (e.g., textile fibres; see also Unkelbach & Greifeneder, 2013). Thus, dependent on the circumstances some proximal cues can become more relevant for an organism than others for inferring a distant criterion.

Finally, the term *ecological correlation* refers to the fact that the relation of proximal cues and distal criterions can vary. For instance, the overlap of object is a more valid cue of depth than the gradient of texture, because the latter is also highly determined by other influences. Thus, importantly, Brunswik stated that an organism perceives its environment in a probabilistic way (relation of cue and criterion is probabilistic) and it requires applying probabilistic means to operate adaptively in that environment (probabilistic functionalism). Consequently, the validity of all perceptions is probabilistic rather than certain.

Brunswik's model was extremely influential for ecological approaches in psychological research of judgment and decision making (e.g., Fiedler, 2000; Goldstein & Gigerenzer, 2002; Karelaia & Hogarth, 2008). Accordingly, in that line of research psychological variables are related to systems like culture, socialization, and language that have adapted in response to ecological demands (e.g., Berry, 1971; Oyserman, 2011). In line with Brunswik's notion, differing environments and stimuli can cause, for instance, feelings that in turn can be the basis of judgment and decision making (e.g., Schwarz, 2012). Hence, it is crucial to take the environment of an organism into account when trying to understand what triggers cognitions, emotions and behavior.

Oyserman (2011), for instance, showed that salient cultural mindsets can have profound consequences for various rather short-term psychological variables (for a review of influences of cultural self-construals on cognition, emotion and motivation see, Markus & Kitayama, 1991). She demonstrated that situational cues can activate individualistic or collectivistic mindsets which in turn influence meaning making processes, processes concerning the self, willingness to invest in relationships, and other complex mental processes.

A good example of analyzing the potential affordances of an environment to understand rather long-term psychological variables has been provided by Barry, Child and Bacon (1959). Regarding socialization processes, they showed across 104 societies from all over the world that child rearing practices are related to a variable that underlies ecological pressure, namely food accumulation on a margin of subsistence. Specifically, they demonstrated that child training practices regarding obedience, responsibilities in households, nurturance of dependent ones, achievement and performance, independence and self-reliance, differed dependent on whether societies were high (primarily dependent on agriculture and pastoral economy) or low (primarily dependent on hunting and gathering) on food accumulation. For instance, in societies primarily dependent on agriculture and pastoral economy, child rearing practices of responsibility and obedience were emphasized, whereas in societies primarily dependent on hunting and gathering the emphasis was more on achievement and performance, and self-reliance and independence. Hence, they deducted that there is a functional adaptation of child rearing practices to prepare and fit children's skills in line with ecological demands.

Overall, Brunswik's lens-model has been influential on a broad range of research areas and still provides a stable and inspiring ground for studies on human behavior and its environment. In the following a psychological process model is introduced that is directly inspired by Brunswik's lens-model.

4.2 Brunswikian Process Model of Processing Ease

In the domain of judgment and decision making it is assumed that environments can elicit feelings beyond the specific meaning of a situation that in turn can have profound influences on judgments and decisions (e.g., Reber & Unkelbach, 2010; Schwarz, 2012; for reviews see, Alter & Oppenheimer, 2009; Reber et al., 2004). The ease of an ongoing mental operation, for instance, can be regarded as a crucial influence on various types of judgments which is elaborated in more detail in Chapter 5. In the current section a Brunswikian process model of the influence of the ease of a mental operation is presented because it will be a valuable basis as I move forward with the theoretical rationale of my current work.

Based on Brunswik's lens model, Unkelbach and Greifeneder (2013) introduce a general process model (for simplified illustration see Figure 5) that conceptualized the ease of cognitive process as a probabilistic proximal cue that allows for inferences about distal criteria that would otherwise be unperceivable for us.

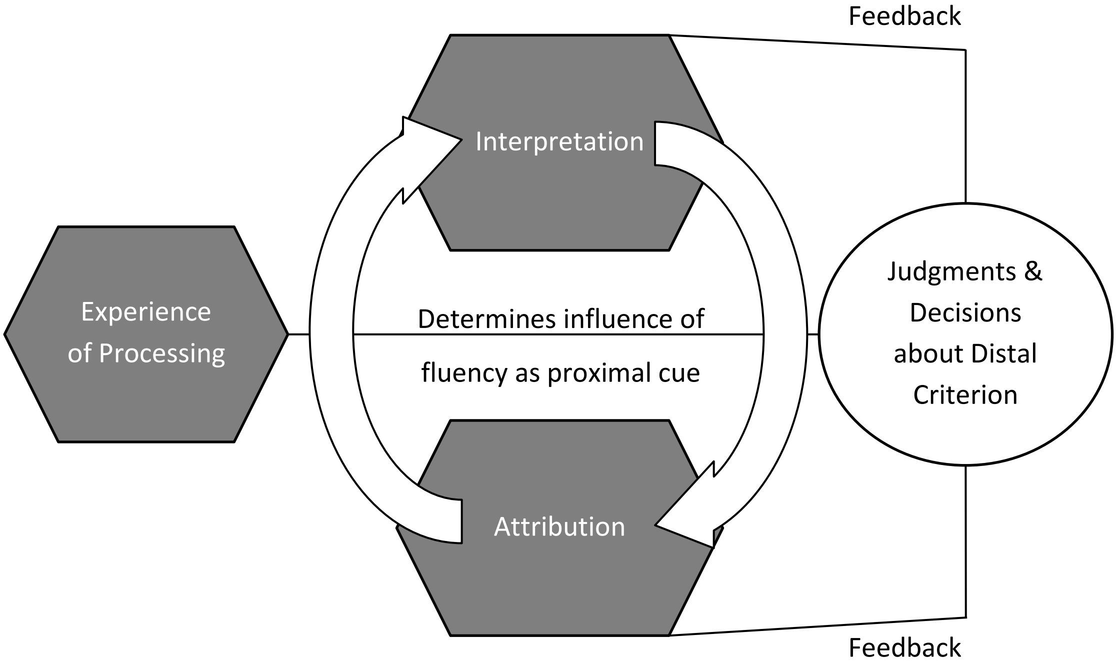

Figure 5. The simplified general process model suggested by Unkelbach and Greifeneder (2013) illustrating how the ease of a process (fluency) can influence judgments and decisions.

Unkelbach and Greifeneder (2013) propose that the influence of the ease of processing on a judgment affords three steps, explained briefly in the following. First, it is crucial that an ease of processing is experienced at all. This seems to be particularly the case when there is a change of ease of processing in a series of stimuli (e.g., Dechêne, Stahl, Hansen, & Wänke, 2009). Generally, the ease of mental operations is assumed to be monitored constantly and remembered well (e.g., Metcalfe & Shimamura, 1994; Whittlesea & Leboe, 2000; Whittlesea & Price, 2001; Whittlesea, 2002). The resulting feeling of ease or difficulty seems to emerge automatically, thus, without any conscious mental operations being necessary.

Second, the ease experience has to be attributed to the relevant object. Thus, ecological validity (interpretation of the ease experience) is fundamental and can be dependent on two sources. One source is provided by Brunswikian feedback learning from prior actual judgments and decision. Accordingly, Unkelbach (2006, 2007) has shown that participants adjust their inferences by means of feedback learning in specific contexts. Specifically, participants who judge the truth-value of statements (distal criterion) rely on the feeling of ease that is experienced while processing the statements (proximal cue; Unkelbach, 2006). He argues that this is probably due to the fact that the ease of processing has been shown to be a reliable indicator of truth-values. Specifically, true statements are objectively easier to process and people have learned this in the past. Therefore, after a relearning training participants show the opposite pattern (high experienced ease and low truth value; Unkelbach, 2006, 2007).

Another source of the interpretation of processing ease grounds in the fact that people hold naïve theories about the meaning of such experiences and adjust their conclusions in line with their interpretation of the experience (e.g., Schwarz, 2004; Winkielman & Schwarz, 2001). Accordingly, Winkielman and Schwarz have shown that when presenting participants with possible interpretations about a memory process, participants adjust their judgments correspondingly. Specifically, participants had to recall either 4 childhood events (experience of ease) or 12 childhood events (experience of difficulty). Then they were either told that positive memories would fade away quickly from memory or that negative memories would fade away quickly. Participants, who experienced a difficult recall (12 events) and thought that negative childhood memories fade away quickly, afterwards judged their childhood as less positive than participants who experienced a difficult recall and thought that negative childhood memories would fade away quickly. Crucially, the opposite results were found for participants who experienced an easy recall task (4 events). Thus, the naïve theory the participants were given influenced how the ease of recall of childhood events was interpreted which in turn profoundly influenced their overall judgment of their childhood. To conclude, feedback learning about mental ease experiences as well as naïve theories about the meaning of that ease can have profound influence on the learned ecological validity of those ease experiences.

Finally, Unkelbach and Greifeneder (2013) regard the attribution and interpretation in their model as two distinct influences on the impact of ease experiences (see Figure 5). First, the attribution of the ease experience sets the boundaries where interpretation can occur at all. They illustrate it with the example of people who have to come up with words that start with the letter "r" might experience the retrieval process to be either hard or easy and may in turn attribute this feeling to the mental operation. Then in a next step in the interpretation process, a cause of this feeling might be found. Specifically, the attributed feeling of ease or difficulty can be interpreted as being an indicator of the frequency of words that start with the letter "r". Given the fact that the consequences (right or wrong decisions) attenuate the learned ecological validity of a proximal cue, a wrong interpretation would adjust accordingly after a while.

Overall, Unkelbach and Greifeneder (2013) provide a process model that accounts for a wide range of effects that have been found in studies on processing ease.

In Chapter 5, the ease of processing as a proximal stimulus is introduced more elaborately. Importantly, it will be shown that the ease of processing seems to be strongly influenced by the frequency of exposures to a stimulus. In the following section language is introduced as an ecological influence that can have major influences on psychological processes.

4.3 Influence of Language Ecology on Psychological Processes

Language ecology is not a very intensely studied topic in social psychology. This is particularly surprising when considering the fact that it is an omnipresent communicate tool that we use excessively in our daily lives. Semin (2001) argues that traditional linguistics did not establish a framework of what language is or how we use it that would have allowed for a better interdisciplinary connection to social psychology (see also Tomasello, 2003). Accordingly, it might not be surprising that one of the most well-known psychological hypotheses about the influence of language on psychological processes comes from a lay-person –Benjamin Lee Whorf– whose actual profession was fire prevention engineering. Whorfianism refers to the principle that the structure inherent to a specific language affects the speaker cognition (e.g., Whorf, 1956). For instance, in the Russian and English languages the color blue is categorized differently. In Russian a fundamental distinction is made between lighter and darker blue colors. Accordingly, in a color discrimination task it has been found that Russian native speaker were faster to discriminate two blue colors when they could be categorized into lighter and darker blue category respectively, than when the two belonged into one of the categories (Winawer et al., 2007). Crucially, this effect has not been found with English native speakers, suggesting that the color categories that were present in the language had an influence on the performance in a perceptual categorization task.

Beyond that, one can distinguish roughly two perspectives on language. There is a traditional perspective on language which assumes that language and cognition are two independent systems, and that language is simply a disembodied tool for representation and computation (e.g., Lenneberg, 1953). It ignores flexible processes that emerge from an interaction with the world, and also the function that language can be seen as an extension of cognitions in the real world (e.g., Pulvermüller, 2007; Smith & Semin, 2004). Alternatively, there is a functional perspective that assumes that language can be seen as a tool that extends cognition in action. Such situated cognition approaches can be found in various areas of psychology (e.g., Barsalou, 2008; Clark, 1997; Glenberg, Witt, & Metcalfe, 2013; Koole & Veenstra, 2015; Marsh, Johnston, Richardson, & Smith, 2009; Oyserman, 2011; Robbins & Ayede, 2009; Schwarz, 2002; Smith & Semin, 2004, 2007).

Accordingly, there is broad range of literature demonstrating that ecological factors like, for instance, frequencies in language and other language-features shape psychological processes like the efficiency of language processing (Balota & Chumbley, 1985; Berry, 1971; Brysbaert & New, 2009; Ellis, 2002; Grainger, 1990; Savage, Bradley, & Forster, 1990), as well as evaluations and judgments (Broadbent, 1967; Fiedler, 1996, 2000; Hintzman, 1988; Semin & Fiedler, 1988, 1992; Smith & Semin, 2004; Unkelbach et al., 2008; Zipf, 1932). Word frequencies of language are of specific interest for the current work and are well-researched ecological factors that are known to have an influence on psychological variables. For instance, it has been shown that high-frequency words are easier to recall than low-frequency words whereas interestingly, it seems to be harder to recognize them in an episodic memory tasks (e.g., Glanzer & Bowles, 1976; Yonelinas, 2002). Furthermore, Broadbent (1967) demonstrated that word-frequencies can account for response biases. Moreover, high-frequency words compared to low-frequency words are judged as words faster and more correctly in lexical decision tasks (Forster, 1976; Kirsner, 1994). Also, auditory word recognition is enhanced for high-frequency compared to low-frequency words (Luce, 1986; Savin, 1963).

Fundamental for the current work, high-frequency words compared to low-frequency words are perceived and articulated more efficiently and more accurately (e.g., Balota & Chumbley, 1984, 1985; Barry & Seymour, 1988; Forster & Chambers, 1973; Jescheniak & Levelt, 1994; Monsell, Doyle, & Haggard, 1989; Rayner & Duffy, 1986). For instance, in a classic study by Balota and Chumbley (1985) participants had to pronounce aloud high-frequency target words (e.g., man, car, dog) and low-frequency target words (e.g., pew, elk, sod) with various delay intervals (0-2900ms) allowing to discriminate between word frequency's influence on lexical access and mere word production. Interestingly, the results showed that when preventing participants to anticipate the moment of pronunciation as well as preventing them from rehearsing the target words during the delay, frequency effect can be found on the mere production of the target words without the influences of lexical access. Crucially, high-frequency target words were pronounced faster than low-frequency target words. Thus, Balota and Chumbley (1985) had not only demonstrated that word frequencies have an influence on the efficiency of lexical access but importantly also that they had an influence on the efficiency of mere word production.

Another prominent example that on first sight may be assumed as an ecological variable in language influencing psychological processes is the so-called *name letter effect* discovered by Nuttin (1985). It refers to the tendency that people seem to prefer letters that are contained in their own names (and particularly initials) over letters that are not contained in their names (and particularly their initials). This has been suggested to serve as a measure of implicit self-esteem (e.g., Greenwald & Banaji, 1995; Koole & DeHart, 2007; Koole, Dijksterhuis, & van Knippenberg, 2001), and there are discussions on the various ways how the name-letter effect can be calculated (e.g., Albers, Rotteveel & Dijksterhuis, 2009). However, the notion that the name letter effect might be merely due to the fact that one is more often exposed to one's own initials than to those of others has been shown to be false (e.g., Greenwald & Banaji, 1995; Hoorens & Nuttin, 1993; Jones, Pelham, Mirenberg, & Hetts, 2002; Kitayama & Karasawa, 1997). Rather, this seems to be an *implicit egotism* effect that occurs merely by the ownership of the initials. This refers to the fact that people generally have a positive association with themselves and this positive evaluation can spill over onto objects that are perceived as being related to themselves (e.g., initials are experienced to be owned). Put simply, people generally like themselves and therefore like letters that are contained in their names.

To conclude, ecological factors like word frequency in language can have a profound influence on psychological processes. Similarly, in the current work, the frequencies of inward and outward dynamics in natural languages are assumed to play a role in the in-out effect by Topolinski et al. (2014). In the following chapter the concept of *processing fluency* is introduced first to understand the consequences that the efficiency of word pronunciation can have. The consequences are elaborated generally and specifically for the currently studied in-out effect (Topolinski et al., 2014) in Chapter 5.

CHAPTER 5 - Fluency

The papers reviewed in Chapter 3 have shown that the in-out phenomenon seems to be a robust and generalizable effect. However, regarding its underlying mechanism, a parsimonious alternative explanation can be proposed which could completely explain the preference of inward over outward words. An alternative underlying mechanism to the approach avoidance account of Topolinski et al. (2014) could be that the two sagittal consonantal articulation directions vary in their motoric or phonotactical processing fluency. It is crucial to note here that, in general, articulation movements can vary in the ease of execution (e.g., Ann, 1996, for sign language; McKinney, 1982), which in turn can influence attitudes toward the associated stimulus (e.g., McGlone & Tofighbakhsh, 2000; Song & Schwarz, 2009; Topolinski & Strack, 2009a, 2010).

Hence, given the fact that there is literature showing attitudinal consequences of articulation ease the current work addresses the role of processing fluency in the articulatory in-out effect (Topolinski et al., 2014). Therefore, in the following the term fluency is introduced in general and also specifically as a possible mechanism behind the in-out phenomenon.

5.1. Processing Fluency

Processing fluency is a metacognitive experience that accompanies information processing and refers to the speed and ease with which information is processed (e.g., Bornstein & D'Agostino, 1992; Jacoby & Dallas, 1981; Jacoby & Whitehouse, 1989; Phaf & Rotteveel, 2005; Reber & Schwarz, 1999; Reber et al., 2004; Reber, Winkielman, & Schwarz, 1998; Schwarz, 1998; Schwarz, 2015; Topolinski & Strack, 2009a, 2010; Winkielman, Schwarz, Fazendeiro, & Reber, 2003). It is an experiences on meta-level, thus, it refers to feelings about one's previous thoughts. It has been shown that the quality of information processing is monitored and remembered well (e.g., Metcalfe & Shimamura, 1994; Whittlesea & Leboe, 2000; see also Whittlesea & Price, 2001; Whittlesea, 2002). Also, the feeling of processing fluency is remembered better than the content of information (e.g., Jacoby, Kelley, Brown, & Jasechko, 1989). In addition to experienced, thus subjective fluency, there is also objective fluency that can be measured in objectively measurable performances (e.g., reaction times, accuracy; Jacoby, 1983; Mandler, 1980). In the following, it is explained more elaborately that fluency experiences can pertain to various types of information processing (perception, recognition, categorization and recall of information), can be influenced by various types of causes (e.g., figure-ground contrast, prior exposure, duration of exposure), and in turn can influence diverse variables (e.g., feeling of familiarity, positive affect, illusion of truth).

5.1.1 Types & Causes of Fluency

In the literature there are several types of fluency. For instance, conceptual fluency denotes a basic metacognitive feeling of ease/difficulty that is experienced because of semantic relatedness of stimuli (e.g., Whittlesea, 1993). Accordingly, it is usually manipulated through variables like, for example, semantic priming or semantic ambiguity. Perceptual fluency, however, is a basic metacognitive feeling of ease/difficulty that is experienced because of physical properties of stimuli (e.g., Jacoby, 1983; Jacoby, Kelley, & Dywan, 1989). Accordingly, it is often manipulated by variables like, for example, repetition, contrast, or duration. Retrieval fluency is a basic metacognitive feeling of ease/difficulty that is experienced while retrieving information from memory (e.g., Benjamin & Bjork, 1996). Accordingly, it is usually manipulated by variables like, for instance, priming, context influences, or the amount of material that has to be recalled.

In the following, several relevant variables are introduced that are known to have an influence on fluency (for reviews see, Alter & Oppenheimer, 2009; Reber et al., 2004). On the one hand, fluency can vary in faster lower level processes. For instance, basic perceptual variables, like the duration of stimulus presentation can influence processing fluency (e.g., Topolinski, Erle, & Reber, 2015; Whittlesea, Jacoby, & Girard, 1990). That is, the more time is available the easier it is to perceive all aspects of a stimulus. Another very basic variable is figure-ground contrast, referring to the fact that a stimulus is easier to perceive when the color of that stimulus is much brighter or darker than the color of the background (e.g., Reber & Schwarz, 1999). Also, the readability of typefaces (e.g., Song & Schwarz, 2008) or handwritings (e.g., Greifeneder et al., 2010) can influence processing fluency, that is, words are more fluently processed when they are written in letters that can be identified quickly and precisely. Spoken words can be more or less fluent as well, dependent on, for instance, the speaker's foreign accent (Levy - Ari & Keysar, 2010). Also, word themselves can also be inherently more or less fluent because of their pronounceability (e.g., Song & Schwarz, 2009).

On the other hand, fluency can vary in higher level processes. One of the more complex variables is, for instance, the accessibility of knowledge that is conceptually related to the to-be-processed stimuli (e.g., Reder, 1987). For instance, the accessibility of related content can facilitate the processing of a stimulus. Also, the complexity of a message itself that is conveyed has an influence on the processing (e.g., Lowrey, 1998), that is, the more complex the topic itself is, the more resources are needed for processing it. There are also more indirect influences like, for instance, corrugator supercilii muscle activity that negatively influences the ease of recall of autobiographical events and in turn according judgments (e.g., Stepper & Strack, 1993), or the judgment of a person's fame when reading names (e.g., Strack & Neumann, 2000). Here, the activity of the corrugator muscle induces a feeling of intense effort that is misinterpreted as the difficulty the task. Also, when using unusual body parts for rather easy actions, a feeling of difficulty is evoked that can be misattributed on the task (e.g., Briñol & Petty, 2003).

The metacognitive feeling of fluency is experienced particularly when there is a change in fluency from one stimulus to another, than when the input of information is rather stable regarding its processing fluency (e.g., Schwarz, 2012). That is, people are more sensitive to fluency experiences when one stimulus is more fluent than another, than when there is a continuous series of similar fluent stimuli. This is why fluency manipulations are more effective when adopted in within-subject designs than in between-subject designs, thus, inducing phasic rather than tonic experience modulations (e.g., Dechêne, Stahl, Hansen, & Wänke, 2009; Hansen, Dechêne, & Wänke, 2008; Shen, Jiang, & Adaval, 2010; Topolinski & Deutsch, 2012, 2013).

5.1.2 Consequences of Fluency

Processing fluency can have profound consequences on psychological processes. One basic and stable finding is, for instance, that easy processing is intrinsically experienced as positive (e.g., Diener et al., 1985; Reber et al., 2004; Topolinski & Strack, 2009a, 2009b, 2009c, 2009d, 2010; Whittlesea & Williams, 1998; Winkielman & Cacioppo, 2001). This positive feeling can be measured explicitly by participants' self-reports (e.g., Monahan et al., 2000; Zajonc, 1968) or by physiological measurements (e.g., EEG, EMG; Harmon-Jones & Allen, 1996, 2001; Topolinski et al., 2009; Topolinski & Strack, 2015; Winkielman & Cacioppo, 2001). Self-report measures asking, for instance, for personal preferences have been shown to be an appropriate way of capturing what participants' attitudes towards stimuli are, unless they are socially inappropriate or not accessible to participants' consciousness.

Given the fact that affect automatically elicits specific facial expressions (e.g., Cacioppo, Petty, Losch, & Kim, 1986; Ekman, 1973), EMG measurements are a well-established way to examine slight affective responses to stimuli that evoke very fast and very subtle facial muscle reactions that are not visible to the naked eye (e.g., Dimberg, Thunberg, & Elmehed, 2000). Studies have shown that EMG activity of the zygomaticus major muscle can be indicative of positive affect, whereas activity of the corrugator supercilii can be indicative of negative affect (Dimberg, 1990; Lang, Greenwald, Bradley, & Hamm, 1993). In the case of the well-known *mere exposure effect* (for a reviews, see Bornstein, 1989; Moreland & Topolinski, 2010; Zajonc, 2000), for instance, participants explicitly evaluate stimuli that they have seen before as more positive than stimuli that they have not seen before. The mere prior exposure causes a gain in processing fluency for the old stimuli compared to the new stimuli, which in turn leads to higher preference judgments for old over new stimuli. Similarly, EMG studies have shown that the zygomaticus major muscle is activated when fluent stimuli are perceived (for a review, see Winkielman et al., 2003). Thus, with both methods - explicitly and implicitly - positive affect was detected as a consequence of fluently processed stimuli. In the following subsection (4.1.3 The Underlying Mechanism of Fluency) positive affect as the underlying mechanism of fluency is explained more elaborately.

Probably due to the positive feeling fluent processing causes, it seems to influence basic information processing styles as well (e.g., Fredrickson, 2001; for reviews see Schwarz, 2002; Schwarz & Clore, 2007). Processing styles (analytic vs. heuristic) can be influenced by various environmental cues as well as from the metacognitive cue of processing fluency. Specifically, it is assumed that whenever a situation is perceived as problematic or even dangerous, an analytic processing style is activated. Whereas in a situation that is perceived as benign or safe, a rather heuristic processing is activated. A positive feeling that is caused by fluent processing signals the absence of danger (e.g., Song & Schwarz, 2009) and therefore, allows for less analytic and more resource-saving heuristic processing styles (e.g., Song & Schwarz, 2008). Whereas a feeling of difficulty caused by disfluent processing signals that there might be a problematic or dangerous situation that affords a more systematic and analytic processing of the situation.

For instance, in a study by Song and Schwarz (2008) this was demonstrated with the so-called *Moses illusion* (Erickson & Mattson, 1981). When beings asked “How many animals of each kind did Moses take on the Ark?” people mostly respond “Two”, even though they would have known that Noah was the Ark-builder. However, when the question is printed in a hard-to-read typeface, participants were more likely give the right answer than when the question was printed in an easy-to-read typeface (see

Figure 6 for an example). This can be interpreted in the way that the processing fluency that was influenced by the difficult (easy) typeface of the question caused an analytic (heuristic) processing style that in turn led to increased likelihood for the correct (wrong) answer.

Figure 6. Examples for fluent (top row) and disfluent (bottom row) typefaces that influence the chance of answering correctly to the question.

Another prominent consequence of fluent processing is the feeling of familiarity. There are various ways to induce a feeling of familiarity via processing fluency, whereas the act of recalling information seems not to be affected by fluency manipulations (for a review, see Yonelinas, 2002). Also in this case, positive affect seems to play a crucial role. Specifically, there seems to be a bidirectional relation between familiarity and positivity. Familiar information feels safe and good and positive affect can elicit an illusion of familiarity (Garcia-Marques & Mackie, 2001; Garcia-Marques, Mackie, Claypool, & Garcia-Marques, 2004; Monin, 2003; Phaf & Rotteveel, 2005; Rotteveel & Phaf, 2007). Interestingly, it has been shown that when participants are in a negative mood they show stronger mere exposure effects than when being in a positive mood (de Vries, Holland, Chenier, Starr, & Winkielman, 2010). The authors argue that being in sad mood can be a signal of a problematic or dangerous situation leading to a higher valuation of familiar objects, whereas being in a happy mood can be a signal of a safe situation leading to exploratory attitude toward novelty.

Another consequence of processing fluency is the illusion of truth of a message. Even trivia statements and words from a foreign language are perceived as more likely to be true when they are expressed in a fluent way (e.g., Begg, Anas, & Farinacci, 1992; Hasher, Goldstein, & Toppino, 1977; Unkelbach, 2007). Also, for applied marketing this has been shown to have profound implications. Fluent advertising claims appear more trustworthy than disfluent claims (e.g., Hawkins & Hoch, 1992). Also political messages appear more credible when they are formulated in more fluent way (Arkes, Hackett, & Boehm, 1989). Moreover, it has been shown that eyewitness testimonies have a stronger impact when they have become more fluent by mere repetition of the testimony (Foster et al., 2012).

Overall, on the one hand, processing fluency as a metacognitive experience accompanying information processing can be influenced by various causes on a rather basic processing level as well as on a higher processing level. On the other hand, processing fluency can have tremendous consequences on various psychological variables.

5.1.3 The Underlying Mechanism of Fluency

In the previous section, the various types, causes and consequences of processing fluency have been described. In the following part the assumed underlying mechanism of the judgmental consequences of processing fluency is explained in more detail.

As already mentioned, processing fluency depends on the ease and speed with which information is processed (e.g., Reber at al., 2004) and seems to be hedonically marked (e.g., Diener et al., 1985; Topolinski & Strack, 2009a, 2010; Whittlesea & Williams, 1998; Winkielman & Cacioppo, 2001). There are several variables that might explain why fluent stimuli might be hedonically marked at all (for fluency-affect link see, Winkielman et al., 2003). According to Winkielman and colleagues (2003) the fact that fluency serves as a cue of familiarity, prototypicality, symmetry, and of cognitive progress, gives insight into the underlying mechanism.

Fluency as a cue of familiarity is linked to positive affect, because from an evolutionary perspective it is advantageous to be cautious with novel objects and to have a preference for objects that seem more familiar, given the fact that they are less likely to be harmful (Zajonc, 1968, 1998). Importantly, this preference for fluent rather than disfluent stimuli is assumed to be mediated by positive affect being elicited by fluent processing. Studies have shown that fluent processing elicits positive affect that also can be captured with psychophysiological measures. This affect itself can be a basis of a judgment of preferences or valence. According to the feeling-as-information model, feelings can serve as a source of information when not explicitly presented as a possible misattribution influence (for an overview, see Schwarz & Clore, 2007).

Fluency as a cue of prototypicality and symmetry is linked to positive affect and experienced as physically attractive. Again, from a biological perspective, animals as well as human beings prefer physically attractive mating partners (short- & long-term) because there seems to be an inherent association with high genetic fitness, positive mating quality, health and fertility (e.g., Buss & Schmitt, 1993; Gangestad & Simpson, 2000; Gangestad & Thornhill, 1997; Greiling & Buss, 2000; Haselton & Gangestad, 2006; Kenrick & Keefe, 1992; Li & Kenrick, 2006; Pillsworth & Haselton, 2006; Scheib, 2001; Scheib, Gangestad, & Thornhill, 1999; Singh, 1993; Thornhill & Gangstead, 1993). However, for humans this preference is not limited to human faces (e.g., Langlois & Roggman, 1990; Rhodes & Tremewan, 1996) but can also be generalized on prototypical and symmetrical shapes and objects (e.g., Berlyne, 1974; Halberstadt & Rhodes, 2000; Martindale & Moore, 1988). Importantly, it is assumed that familiarity might play a crucial role here as well, because it is inherent to prototypicality by definition.

Finally, fluency as a cue of cognitive progress is linked to positive affect, because it entails positive feedback about a current cognitive process. A fluent process signals a feeling of progress towards recognizing the environment without error and with related relevant knowledge being available for further actions that might be necessary (Carver & Scheier, 1990; Derryberry & Tucker, 1994; Fernandez-Duque, Baird, & Posner, 2000; Schwarz, 2002; Simon, 1967; Ramachandran & Hirstein, 1999; Vallacher & Nowak, 1999; Winkielman, Schwarz, & Nowak, 2002). This can, for instance, be elicited by easier, faster and more coherent processing of word triads that bear a common remote associate than of word triads that do not bear a common remote associate and thus are incoherent (Topolinski & Strack 2009).

Overall, it seems that identifying stimuli fast and easily has adaptive values on its own, which in turn elicits positive affect that is measurable with explicit self-reports as well as psychophysiological measures.

5.2 Embodied Groundings of Fluency

As previously described, there are various sources of processing fluency (see Chapter 5.1.1 Types and Causes of Fluency). Another source that needs to be explained more elaborately for the current work lays in the efficiency of motoric actions. In this vein, processing fluency can also be embedded into the embodied cognition theory (see also Chapter 2.6 Excursus on Embodied Cognition). In the following section several embodied cognition examples from the fluency literature are explained, because they are relevant for the theoretical rationale behind the proposed fluency-account of the in-out effect by Topolinski et al. (2014).

5.2.1 Embodiment & Fluency in General

As previously explained, the embodied cognition theory (e.g., Barsalou, 1999; Schubert & Semin, 2009; Semin & Smith, 2008) states that all kind of representations of stimuli also consist of sensorimotor simulations in the sensorimotor system, dependent on the stimulus' inherent affordances (e.g., Glenberg & Robertson, 2000; Masson, Bub, & Warren, 2008; Niedenthal et al., 2005). Hence, whenever a stimulus is perceived the specific affordances a stimulus entails are also activated and simulated.

In a well-known experiment by Van den Bergh, Vrana, and Eelen (1990; see also Beilock & Holt, 2007) they studied sensorimotor simulations of object-related affordances and its affective consequences due to processing fluency. They showed that skilled typists preferred letter pairs that were to-be-typed with two fingers over those that were to-be-typed with the same finger. Thus, merely perceiving the letter pairs already made them simulate the act of typing them, or more specifically, with which finger they would have to type the letters. The easier the typing could theoretically be accomplished the more they were preferred by the typists. Thus, the higher the fluency of the sensorimotor simulation was, the higher the preference for the letter pairs.

Moreover, in a study in the domain of art appreciation it was demonstrated that matching the perceivers' hand movements to the previous movements of the artist that were executed during production of the piece of art, leads to higher preferences for the artwork than when interfering with a different hand movement (Leder, Bär, & Topolinski, 2012). Assuming that merely perceiving artwork may trigger sensorimotor simulations of movements that are necessary during the production of that piece of art (e.g., Freedberg & Galese, 2007), it is conceivable that a different movement might interfere with a fluent processing of the artwork, whereas a matching movement might facilitate the processing of the artwork. Similarly, Topolinski (2010) demonstrated that even trained eye-movements can increase preferences for similar stimulus movements compared to novel stimulus movements, even without previous stimulus perception. Thus, the mere repetition of the eye-movement resulted in a more efficient processing of the visual stimuli.

Similarly, Shen and Sengupta (2012) demonstrated across several studies that when preventing participants from sensorimotor simulations that a specific target-object would afford (e.g., reaching out for it and holding it), it impaired evaluations of that target object. Specifically, they showed that participants who had to hold a ball in their dominant hand when evaluating objects like, for instance, a box of candies, evaluated the candies less positive compared to participants holding the ball in their non-dominant hand. They argue that the processing ease of the target objects (e.g., box of candies) was declined by interfering the sensorimotor simulation of reaching out for the candies and grasping them with a blocking movement of holding ball. Interestingly, this effect was only found when the nature of the object afforded a hand movement like, for instance, holding it.

Importantly, fluency effects have not only been shown with stimulus specific sensorimotor simulations but also with executed motoric actions. In line with that Casasanto and Chrysikou (2011), for instance, have shown that the efficiency of executed manual motor experiences have an influence on mappings of left and right space laterality to negative and positive valence categories. Thus, not only the ease of simulated but also of executed motor experiences can have an influence on stimulus evaluations (see also Casasanto, 2009).

To conclude, beside the actual ease of movement execution also the execution of stimulus specific sensorimotor simulations play a crucial role in processing and evaluating stimuli that afford specific actions. These sensorimotor simulations can be trained by repetition and thereby increase the processing fluency of a stimulus. Given the fact that whenever a stimulus is perceived, associated sensorimotor simulations are activated, each encounter with the stimulus serves as a simulation-training that enhances the efficiency of the specific sensorimotor simulation which in turn elicits positive affect. However, when these stimulus specific sensorimotor simulations are prevented by blocking the specific effectors, fluency gains can be blocked. In the following section this is explained in more detail for the domain of oral fluency processes.

5.2.2 Embodiment & Oral Fluency

Processing fluency is also an intensely researched topic in the domain of verbal stimuli that trigger oral sensorimotor simulations. The most influential studies are explained in more detail in the following section.

Whenever we encounter a verbal stimulus, the automatic and overlearned response of reading and pronouncing it, is activated (e.g., Stroop, 1935). This is why there is interference shown in reaction times when participants have to name the color of the ink of a word that denotes to another colorword (e.g., the word "red" printed in green color). Also in the oral domain, the sensorimotor simulations - due to the affordances of verbal stimuli - can be more fluent with repetitions. In line with that, Topolinski and Strack (2009, 2010) stated that increased fluency of sensorimotor simulations of pronouncing verbal stimuli constitutes the underlying mechanism for the previously explained mere-exposure effect (Zajonc, 1968; for a reviews, see Bornstein, 1989; Zajonc, 2000). They argued that no overt vocalization would be necessary, given the fact that merely perceiving verbal stimuli leads to covert simulation of articulation kinematics (e.g., Barsalou et al., 2008; Stroop, 1935). Specifically, they assumed that the preference for repeated verbal stimuli over novel ones would be elicited by positive affect being evoked by pronunciation simulations experienced as being more fluent (see also Topolinski, Lindner, & Freudenberg, 2013).

To demonstrate this, they manipulated whether or not sensorimotor simulations of pronouncing verbal stimuli were possible to execute. Participants were presented with words as verbal stimuli and Chinese ideographs as visual control stimuli that had to be evaluated spontaneously. Importantly, the manipulation of sensorimotor simulations was operationalized by means of an interfering oral motor task, namely chewing a tasteless gum, or by a non-interfering manual motor task, namely kneading a soft foam-ball. The results showed that participants in the manual motor task condition showed the classic mere exposure effect, namely that repeated verbal as well as visual stimuli were preferred over novel ones. Crucially, for participants in the oral motor task condition the classic mere exposure effect could only be found for visual stimuli but no longer for verbal stimuli, that is repeated verbal as well as visual stimuli were preferred over novel ones. Thus, the prevention of simulating the pronunciation of words inhibited a training effect that classically leads to a fluency gain. In turn, the fluent pronunciation simulation elicited positive affect that was attributed to the stimuli. This demonstrates the role of fluency of oral sensorimotor simulations in the generation of attitudes towards words. On top of that, in a following experiment, they demonstrated by means of a double dissociation of two types of stimuli (words vs. tunes), that a tongue-movement interference task destroyed the mere exposure effect for words but not for tunes, whereas a vocal interference task destroyed the mere exposure effect for tunes but not for words. Thus, the gain in simulation fluency is specifically tied to the modality involved in the movement.

Interestingly, Topolinski and Strack (2010) could generalize their notion that fluency gains are dependent on stimulus-specific sensorimotor simulations by means of preventing another oral fluency effect, namely the false fame effect (Jacoby et al., 1989). Classically, in this paradigm participants are presented a series of names and are explicitly told, that they are not famous. In a subsequent test-phase participants receive those names together with new names and have to judge how famous they are. Notably, for participants who received the judgment task one day after the day of name presentation, the old names were more likely to be judged to be referring to famous persons than novel names. Whereas, for participants who received the judgment task immediately after name presentation the old names were as likely to be judged as famous as novel ones. Thus, the immediate presentation allowed for correction of the judgment, whereas the delayed presentation did not. Again, by blocking oral movement versus manual movements, Topolinski and Strack (2010) showed that also this effect was substantially dependent on the fluency of oral sensorimotor simulations.

There are also other well-known effects that might rely on the fluency of oral sensorimotor simulations as well. For instance, unknown aphorisms that are phrased in a rhyming (e.g., "Caution and measure will win you treasure.") rather than a non-rhyming (e.g., "Caution and measure will win you riches.") pattern, are more likely to be judged as being true. This might also be due to the fact that a rhyme entails at least two partially same sounding words. Thus, by mere repetition of similar sounds the sentence is experienced as more fluent to pronounce, leading to increased truth-judgments.

In line with the findings of Topolinski and Strack (2009, 2010) it is conceivable that also for the in-out effect (Topolinski et al., 2014) oral motor fluency might play a crucial role. The literature has shown that mere pronunciation efficiency can elicit higher preference ratings for easy-to-pronounce compared to hard-to-pronounce words (e.g., Song & Schwarz, 2009). So far, the pronunciation efficiency has not been studied for the in-out effect. However, if inward words are easier and faster to process than outward words, then processing fluency would be a legitimate alternative explanation for the in-out effect. The possible underlying mechanisms of this possibility are explained in the following two sections.

5.3 Fluency as an Underlying Mechanism of the In-Out Effect

Regarding the in-out effect of Topolinski et al. (2014), there are two possible reasons why inward words might be experienced as being more fluent than outward words, which in turn might lead to the finding that inward words are preferred over outward words. First, consonantal inward movements might be easier to execute than consonantal outward movements because the biomechanics of our speech organs might be inherently structured in way that facilitates consonantal inward over outward pronunciations. Second, consonantal inward movements might be easier to execute than consonantal outward movements because our speech organs might be repeatedly trained by an external influence that thereby facilitates consonantal inward over outward pronunciations. In the following two sections, these two possibilities are elaborated.

5.3.1 Inherent Biomechanics as an Underlying Mechanism of the In-Out Effect

First, some movements are easier to execute than others, due to mere biomechanics (e.g., Brand, Breach, & Thompson, 1981; Cruse, 1986; Nelson, 1983). For instance, flexing fingers is easier than extending them (Ann, 1996). Applied to oral inward and outward dynamics, swallowing is motorically easier than expectorating, because in contrast to deglutition, emesis involves a series of strong spasmodic muscle contractions (Lumsden & Holden, 1969). Moreover, a bulk of literature has shown that more efficient movements trigger positive feelings (e.g., Beilock & Holt, 2007; Cannon, Hayes, & Tipper, 2010; Casasanto & Chrysikou, 2011; Leder et al., 2012; Ping, Dhillon, & Beilock, 2009; Regenberg, Häfner, & Semin, 2012; Topolinski, 2010; Van den Bergh et al., 1990).

As described above, also in the oral domain (Song & Schwarz, 2009; Topolinski & Strack, 2009a, 2010; Vrana & Van den Bergh, 1995) the efficiency of pronunciation simulations can have profound effects on word preferences. Thus, it might be the case that the inherent biomechanics of our speech-organs that are needed to pronounce words, are better suited to articulate inward compared to outward words, which in turn causes differences in word-preferences (see Figure 7). In other words, given the fact that muscular dynamics similar to the articulation of inward words (swallowing) are known to be motorically easier than muscular dynamics similar to articulating outward words (expectorating; Lumsden & Holden, 1969), it is conceivable that inward words are simply easier to pronounce than outward words, which could completely explain the in-out phenomenon.

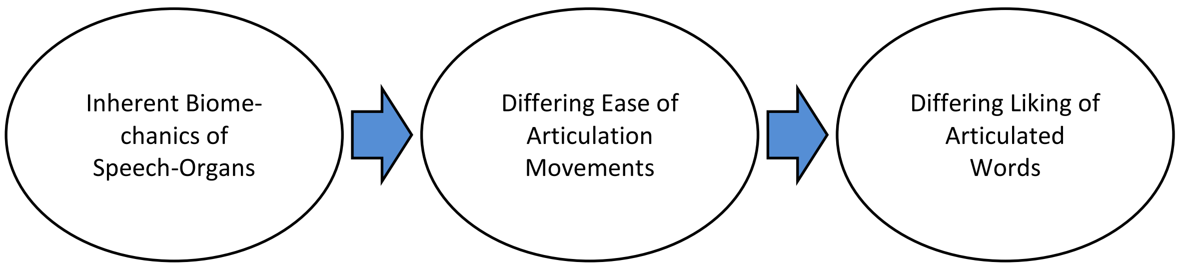

Figure 7. Inherent biomechanics of speech-organs as a possible underlying mechanism of the in-out effect (Topolinski et al., 2014).

5.3.2 Frequency of Occurrence as an Underlying Mechanism of the In-Out Effect

Besides mere inherent biomechanics, there is another possible reason why inward words could be higher in processing fluency than outward words. Anybody who has ever tried to learn a choreography with a specific sequence of movements has experienced that in general, some movement sequences can be easier (harder) to execute than others because they have been exerted more (less) often in the past. In fact, as the fluency literature has shown, such movement repetitions can increase processing fluency which, in turn, can trigger positive affect (for the oral domain, see Topolinski & Strack, 2009a, 2010). Even when not being overtly articulated, words than have been covertly simulated before have been shown to be more fluently processed the next time and are in turn preferred over novel words.

For verbal stimuli, a likely source for such an articulation movement training lies in the nature of language itself. That is, it might be simply the fact that consonantal inward movements are more frequent in natural language than outward movements, are thereby trained more excessively and in turn differ in processing fluency and consequently in preference ratings (see Figure 8).

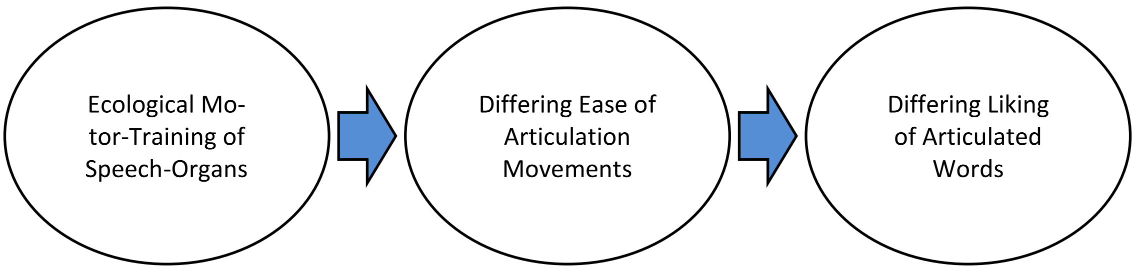

Figure 8. Ecological motor-training of speech-organs as a possible underlying mechanism of the in-out effect (Topolinski et al., 2014).

As already explained in a previous section (Chapter 4), ecological factors like language have been shown to shape psychological responses (e.g., Fiedler, 1996, 2000; Unkelbach et al., 2008). Particularly, frequencies and other features of language are well-researched ecological factors that determine evaluations and judgments (e.g., Broadbent, 1967; Hintzman, 1988; Semin & Fiedler, 1988, 1992; Smith & Semin, 2004; Zipf, 1932).

Importantly, word frequencies in language have been shown to influence the efficiency of language processing (e.g., Balota & Chumbley, 1985; Brysbaert & New, 2009; Ellis, 2002; Grainger, 1990). For instance, as explained previously, in a study by Balota and Chumbley (1985) it has been demonstrated that word frequencies do not only have an influence on the efficiency of lexical access but importantly also on the efficiency of mere word pronunciation. Thus, for making a relevant argument for the in-out effect of Topolinski et al. (2014) it should be investigated whether frequency differences can be found for inward compared to outward consonantal dynamics in languages where the in-out effect has been found. If there would be more inward than outward dynamics, it is conceivable that that these frequency differences lead to more efficient pronunciation of inward compared to outward dynamics which in turn could explain why inward words are preferred over outward words.

In sum, both, a fluency gain for inward words due to inherent biomechanical structures or due to training of movements by higher frequencies in language, are conceivable. However, given the fact that a test of the biomechanical contribution to articulation ease is beyond a psychological examination, this has not been tested in the current work. Still, a fluency gain of inward over outward words due to language characteristics and articulation training is psychologically testable and was therefore examined in the present work. The following section provides an overview of the hypotheses and studies.

CHAPTER 6 - Overview of Present Work & Hypotheses

Aim of the present work was to systematically test the role of fluency for the in-out effect reported by Topolinski et al. (2014). Eight studies were conducted to investigate whether consonantal inward kinematics are more fluently processed than consonantal outward kinematics, where this fluency might originate from, and what role it plays for the underlying mechanisms of the in-out effect.

First, a potential linguistic source of fluency was examined in the two languages where the in-out effect has been found originally, namely English and German. *Study 1a* and *Study 1b* analyzed English and German corpus data to explore the phonotactic frequencies of consonantal inward and outward kinematics. I expected to find in both corpora, for English and German, that there are more consonantal inward than outward kinematics.

Second, *Study 2a* and *Study 2b* tested experimentally if inward words are easier to articulate overtly than outward words. This was tested by means of measuring the onset latency of participants' vocal articulation response. In order to get a precise measure independent from specific recording capabilities of one specific programming software, the study was conducted with two different kinds of software. Because I expected inward words to be easier to be articulated than outward words, I expected faster vocal articulation onset latencies for inward words than for outward words.

Third, in *Study 3* it was explored whether silent reading durations might differ between inward and outward words. Studying silent reading durations is important for the argument of a fluency-account because the original finding by Topolinski et al. (2014) has mainly been shown in silent reading tasks. Therefore, the reaction times of key press responses after finishing reading have been measured in this study. I hypothesized here that inward words would also be silently articulated faster than outward words, because inward words are also silently easier to articulate than outward words.

Fourth, *Study 4a* and *Study 4b* examined whether such fluency differences could also hold for subjective fluency ratings. Subjectively experienced ease of the articulation of inward and outward words was examined with an English as well as with a

German speaking sample. By means of self-reported ease ratings, subjectively experienced ease of articulation was measured. Here, the hypothesis was that inward words would also be subjectively experienced as being easier to pronounce than outward words.

Fifth, in *Study 5* and *Study 6* it was planned to test whether processing fluency in the form of subjective processing fluency as well as objective processing fluency would partially or completely mediate the influence of consonantal inward and outward kinematics on preference for inward and outward words. In *Study 5* item-based analyses were conducted, including the variables from the previously mentioned studies (average explicit liking, voice onset latency in overt reading, silent reading latency and experienced ease). In Study 6 mediation analyses were conducted with data on subject-level from a within study design that measured explicit preferences and experienced ease of inward and outward words. In both studies the hypothesis was that objective and subjective fluency would mediate the effect of consonantal inward and outward kinematics on preference for inward and outward words.

Finally, because of advantages of interaction testing over mediation testing (see, Jacoby & Sassenberg, 2011; Spencer, Zanna, & Fong, 2005), in *Study 7* and *Study 8* it was tested whether higher evaluations of inward words over outward words can be influenced by fluency gains. In both studies articulation ease was actively manipulated by letting participants train inward or outward kinematics. In a subsequent phase it was tested whether this articulation training would modulate the in-out effect. Thus, the ease of pronunciation was changed by a simulation training of respective kinematic directions in order to test whether subsequent explicit liking ratings of inward and outward words would be changed. Additionally, in *Study 8* the simulation training was intensified to see whether a stronger modulation of the in-out effect could be found. For both studies, I hypothesized that a kinematic training of outward words would result in more positive evaluations of outward words than inward words. For a kinematic training of inward words a stronger classic in-out effect was expected. In addition, a stronger modulation as a result of a stronger articulation training was expected in *Study 8*.

CHAPTER 7 – Linguistic Fluency Source

7.1 Studies 1a and 1b: Corpus Analyses

The following studies have been conducted to find a potential linguistic source of fluency for the in-out effect. The idea was that the phenomenon that inward words are preferred over outward words might not exclusively rely on motivational states being activated but also on the fluency of the articulatory motor-simulation that the words trigger automatically. Thus, simulating the inward word MENIKA might be motorically easier to articulate than the outward word KENIMA which might in turn influence the attitude toward those words.

The theoretical rationale behind that is that the ease of sensorimotor simulations has been shown to have profound influences on preferences (e.g., Beilock & Holt, 2007; Leder et al., 2012; Shen & Sengupta, 2012; Topolinski, 2010; Van et al., 1990). Given the fact that it has been shown that word frequencies in language have an influence on fluency of language processing (e.g., Balota & Chumbley, 1985; Brysbaert & New, 2009; Ellis, 2002; Grainger, 1990), it is conceivable that a possible source of these fluency differences of sensorimotor articulation simulations might lie in the nature of language. Specifically, inward words might be easier to articulate than outward words because consonantal inward wanderings are simply more common in natural language than outward wanderings, which consequently leads to the fact that consonantal inward dynamics are naturally more trained motorically than outward dynamics.

To explore this argument, the phonotactic frequencies of consonantal inward and outward dynamics were studied in the two languages addressed in Topolinski et al. (2014), namely English and German. English and German corpus data were analyzed to count the phonotactic frequencies of consonantal inward and outward kinematics. It is important to note that natural words rarely feature systematic kinematics, such as MASTER, STRIKE, and STRONG feature inward, and ACROSS, ACTIVE, and CLAIM feature outward kinematics of several consecutive consonantal phonemes (IPA, 1999). Those words are rather exceptions in contrast to words like, for example, DISCOVER, BECOMING, and MILKSHAKE that roughly feature an inward, then an outward and finally an inward kinematic. Also other mixed consonantal kinematics are more common in natural language than pure inward and outward kinematics.

However, restraining the analysis to these very rare cases would limit the interpretability of the present analysis. Thus, I used the following logic to include most words in a given language corpus. By definition, an inward word starts with a front consonant (e.g., B) and ends with a back consonant (e.g., K). Conversely, an outward word starts with a back consonant and ends with a front consonant. Thus, assessing the frequencies of front and back consonants occurring as first and last consonants in natural words yields a rough yet valid estimate of inward and outward dynamics. For instance, if a given word starts with a front consonant, whatever further consonantal sequences might occur, their overall trajectory can only be inwards (even if there are partial reversals).

For the English language, the corpus provided by Warriner, Kuperman, and Brysbaert (2013) was used. It is a compilation out of older and small-sized corpora. One of them was, for example, developed by Bradley and Lang (1999) that featured only 1,034 words. The new version by Warriner et al. (2013) features more than fifty times that amount. For the German language, the corpus provided by Brysbaert and colleagues (2011) was used. It consists of the SUBTLEX-DE corpus that originally featured 377,524 words. Due to stricter rules applied, the new version by Brysbaert et al. (2011) features roughly half that amount.

7.1.1 Hypothesis

Following the proposition that natural language might be an ecological source of higher motor fluency for inward over outward words, I expected to find higher frequencies of inward words than outward words in languages where the in-out effect has been observed before, namely in English as well as in German.

7.1.2 Design

The hypothesis was tested using two (for front and back consonantal separate) one-factorial within design with the factor of Letter-Position Within a Word (first vs. last) as the within factor.

7.1.3 Method

Materials. For the English language, the 60,384 most common English words according to Warriner et al. (2013) were used. This corpus was composed out of the following sources: Bradley and Lang's (1999) ANEW database, Van Overschelde, Rawson, and Dunlosky's (2004) category norms, and the SUBTLEX-US corpus (Brysbaert & New, 2009). From the about 50-million-token SUBTLEX-US subtitle corpus about 30,000 lemmas (nouns, verbs, and adjectives) were chosen. For their new corpus, Warriner and colleagues chose only words with the highest-frequency that were known by at least 70 % of raters in a study by Kuperman, Stadthagen-Gonzalez, and Brysbaert (2012). Overall, this procedure resulted in 60,384 words.

For the German language, the 190,501 most common German words according to Brysbaert et al. (2011) were used. It was generated out of the about 25-million-token SUBTLEX-DE corpus that originally featured 377,524 words. For their new corpus, Brysbaert and colleagues excluded words that started with non-alphabetic characters as well as words that were not observed in another corpus provided by Google. Overall, this procedure resulted in 190,501 words.

For both corpora, I discarded words from the analysis that did not contain any or just a single consonant, because these words do not feature any consonantal kinematics by definition. Finally, this resulted in two corpora featuring 59,844 words for the English language and 189,176 words for the German language.

Procedure. To assure validity with regard to the previously published in-out effect, I confined the analysis to those consonants that were actually used in the Topolinski et al. (2014) studies. Those were the front consonants B, F, M, and P for the English language, and B, M, P, and W for the German language; and the back consonants K for the English language, and G, K, and R for the German language. (Please note that in the following, I refer to *first* and *last consonants* as the first and last consonant within a single word and to *front* and *back consonants* as the front or back localization of the articulation spot of consonants within the mouth.) For each word, only the first and last consonants were analyzed. Importantly, the analyses were not restricted to those words that started and ended with a consonant (which would have reduced the corpus considerably), but involved also words for which the very first or last letter was a vowel. Vowels are irrelevant for the in-out effect because the phonation of vowels does not require narrow localized muscle strictures but rather broad oral and facial expressions (Ladefoged, 2001a, 2001b, 2006). Accordingly, words like, for instance, BOOK and EBONY both have the front consonant B as the first consonantal phoneme and thus have been analyzed in the same manner regarding their first consonant.

For the following analyses, the frequencies of front and back consonants, being the first and/or last consonants in a given word, were counted. Of course, these frequencies are strongly influenced by the general frequency of a given letter (e.g., M is more frequent than K) and by the number of letters constituting a group (e.g., English front consonants contained B, F, M and P, while English back consonants contained only K). However, this is not a confounding variable in the following analyses, because the following statistical tests were run only for each single consonant group, and not between consonant groups. Thus, for instance, even if K is less frequent than M, this should not influence whether K is more often the first or last consonant in a word.

7.1.4 Results

Study 1a. A McNemar test showed that in the English corpus front consonants were more frequently the first consonant (27.20 %) than the last consonant (4.60 %), $\chi^2(1) = 10{,}406.27$, $p < .001$; and that the back consonant was more frequently the last consonant (1.90 %) than the first consonant (1.10 %), $\chi^2(1) = 135.76$, $p < .001$.

Comparing the frequencies of words consisting of a front consonant as the first consonant and a back consonant as the last consonant (inward words) to those consisting of a back consonant as the first consonant and a front consonant as the last letter (outward words) yields the possibility to compare the frequencies of overall inward vs. outward wandering words. A McNemar test indicated that in the English corpus there were more inward wandering words (0.54 %) than outward wandering words (0.10 %), $\chi^2(1) = 179.27$, $p < .001$.

Study 1b. A McNemar test showed that in the German corpus front consonants were more frequently the first consonant (23.30 %) than the last consonant (5.50 %), $\chi^2(1) = 23{,}080.03$, $p < .001$; and back consonants were more frequently the last consonant (20.30 %) than the first consonant (18.70 %), $\chi^2(1) = 165.90$, $p < .001$.

Again, the possibility to compare the frequencies of overall inward vs. outward wandering words was employed as explained in Study 1a. A McNemar test indicated here that when comparing the frequencies of overall inward vs. outward wandering words, in the German corpus there were more overall inward wandering words (4.70 %) than overall outward wandering words (1.05 %), $\chi^2 (1) = 4{,}391.62$, $p < .001$.

7.1.5 Discussion

By analyzing the occurrences of front and back consonants in starting or ending positions of natural words in English and German, I found that front consonants are more often the starting consonant and back consonants are more often the ending consonant in a word, which implies an inward direction. Restricting the analyses to words for which the starting and ending consonants are front and back respectively or back and front consonants respectively, I even found that there are more *natural* inward than outward words. This is strong support for the hypothesis that language itself features more inward than outward dynamics, and that individuals are more often exposed to the former than to the latter category. Thus, natural language on its own could be considered as a natural ecological source of higher motor fluency for inward over outward words. In turn, this higher fluency might be the ground for higher preferences found for inward over outward words (Topolinski et al., 2014).

As a consequence of this natural sensorimotor simulation training caused by linguistic means, English and German speaking participants should be faster in articulating inward than outward wandering transitions of consonants. This was experimentally tested in the following Study 2a and Study 2b.

CHAPTER 8 – Objective and Subjective Fluency

8.1 Studies 2a and 2b: Overt Articulation Latency

The goal of Studies 2a and 2b was to obtain an objective measurement of articulation fluency of inward and outward words. Studies 1a and 1b have demonstrated that the English and German languages naturally serve as a higher sensorimotor simulation and regular motor training of articulating inward compared to outward dynamics. Thus, language could be considered as a natural ecological source of higher motor fluency for inward over outward words. Given the fact that in the literature it has been shown that word frequencies in natural langue have profound influences on pronunciation fluency (Balota & Chumbley, 1985), the next logical step is to study objective pronunciation fluency.

Thus, for the purpose of measuring the objective fluency of the articulation of inward and outward words, participants were asked to read aloud inward and outward words as fast and as accurate as possible. The onset latency of these vocal articulation responses was assessed, which is an established measure for the time course of lexical processing (see Stroop, 1935; Bargh et al., 1996). The speed with which the pronunciations of the words were initiated was thought to reflect the articulation fluency of the stimuli.

To obtain results that can be compared to the original finding of Topolinski et al. (2014) as well as reflect the onset latencies of inward and outward kinematics uninfluenced by previous exposure, I turned back to the artificially constructed stimuli used in the original paper. The authors generated words that consisted of clean consonantal inward and outward kinematics, with random vowels inserted in between.

Study 2b was a replication of Study 2a using a different recording programming software in order to ensure that the findings were not specific to the recording capability of the specific software (Inquisit and DirectRT) together with the technical equipment (Pronomic HS-31 EA headsets).

8.1.1 Hypothesis

Following the reasoning that inward words were expected to be easier to be articulated than outward words, I expected faster onset latencies of overt vocal articulation responses for inward words than for outward words in Study 2a and Study 2b.

8.1.2 Design

The hypothesis was tested using a one factorial within subject design with the factor of Consonantal stricture direction (inward vs. outward) as the within factor.

8.1.3 Method

Participants. In Study 2a, *N* = 61 (35 female, 19 male; mean age 27, *SD* = 8; in 7 cases demographic data were not recorded), and in Study 2b, *N* = 119 (80 female, 35 male; mean age 27, *SD* = 9; in 4 cases demographic data were not recorded) German speaking participants with various professional backgrounds participated for a reward of €10 in a larger experimental battery. Both samples were recruited via the volunteer participants' pool of the Department of Psychology at the University of Würzburg.

Materials. The stimuli were the 60 inward and 60 outward words used in Topolinski et al. (2014, Experiments 4, 5, 7, 8, and 9) and were adapted to German speaking samples (called stimulus pool C). The words had been constructed by the procedure explained in the following. Three groups of consonants from three anatomically clearly separated articulation spots in German phonation were used. These were located in the front (labial: B, F, M, P), middle (alveolar: D, L, N, S, T), and rear (velar-uvular: G, K, R) of the mouth. Then, consonant sequences of front-middle-rear (e.g., B-D-K) and rear-middle-front (e.g., K-D-B) were construed by randomly sampling one letter from each of these three groups, respectively. By this means inward and outward sequences of consonants were derived. Then, random vowels were inserted in between the consonants to obtain pronounceable words (e.g., BUDEKA for an inward and KUDEBA for an outward wandering word). This procedure resulted in inward and outward words that overall did not differ in their vowel sequence, length, or letter frequency, but only in their consonant sequence. Finally, words containing meaningful syllables in the German language had been discarded from the final stimulus pool, to preserve consonantal inward and outward kinematics as the only controlled varying factor.

Procedure. Both, Study 2a and Study 2b were part of larger sets of unrelated experimental tasks (e.g., Schadenfreude inductions, anagram ratings, empathy ratings). Participants were tested in groups up to three in the laboratory, but were prevented from hearing each other's responses during the task. Participants were equipped with Pronomic HS-31 EA headsets (frequency response: 20 - 20.000Hz, sensitivity -45dB, +/- 3dB) to record their verbal responses, and with earplugs and earmuffs to prevent participants being disturbed by the verbal responses of the other participants' responses in the laboratory. Participants were instructed to read aloud each presented word as fast and as accurate as possible when these appeared on the screen. They were asked to respond in their regular speaking voice and to prevent themselves from speaking artificially louder than they would usually do. A voice key setup realized with Inquisit in Study 2a, and with DirectRT in Study 2b, recorded participants' verbal reactions. The sensitivity of the headset-microphones was calibrated in both programs such that they did not react to background sounds (e.g., other participants' voices) but only to the voices speaking right into the microphones.

For each participant, 30 inward and 30 outward words were randomly sampled anew from the stimulus pool and presented in random order. Each target word was presented in the center of the screen until the participant had given a verbal response, with an inter-trial interval of 200ms (5 s for Study 2b; see Figure 9). 10 test trials featuring unsystematic control words (from the baseline words in Topolinski et al., 2014, Study 5) preceded the crucial test trials to allow participants to accommodate to the task and, if necessary, to adapt their voice to the sensitivity of the microphones. In the end, participants provided demographic variables, including gender and age. The whole procedure took about 10 minutes for Study 2a and about 15 minutes for Study 2b.

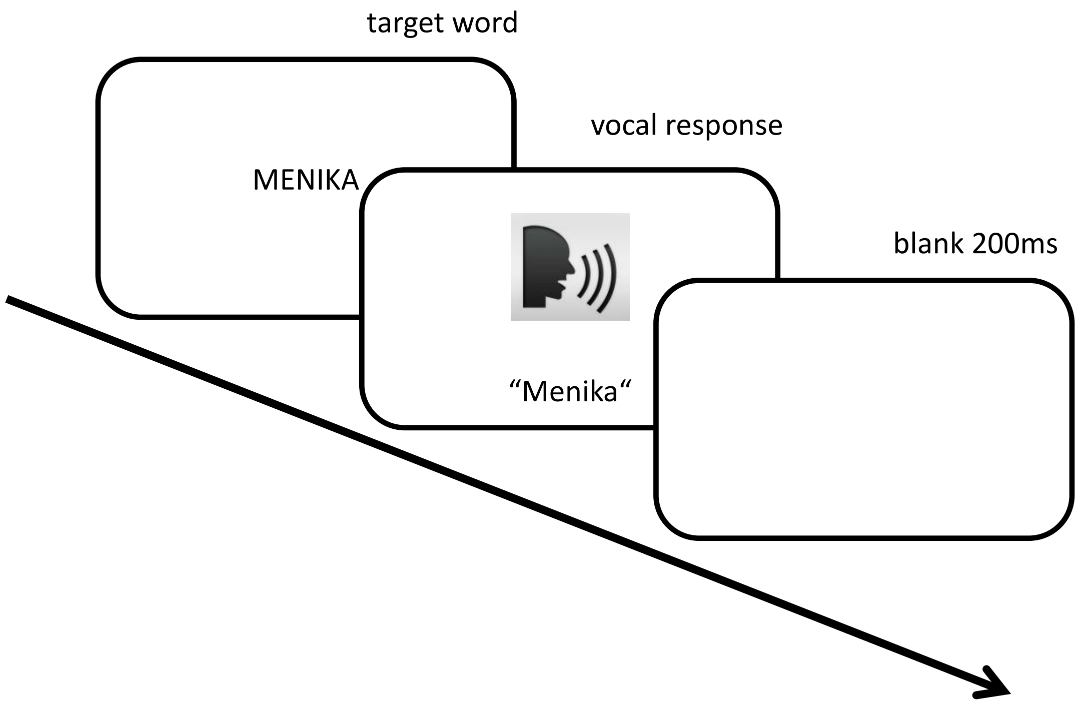

Figure 9. Sequence of a test trial in Study 2a.

8.1.4 Results

Study 2a. To prevent influences from outliers (e.g., coughing, yawning, stuttering) a cut-off of < 300ms and > 3000ms was applied to all trials. Participants' articulation onset latency for inward words was faster (*M* = 677ms, *SE* = 21) than for outward words (*M* = 704ms, *SE* = 21), *t*(60) = 2.76, *p* = .008, d_z = 0.35, 95% CI [0.09, 0.61] (see Figure 10).

Study 2b. The same cut-off criterion as in Study 2a was applied. Again, articulation onset latency was faster for inward (*M* = 733ms, *SE* = 18) than for outward words (*M* = 761ms, *SE* = 18), *t*(118) = 4.74, *p* < .001, d_z = 0.44, 95% CI [0.25, 0.62] (see Figure 10).

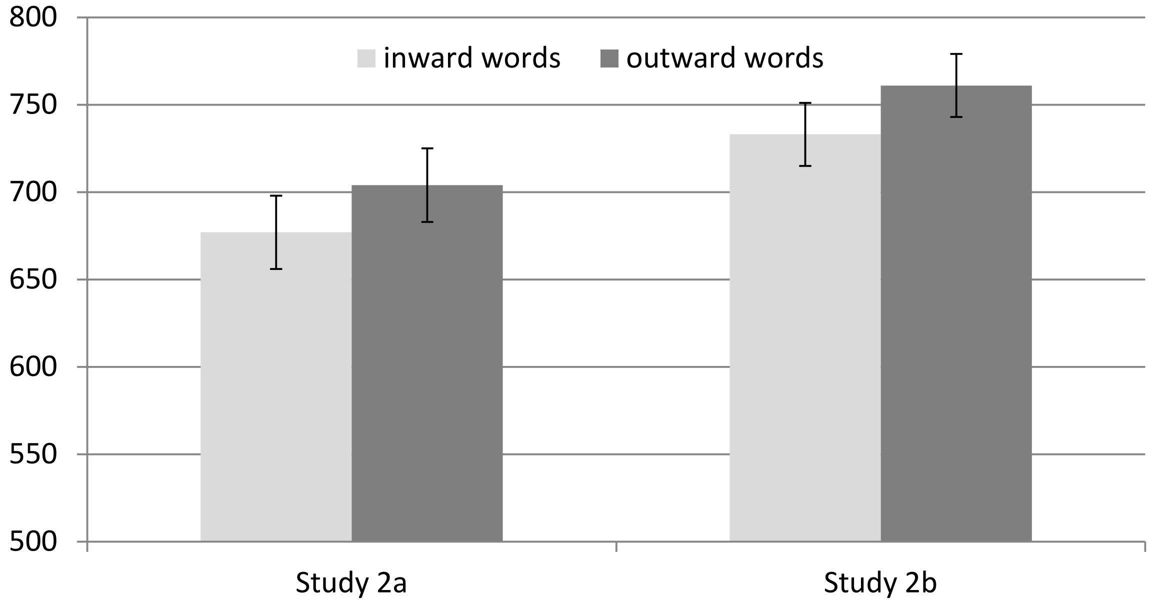

Figure 10. Vocal articulation onset latencies for Study 2a and Study 2b. Error bars indicate +/- 1 SEM.

8.1.5 Discussion

As predicted, in both experiments participants were faster in initiating an overt articulation of inward than of outward words, amounting to a small but reliable advantage of about 27 milliseconds (comparable to around 20ms for articulation Stroop effects in e.g., Bargh et al., 1996; Holle et al., 1997). As I argue, this effect probably stems from the slightly higher frequency of inward over outward kinematics in the German language itself (Study 1b). As further evidence for this general pronunciation advantage of consonantal inward over outward kinematics and as a step closer to the original finding, Study 3 assessed silent reading durations. It is crucial to show that also silent reading durations might be affected by the fluency of inward and outward kinematics because the original finding by Topolinski et al. (2014) has been solely demonstrated with silent reading tasks.

8.2 Study 3: Silent Articulation Latency

The goal of Study 3 was to generalize the findings from Studies 2a and 2b to a different measurement of objective pronunciation fluency. In Studies 2a and 2b it was found that the overt articulation of inward compared to outward words was initiated faster, which might be due to the fact that the English and German languages serve as an ecological source of this motor fluency (Studies 1a and 1b). Beside overt articulation, also silent reading has been shown to be good indicator of oral motor fluency for words (e.g., Topolinski & Strack, 2009a, 2010). Therefore, silent reading times were measured by asking participants to read through inward and outward target words and to press a key once they had finished this.

8.2.1 Hypotheses

In line with prior hypotheses, I expected here also that inward words would be silently articulated faster than outward words because inward words are easier to process than outward words.

8.2.2 Design

The hypothesis was tested using a one factorial within subject design with the factor Consonantal stricture direction (inward vs. outward) as the within factor.

8.2.3 Method

Participants. *N* = 77 (45 female, 7 male; mean age 24, *SD* = 7; in 25 cases demographic data were not recorded) German speaking participants took part in a larger experimental battery for a reward of € 5. They were recruited via the volunteer participants pool of the Department of Psychology at the University of Würzburg.

Materials and procedure. Study 2 was replicated with the following modifications. Instead of overt verbal pronunciations, participants were asked to read each appearing word and to press a response key once they have accomplished this (see Figure 11). The target word disappeared once the participant had pressed the button followed by an inter-trial interval of 1 s. The task was again part of a larger experimental battery and took about 5 minutes.

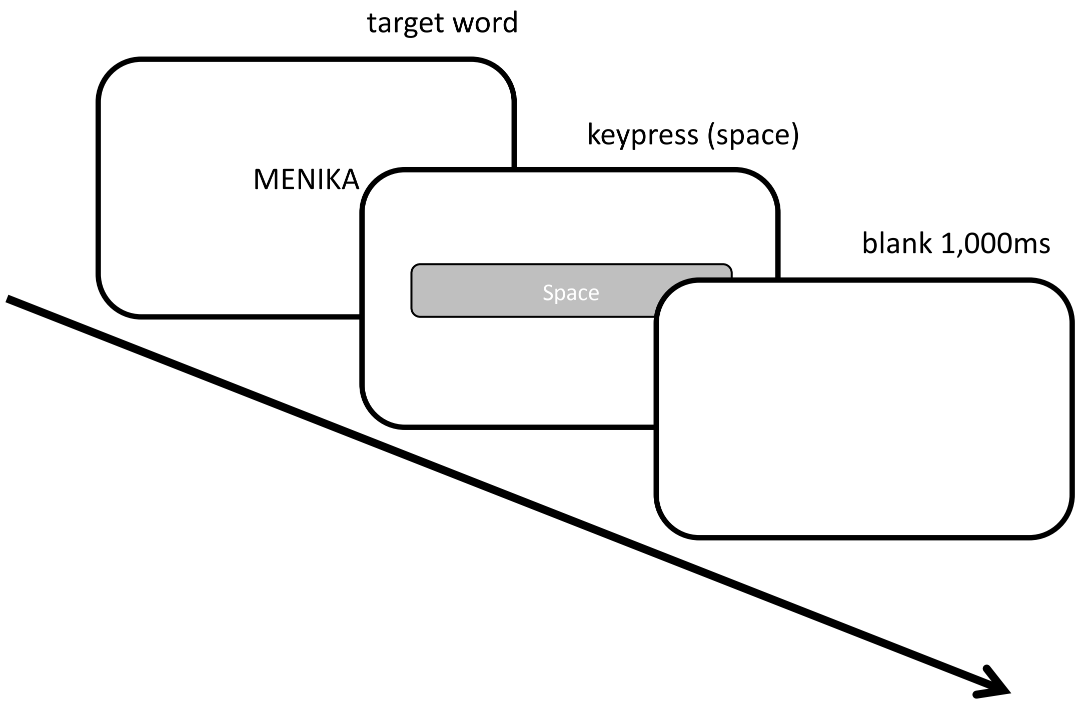

Figure 11. Sequence of a test trial in Study 3.

8.2.4 Results

To prevent influences from outliers (e.g., coughing, yawning, stuttering) a cut-off of < 300ms and > 3000ms was applied to all trials. A T-test of paired samples showed that participants responded faster for inward (*M* = 848ms, *SE* = 30) than for outward words (*M* = 865ms, *SE* = 30), $t(77) = 2.32$, $p = .023$, $d_z = 0.26$, 95% CI [0.04, 0.49], suggesting that inward words were silently articulated more efficiently than outward words (see Figure 12).

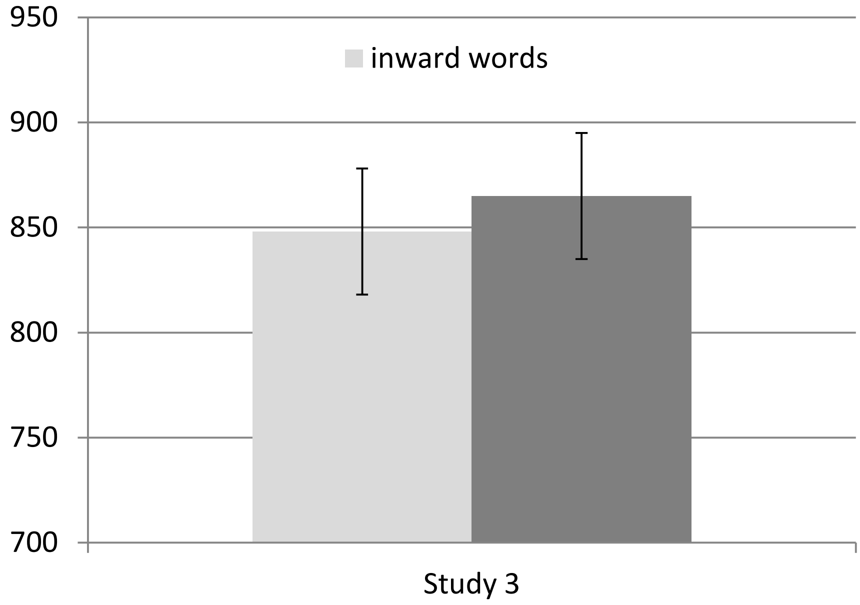

Figure 12. Silent articulation durations for Study 3. Error bars indicate +/- 1 SEM.

8.2.5 Discussion

In this study the articulation efficiency of inward and outward words was measured by means of assessing reading durations. Participants indicated their reading durations by pressing a key as soon as they finished reading silently the presented inward and outward words. Converging with Study 2a and Study 2b, participants were faster in reading through inward than through outward words. It is important to note that silent reading durations also differ between inward and outward wandering words, because the original in-out effect (Topolinski et al., 2014) has also been shown with silent reading tasks. So far, the findings speak in favor of a fluency account of the in-out effect.

In contrast to objectively measured articulation efficiency, in the following Study 4a and Study 4b, subjectively experienced fluency should be assessed.

8.3 Studies 4a and 4b: Experienced Ease

While Studies 2-3 assessed objective pronunciation and reading fluency of inward and outward words, the current study examined subjectively experienced fluency

(Hertwig, Herzog, Schooler, Reimer, 2008; Poldrack & Logan, 1998; see Reber et al., 2004 for a review). The fluency literature has shown that for studying the processing fluency of stimuli, one important aspect is to ask participants directly about the subjectively experienced ease (Forster, Leder, & Ansorge, 2013).

Thus, in the following, participants were asked to rely on their gut feeling when reporting their experienced ease of pronunciation of the presented stimuli. While the response-latency measures in Study 2a, Study 2b and Study 3 could not be implemented in online surveys to also address English speaking samples, the present ratings were assessed both in English (Study 4a) and German speaking (Study 4b) samples to demonstrate the cross-language replicability of this fluency effect.

8.3.1 Hypotheses

In line with the prior hypotheses, I expected in Study 4a as well as in Study 4b that inward words would also be subjectively experienced as being easier to pronounce than outward words.

8.3.2 Design

The hypothesis was tested using a one factorial within subject design with the factor Consonantal stricture direction (inward vs. outward) as the within factor.

8.3.3 Method

Participants. In Study 4a, *N* = 100 (33 female, 66 male, 1 reporting “none of the above genders”; mean age 32, *SD* = 11) English speaking participants took part online for a reward of $0.60. They were recruited online via Amazon Mechanical Turk. In Study 4b, *N* = 58 (41 female, 17 male; mean age 23, *SD* = 3) German speaking participants took part for a reward of €3 in a larger experimental battery. They were recruited via the volunteer participants pool of the Department of Psychology at the University of Würzburg.

Materials. In Study 4b, addressing a German speaking sample, the same pool as in the present Studies 2-3 was used (Topolinski et al., 2014, Study 4). In Study 4a, a stimulus pool created for English phonation provided in Topolinski et al. (2014, Study 6) was used. This had been constructed the following way.

The same procedure for constructing German inward and outward words specified for the English language phonation was applied. This resulted in different consonants being part of the three articulation-spot group than in the German language. Specifically, English phonation has less consonants being distinctly articulated in the rear: only K instead of G, K and R. Therefore, the articulation spot groups the consonants were taken from were the same as in the German pool for the front (labial: B, M, P) and the middle (alveolar: D, L, N, S, T) articulation spot, but different for the rear articulation spot (velar-uvular: K). After the construction of all possible consonant combinations with random vowels being inserted in between of them, again words that contained meaningful syllables in the English language had been discarded from the final stimulus pool. This procedure resulted in 120 inward and 120 outward words.

Procedure. Study 4a was an online experiment addressing English speaking participants conducted on Amazon Mechanical Turk. The task was introduced as a survey about the experienced ease of pronouncing nonsense words. Study 4b was part of a larger set of unrelated experimental tasks for German onsite participants. In both studies, 30 inward and 30 outward words were randomly sampled from the larger stimulus pools and presented in random order. Participants were asked to indicate *How easy is this word to pronounce?* on an 11-point answering scale ranging from 0 *(very hard)* to 10 *(very easy)* by either clicking on a respective button (Study 4a) or by typing in the respective number using the keyboard (Study 4b; see Figure 13). Participants were instructed to read the target words silently and to provide their answers spontaneously. While the targets were presented until participants' response in Study 4a, they were presented for 3,000ms followed by an input text box in Study 4b. In the end, participants were asked about demographic variables, including gender and age. The whole procedure took about 5 minutes.

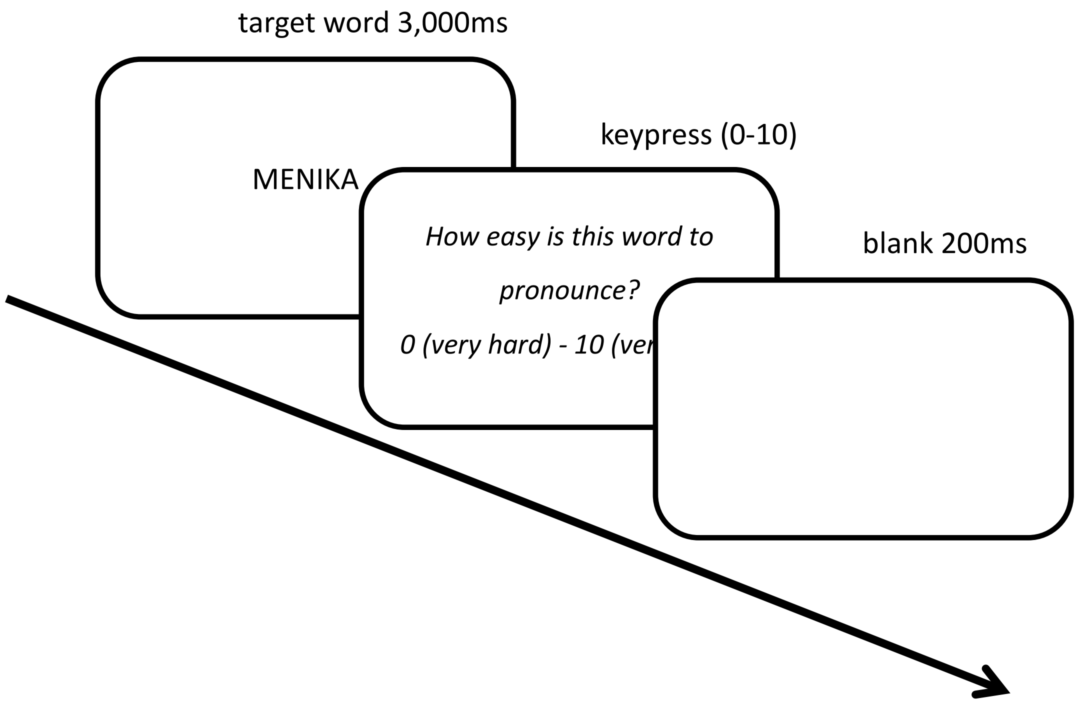

Figure 13. Sequence of a test trial in Study 4b.

8.3.4 Results

Study 4a. The English speaking participants reported higher pronunciation ease for inward (*M* = 6.75, *SE* = 0.16) than for outward words (*M* = 6.55, *SE* = 0.16), $t(99) = 4.62$, $p < .001$, $d_z = 0.46$, 95% CI [0.25, 0.67] (see Figure 14).

Study 4b. The German speaking on-site sample also reported higher pronunciation ease for inward (*M* = 5.77, *SE* = 0.24) than for outward words (*M* = 5.60, *SE* = 0.23), $t(57) = 2.60$, $p = .012$, $d_z = 0.34$, 95% CI [0.08, 0.60] (see Figure 14).

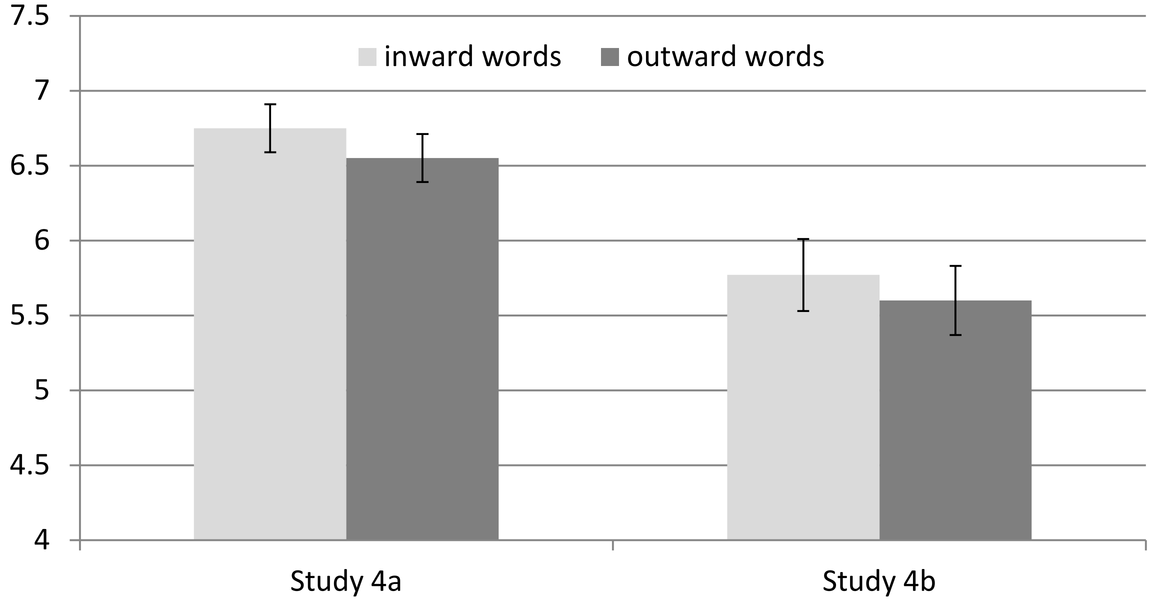

Figure 14. Experienced articulation ease for Study 4a and Study 4b. Error bars indicate +/- 1 SEM. For clarity, the scale was cropped. It was originally from 0 to 10.

8.3.5 Discussion

The current studies explored the question what psychological consequences the objective measureable fluency differences of inward and outward words might have. Converging with Study 2a, Study 2b and Study 3 which found an objective articulation advantage for inward over outward kinematics, the present studies found a similar advantage for subjective fluency ratings (Reber et al., 2004). Thus, we can conclude that inward words are more fluent than outward words. In the following sections mediational analyses were conducted to test the mediational role of objective and subjective fluency in the in-out effect.

CHAPTER 9 – Mediational Analyses

9.1 Study 5: Item-based Mediation Analyses Across Studies

So far, the results speak in favor of a fluency account, namely that processing fluency plays a crucial role for the in-out effect. To sum up, it has been shown that consonantal inward dynamics compared to outward dynamics are more frequent in the English and German languages, are vocally initiated faster, are silently articulated faster and are subjectively experienced as easier to pronounce. To demonstrate that processing fluency (M) might account for the in-out effect (X →Y), a mediation analysis with processing fluency as a hypothesized mediator is useful (see Figure 15). Specifically, my hypothesis is that inward words are processed more fluently than outward words and that this difference in fluency might partially drive the in-out-effect.

For the mediation analysis, an item-based analysis across data from the Studies 2a, 3, 4b, with new set of data for explicit preferences will be performed (cf. Clark, 1973). Item-specific parameters for each inward and outward word were derived. However, it should be noted that an item-based analysis across studies (i.e., different experiments, different paradigms, and different participants) means that a large amount of error variance is introduced into the analysis. Nevertheless, using the data that have been gathered already, I used an item-based method to analyze mediation across studies. For that, I adopted the technique suggested by Preacher & Hayes (2004) for mediation with bootstrap estimation for coefficients.

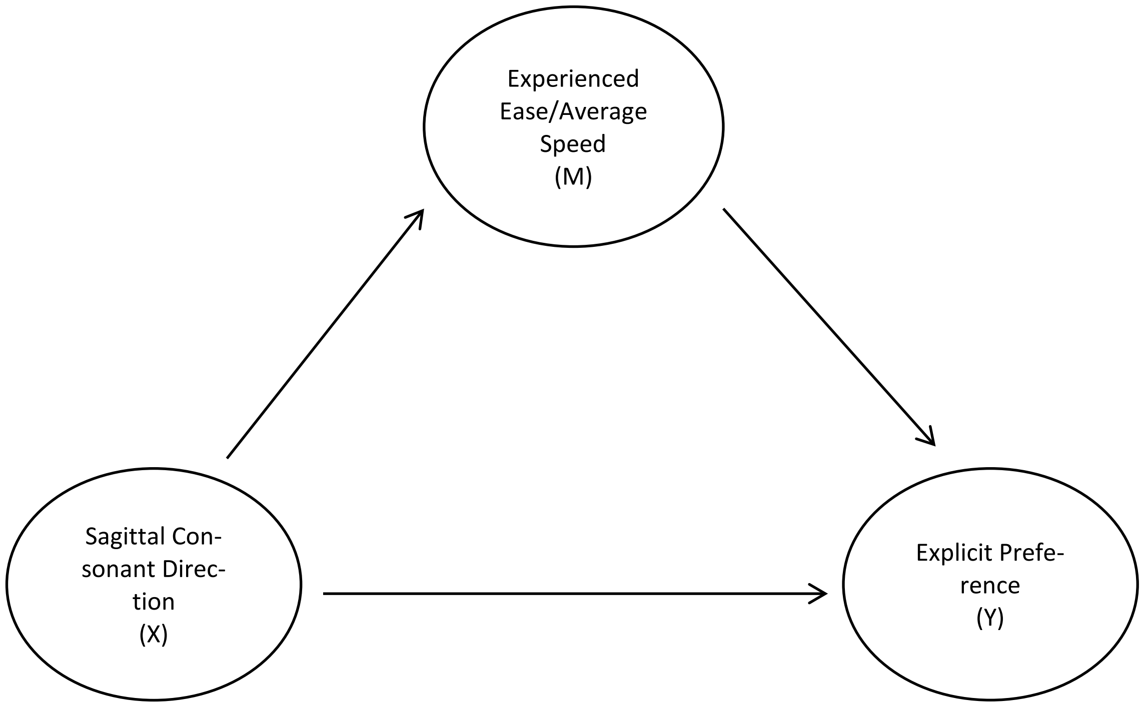

Figure 15. Illustration of the currently tested mediation design.

9.1.1 Hypotheses

In Study 5 it was expected that objective as well as subjective motor fluency (M) do mediate the effect that consonantal inward dynamics (X) lead to higher preferences than consonantal outward dynamics (Y; see Figure 15).

9.1.2 Method & Results

Explicit Preference. For an explicit preference measurement, in a new study, *N* = 115 participants rated their preference of 30 inward and 30 outward words that were randomly sampled from the larger stimulus pool. Specifically, each participant received half the amount of the total stimulus pool. They rated the target words on an 11-point scale ranging from 0 *(not at all)* to 10 *(very much)*. Then the average preference for each of the total 60 inward and 60 outward words was computed across participants. The mean preference ratings of the single items ranged from 3.34 to 6.25.

Voice Onset Latency in Overt Reading. In Study 2a, *N* = 61 participants overtly pronounced 30 inward and 30 outward words that were randomly sampled from the larger stimulus pool. The average voice onset latency for each of the total 60 inward and 60 outward words was computed. The mean voice onset latencies of the single items ranged from 578.75ms to 888.54ms.

Silent Reading Latency. In Study 3, *N* = 77 participants' silent reading latencies indicated by a key-press for 30 inward and 30 outward words was assessed that were randomly sampled from the larger stimulus pool. The average reading latency for each of the total 60 inward and 60 outward words was computed. The mean silent reading latencies of the single items ranged from 737.00ms to 1129.73ms.

Experienced Ease. In Study 4b, *N* = 58 participants rated their experienced ease of pronouncing 30 inward and 30 outward words that were randomly sampled from the larger stimulus pool. The average pronunciation ease for each of the total 60 inward and 60 outward words was computed. The mean experienced ease of the single items ranged from 5.00 to 8.11.

By means of this procedure, parameters for explicit liking, voice onset latency in overt reading, silent reading latency and experienced ease for each of the amount of 60 inward and 60 outward words were obtained (see Appendix). For example, the word BATIKU has a preference rating of 5.79, a voice onset latency in overt reading of 634ms, a silent reading latency of 851ms and a subjectively experience ease rating of 6.00.

Correlations between item-parameters. Table 3, Table 4, and Table 5 depicts the correlations between the item-parameters for Explicit Preference, Voice Onset Latency in Overt Reading, Silent Reading Latency, Experienced Ease and also the average of Voice Onset Latency in Overt Reading and Silent Reading Latency (Average Speed) for all inward and outward words. In Table 3 the correlation values for inward and outward words are combined. In Table 4 and Table 5 the correlation values are reported separately for inward and outward words, respectively.

Table 3

Pearson Correlations between average Explicit Liking, Voice Onset Latency in Overt Reading, Silent Reading Latency and Experienced Ease in Study 7.

Variable	2	3	4	5
1. Explicit Preference	-.17 †	-.14	.32 ***	-.19*
2. Voice Onset Latency	---	.28**	-.08	.80**
3. Silent Reading Latency	---	---	-.06	.80**
4. Experienced Ease	---	---	---	-.09
5. Average Speed	---	---	---	---

Note. *N* = 120 for each cell.

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$; tested two-tailed.

Table 4

Pearson Correlations between average Explicit Liking, Voice Onset Latency in Overt Reading, Silent Reading Latency and Experienced Ease for inward words in Study 7.

Variable	2	3	4	5
1. In. Explicit Preference	-.18	-.09	.18	-.19
2. In. Voice Onset Latency	---	.10	-.04	.78**
3. In. Silent Reading Latency	---	---	-.02	.70**
4. In. Experienced Ease	---	---	---	-.02
5. In. Average Speed	---	---	---	---

Note. *N* = 60 for each cell.

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$; tested two-tailed.

Table 5
Pearson Correlations between average Explicit Liking, Voice Onset Latency in Overt Reading, Silent Reading Latency and Experienced Ease for outward words in Study 7.

Variable	2	3	4	5
1. Out. Explicit Preference	-.03	-.10	.46 **	-.08
2. Out. Voice Onset Latency	---	.36**	-.06	.80**
3. Out. Silent Reading Latency	---	---	-.09	.85**
4. Out. Experienced Ease	---	---	---	-.09
5. Out. Average Speed	---	---	---	---

Note. N = 60 for each cell.

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$; tested two-tailed.

The correlation pattern of the combined values and the values for outward words are similar. Explicit Preferences correlate with Experienced Ease for the combined values ($r = .32$, $p < .001$) as well as for the separated outward values ($r = .46$, $p < .01$). For inward words this correlation does not reach significance.

Furthermore, Voice Onset Latency in Overt Reading correlates with Silent Reading Latency, for the combined values ($r = .28$, $p < .001$) as well as for the separated outward values ($r = .36$, $p < .001$). Again, for inward words this correlation does not reach significance.

Interestingly, for the combined values, Average Speed (Average of Voice Onset Latency in Overt Reading and Silent Reading Latency) correlates significantly with Explicit Preferences ($r = .36$, $p < .001$) in contrast to the separate speed variables ($p > .10$; $p > .10$). For inward and outward words separated, these correlations do not reach significance.

Mediational analysis. Several mediation analyses were planned for the purpose of obtaining a hint whether processing fluency in the form of subjective processing fluency (Experienced Ease) as well as objective processing fluency (Voice Onset Latency in Overt Reading, Silent Reading Latency, average of both: Average Speed), might play a mediating role in the relation between Consonantal Stricture Dynamics and Explicit Preference. These separate analyses were conducted using *bootstrapping* procedures (e.g., MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002; Preacher & Hayes, 2004). Bootstrapping is widely recommended instead of using the *Sobel test* (Sobel, 1982), because in contrast to the Sobel test bootstrapping does not make any assumptions about the normality or symmetry of the distribution shape of the data and has more statistical power (e.g., Efron & Tibshirani, 1993; Hayes, 2009; MacKinnon, Fairchild, & Fritz, 2007; Mooney & Duval, 1993). This technique was applied in SPSS with a macro by Preacher and Hayes (2004).

1000 bootstrap resamples of the data were used. Statistical significance would be indicated by the 90 % confidence interval of the *indirect effect* (i.e., the in-out effect via fluency) not including zero. I choose alpha at .10 because of the decreased power of item-based analyses.

The first analysis should test whether subjective processing fluency, namely experienced ease of pronunciation, might have a mediational effect in the relation between sagittal consonant direction and explicit preferences. To test the mediation, several preconditions have to be met (Baron & Kenny, 1986; Preacher & Hayes, 2004).

First, it is necessary to show the *total effect*, namely that the independent variable Sagittal Consonant Direction (X) has an influence on the dependent variable Explicit Preference (Y; see Figure 15). The results show that this precondition is met by the current data: Sagittal Consonant Direction (X) has a significant impact on Explicit Preference, $t(118) = 3.37$, $p = .001$, $d = 0.62$, 95% CI [0.25, 0.98].

Another precondition is that independent variable Sagittal Consonant Direction (X) has an influence on the hypothesized mediator, namely Experienced Ease (M; see Figure 15). The results show that this precondition is not met by the current data: Sagittal Consonant Direction does not have an impact on Experienced Ease, $t(118) = 1.23$, $p = .223$. This is probably due to power loss because of the data conversion from subject- to item-level. According to Preacher and Hayes (2004) the preconditions for a mediation analysis are not met by the current data (see also, Baron & Kenny, 1986). Therefore, no mediational analysis could be conducted for Experienced Ease as a hypothetical mediator.

Next, it was tested whether a mediation with objective fluency as a hypothesized mediator could be found. A speed variable was computed by averaging the two objective fluency dependent variables (Average Speed). Given the fact that the Average Speed correlates best with the dependent measure of Explicit Preference, Average Speed was chosen to be a possible mediator in the current analysis (see Table 3). As mentioned previously, the first precondition about the *total effect* has been met by the current data, namely that the independent variable Sagittal Consonant Direction (X) has an influence on the dependent variable Explicit Preference (Y).

Another precondition is that independent variable Sagittal Consonant Direction (X) has an influence on the hypothesized mediator, namely Average Speed (M). The results show that this precondition is met by the current data: Sagittal Consonant Direction (X) has a significant impact on Average Speed, $t(118) = -2.68$, $p = .008$, $d = 0.49$, 95% CI [0.13, 0.85].

The next precondition for a mediational analysis is that the hypothesized mediator Average Speed (M) significantly predicts the dependent variable Explicit Preference (Y). The results indicated that Explicit Preference (Y) is significantly predicted by Average Speed $\beta = -.002$, $t(118) = -2.09$, $p = .039$.

According to Preacher and Hayes (2004), these preconditions allow for the regression analysis testing the *direct effect* indicating a possible mediation. Specifically, it tests whether the dependent variable Explicit Preference (Y) is predicted by the independent variable Sagittal Consonant Direction (X) when controlling for the hypothesized mediator Average Speed (M). In this model Average Speed (M) did not significantly predict Explicit Preference (Y) anymore ($\beta < -.01$, $p = .169$.) when Consonantal Stricture Dynamics ($\beta = .14$, $t(117) = 2.95$, $p = .004$.) was included into the model. This speaks against a mediational effect of averaged objective fluency (Average Speed) on the relation of Consonantal Stricture Dynamics on Explicit Preference.

9.1.3 Discussion

The current study explored the question whether subjectively experienced fluency differences and objective fluency differences of inward and outward words might play a mediating role in the relation between sagittal consonant direction (inward, outward) and preferences of inward and outward words. To test this hypothesis data from previous studies were combined in item-based analyses. The results suggested that objective fluency does not play a mediating role. Moreover, subjective fluency seems not to be influenced by sagittal consonant direction on item-level.

This might be due to power loss. From a methodological point of view, when converting data on item-level, there is a loss of power, which can be seen at the overall relatively low effect sizes that partially are not significant anymore (see also Clark, 1973). This is especially pronounced in the current case, because for each participant the items were sampled randomly from a large stimulus pool; thus, the data were aggregated across different subsets of participants for different items. In order to prevent loss of power, for the mediational analyses in Study 6 new data were collected in a within-subjects design which allowed for analyzing the data on subject- and trial-level.

9.2 Study 6: Mediation Analysis in a Within-Subjects Experiment

In the previous study an item-based mediation analysis was conducted with data from different studies. This might have led to a loss of power as mentioned previously. Therefore and also to tap the psychological procedures of fluency mechanism more directly, in the present study participants were asked within one trial to report both their experienced ease of pronunciation of the presented stimuli as well as their spontaneous liking. To test a mediation, I adopted the technique suggested by Judd, Kenny, and McClelland (2001) for testing mediation effects in within-subject designs. Given the fact that the fluency-preference relationship is analyzed on trial-level, the previously mentioned technique by Preacher & Hayes (2004) for mediation with bootstrap estimation for coefficients was applied (applied in SPSS with a macro by Preacher and Hayes, 2004).

9.2.1 Hypotheses

In line my overall hypothesis, I expected in Study 6 that ease of pronunciation - as a hypothetical mediator – does mediate the effect that consonantal inward dynamics lead to higher preferences than consonantal outward dynamics on subject-level as well as on trial-level.

9.2.2 Method

Participants. In Study 6, *N* = 100 (75 female, 25 male; mean age 24 *SD* = 6) German speaking participants took part for a reward of €3 in a larger experimental battery. They were recruited via the volunteer participants' pool of the Department of Psychology at the University of Cologne.

Materials. In Study 6, the same stimulus pool as in the present Studies 2-4b was used (Topolinski et al., 2014, Study 4), containing 120 inward and 120 outward words for German speaking samples.

Procedure. The current study was part of a larger set of unrelated experimental tasks for German onsite participants. For each participant, 30 inward and 30 outward words were randomly sampled from the larger stimulus pools and presented in random order. Participants received the target words together with two questions presented in either one order or the other. In one group participants were asked first *How much do you like this word?*, and then always *How easy is this word to pronounce?*, in the second group they were asked in the opposite order. Both questions had to be answered on an 11-point answering scale ranging from 0 *(not at all)* to 10 *(very much)* by typing in the respective number using the keyboard. Participants were instructed to read the target words silently and to provide their answers spontaneously. For each question, target words were presented for 2,000ms followed by an input text box (see Figure 16). In the end, participants were asked about demographic variables, including gender and age. The whole procedure took about 7 minutes.

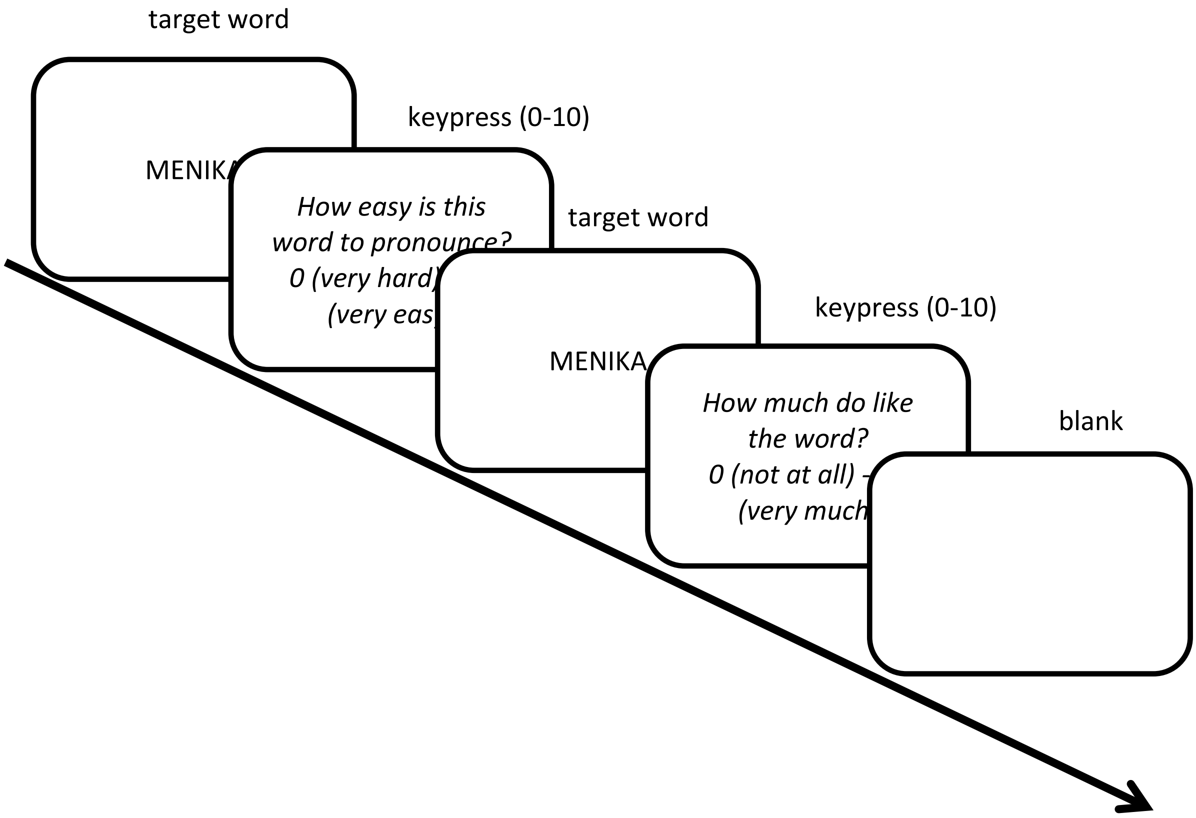

Figure 16. Sequence of trials in Study 6.

9.2.3 Results

Subjective Ease. Higher pronunciation ease was found for inward (*M* = 7.13, *SE* = 0.16) compared to outward words (*M* = 6.99, *SE* = 0.16), $t(99) = 2.51$, $p = .014$, d_z = 0.25, 95% CI [0.05, 0.45] (see Figure 17). Furthermore, the order of judgments (ease-preference or preference-ease) did not interact with the subjective ease ratings, $F < 1$, $p = .479$.

Explicit Preference. Higher explicit liking ratings were found for inward (*M* = 5.26, *SE* = 0.11) compared to outward words (*M* = 5.00, *SE* = 0.12), $t(99) = 4.24$, $p < .001$, d_z = 0.43, 95% CI [0.22, 0.63] (see Figure 17). Moreover, the order of judgments (ease-preference or preference-ease) did not interact with the explicit preference ratings, $F < 1$, $p = .669$.

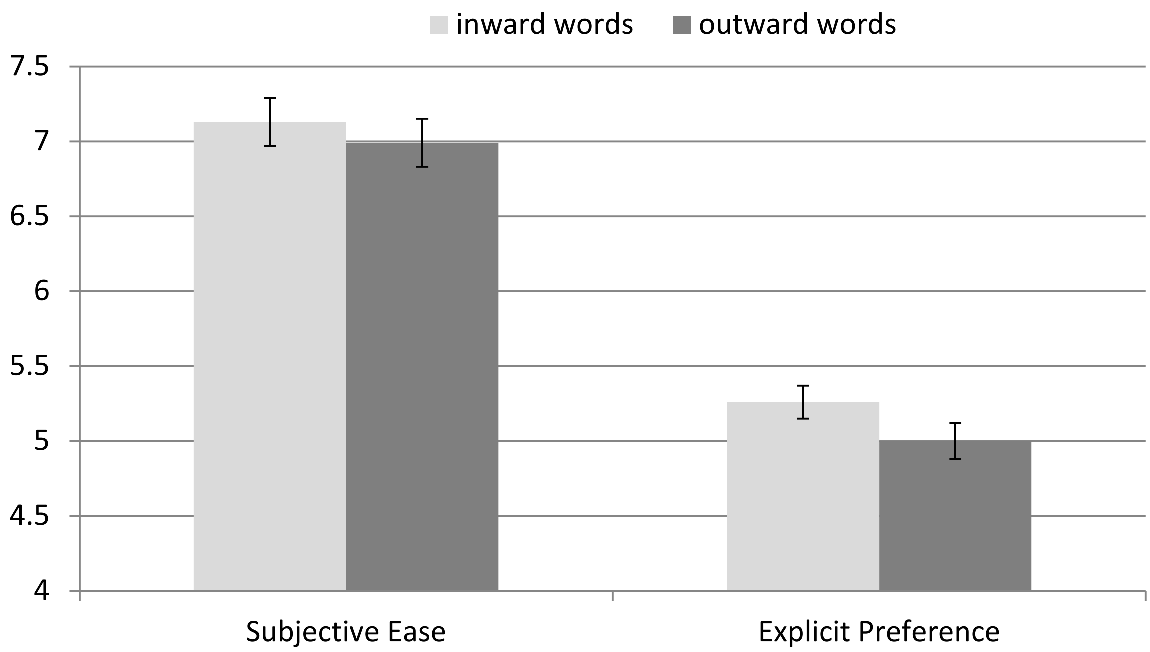

Figure 17. Subjectively experienced articulation ease and explicit preferences in Study 6. Error bars indicate +/- 1 SEM. For clarity, the scale was cropped. It was originally from 0 to 10.

Mediation analysis on subject-level. To test the hypothesis that subjective processing fluency might play a possible mediational role in the relation between sagittal consonant direction (inward and outward) and preferences, a mediation analysis for within-subject designs (Judd, et al., 2001) was conducted. Note that because the order of judgment (ease-preference or preference-ease) did not interact with the subjective ease ratings ($F < 1$), nor with the explicit preference ratings ($F < 1$), this factor was not included in the following analyses.

According to Judd and colleagues (2001) first it is necessary to compute difference scores to represent within-subject effects in the regression analyses. Specifically, within-subject effects of the independent variable Sagittal Consonant Direction on the dependent variable Explicit Preference and on the hypothesized mediator Experienced Ease are needed. Therefore, for the dependent variable Explicit Preference a difference score (inward preference minus outward preference) for each participant was calculated. Then, for the mediator Subjective Ease a difference score (inward ease minus outward ease) was obtained for each participant. Moreover, according to Judd and colleagues (2001) the centered sum score of the mediator (centered score of inward ease plus outward ease) is useful, because it facilitates the interpretation of the intercept in the in the following regression analyses (using the centered sum score, the intercept in the following analysis will represent the in-out effect, controlled for fluency).

Next, it is necessary to show that there is a significant mean difference of preference for inward and outward words (in-out effect). The results meet this precondition: The in-out effect (M = 0.26) can be found in the current data, $t(99) = 4.24$, $p < .001$. Note that this test is equivalent to the previous test on explicit preferences.

Next, this in-out effect can be analyzed considering the meditator Experienced Ease. According to Judd and colleagues (2001) there are two preconditions for the mediator Experienced Ease. First, the mean difference of Experienced Ease for inward and outward words (fluency effect) has to be in the predicted direction (here, same direction) compared to the mean difference of inward and outward words (in-out preference effect). The results show that this in-out fluency effect (M = 0.14) is present in the current data, $t(99) = 2.51$, $p = .014$ (see also above the single comparisons in the subjects-based analysis). Second, the difference of Experienced Ease for inward and outward words (fluency effect) has to significantly predict the difference of Explicit Preferences for inward and outward words (in-out effect). This second precondition is also met: The results indicate that the fluency effect significantly predicts the in-out effect, $\beta = .46$, t(98) = 4.47, $p < .001$.

Given the fact that all the preconditions proposed by Judd and colleagues (2001) are satisfied by the current data, the hypothesized mediational role of Experienced Ease can be analyzed in the following step. For this purpose Judd and colleagues (2001) propose a regression analysis in which the difference of Explicit Preferences is regressed on the centered sum score of the mediator Experienced Ease (inward ease plus outward ease) and on the difference of Experienced Ease. In this model the difference of Experienced Ease is a significant predictor of the difference of Explicit Preferences, β = .43, t(97) = 4.15, p < .001. The centered sum score of Experienced Ease as a predictor was marginally significant, β = -.10, t(97) = -1.69, p = .094. According to Judd and colleagues (2001) these results speak in favor of a mediational role of Experienced Ease in the relation of the independent variable Sagittal Consonant Direction on the dependent variable Explicit Preference.

Furthermore, the intercept of the current model estimates the mean difference in Explicit Preferences over and above the influence of Experienced Ease. Hence, it represents the residual in-out effect over and above the mediation of the fluency effect. In the current model the residual difference remains significantly different from zero, β = .20, t(97) = 3.49, p = .001, arguing against complete mediation. According to Judd and colleagues (2001) this speaks in favor of a partial mediation of Experienced Ease in the relation of independent variable Sagittal Consonant Direction on the dependent variable Explicit Preference.

Mediation analysis on trial-level. To test the same hypothesis as mentioned previously, namely that processing fluency might play a possible mediational role in the relation between sagittal consonant direction (inward and outward) and preferences, a mediation analysis on trial-level (i.e., without data aggregation) was conducted with the bootstrapping technique according to Preacher and Hayes (2004). Again, all the preconditions, mentioned previously, have to be met on trial-level.

First, the precondition of a *total effect* has to be met, namely that the independent variable Sagittal Consonant Direction (X) has an influence on the dependent variable Explicit Preference (Y; see Figure 15). The results show that this precondition is met by the current data: Sagittal Consonant Direction (X) has a significant impact on Explicit Preference, t(5992) = 4.61, p < .001, d = 0.12, 95% CI [0.06, 0.17].

Next, the precondition has to be met that the independent variable Sagittal Consonant Direction (X) has an influence on the hypothesized mediator, namely Experienced Ease (M). The results demonstrate that this precondition is met by the current data: Sagittal Consonant Direction has a significant impact on Experienced Ease, t(5991) = 2.44, p = .015, d = 0.06, 95% CI [0.01, 0.11].

Next, a regression analysis is conducted to test whether the dependent variable Explicit Preference (Y) is predicted by the hypothesized mediator Experienced Ease (M) when controlling for the independent variable Sagittal Consonant Direction (X). The results indicated that Experienced Ease did significantly predict Explicit Preference when controlling for Sagittal Consonant Direction, $\beta = .33$, $t(5984) = 26.62$, $p < .001$.

According to Preacher and Hayes (2004), these preconditions allow for the regression analysis testing the *direct effect* that indicates whether there is a full mediation. Specifically, it tests whether the dependent variable Explicit Preference (Y) is predicted by the independent variable Sagittal Consonant Direction (X) when controlling for hypothesized mediator Experienced Ease (M). The results indicated that Sagittal Consonant Direction did significantly predict Explicit Preference, even when entering the mediator Experienced Ease, $\beta = .11$, $t(5984) = 4.07$, $p < .001$. According to Preacher and Hayes (2004) this speaks against a complete mediation of the hypothesized mediator Experienced Ease.

As a next step, a regression analysis is conducted that tests the *indirect effect* according to Preacher and Hayes (2004) that indicates whether there is a partial mediation. Specifically, it tests whether the dependent variable Explicit Preference (Y) is predicted by the independent variable Sagittal Consonant Direction (X) via the hypothesized mediator Experienced Ease (M). Put simply, it tests whether there is an effect from the independent variable Sagittal Consonant Direction (X) on the mediator Experienced Ease (M) that influences the dependent variable Explicit Preference (Y). The results show that the confidence interval of the indirect effect via Experienced Ease does not contain zero which indicates that the indirect effect is significant, $\beta = .02$, CI[.01, .04]. According to Preacher and Hayes (2004) this indicates a partial mediation of the hypothesized mediator Experienced Ease (M) on the relation of Sagittal Consonant Direction (X) on Explicit Preference (Y).

9.2.4 Discussion

The current study explored the question whether subjectively experienced fluency differences of inward and outward words might play a mediating role in the relation between consonantal stricture directions and preferences. In order to test this hypothesis experienced ease and explicit preferences was measured in a within participants design. The mediational analyses were conducted on subject- as well as on trial-level. The analysis on subject-level as well as the analysis on trial-level indicated partial mediation. That is, experienced ease as a hypothesized mediator does play a partially mediating role in the influence of consonantal stricture dynamics on explicit preferences.

Even though the order of the questions posed did not significantly affect the ratings of Experienced Ease or Explicit Preference, one can still assume that this may pose a confounding influence on the results. First, answering first a question on how easy-to-pronounce a stimulus was perceived and then how much a stimulus is liked, or the other way round, can have fundamental consequences on responding (e.g., Schwarz, Strack, Hippler, & Bishop, 1991; Strack, 1992). Second, participants were presented with the stimuli before each of the questions was posed, that is, they were exposed to all stimuli twice. Why this might pose a problem is discussed more elaborately in the General Discussion.

Overall, the data of the two mediation analyses are not completely clear-cut. The first mediation analysis on item-level could not be conducted for subjective fluency. For objective fluency, the results of the item-based analysis were not in line with a mediational role in the in-out effect. The current mediation analyses conducted on subjective fluency from a within-subjects design are not in line with the previous one conducted on objective fluency. The current data are on subject-level as well as on trial-level in favor of a partial mediation of subjective fluency in the in-out effect. This might hint at the fact that subjective fluency might play a more relevant role than objective fluency in the in-out effect, but given the fact that the two studies (5 & 6) are quite different regarding their set-up and their statistical power, I do not want to overinterpret this comparison.

Therefore, I interpret this data taken together as not providing strong evidence for or against a fluency account. The first data speak against a mediating role of objective fluency, whereas the second speak in favor of a partially mediating role of subjective fluency. From that point of view an experimental design that actively manipulates fluency gains of consonantal inward over outward dynamics might lead to more conclusive insights into this process (for advantages of interaction testing versus mediational analyses see, Jacoby & Sassenberg, 2011; Spencer et al., 2005).

CHAPTER 10 - Manipulation of Fluency

10.1 Study 7: Retraining Articulation Fluency I

The studies so far showed that consonantal inward kinematics are more common in natural language (Study 1a and Study 1b), and that probably due to this higher frequency inward words show a fluency advantage over outward words in overt pronouncing, silent reading, and subjective ease (Studies 2-4). The present experiment was conducted to examine whether the basic preference for inward over outward words, as in the original Topolinski et al. (2014) studies, can be influenced by this fluency gain. Pronunciation fluency of consonantal inward and outward kinematics was manipulated by letting participants internally rehearse a high amount of either inward or outward words in the phonological loop (articulatory loop, Baddeley, 2003; Baddeley & Hitch, 1974) and thus train the respective kinematic directions before explicitly rating a different set of inward and outward words for liking.

There are studies that have shown that for fluency effects, which are assumed to be influenced by ecological means (e.g., frequency of occurrences), it is possible to change the inferences that are drawn from fluency by means of manipulating ecological cues (Unkelbach, 2006, 2007). More closely to the current approach, Casasanto and Chrysikou (2011) have shown that the relation between high and low motor fluency and positive and negative evaluations, respectively, can be reversed, when manipulating the ease of motoric actions. Therefore, it is conceivable that changing the ease of pronunciation for inward and outward words should lead to a modulation of later explicit liking ratings, if the latter rely on fluency.

10.1.1 Hypotheses

Here, I hypothesized that a kinematic training of outward words would result in more positive evaluations of outward words than inward words. For a kinematic training of inward words a stronger classic in-out effect was expected.

10.1.2 Design

The hypothesis was tested using a 2 (Consonantal stricture direction of test stimuli: inwards, outwards; within) X 2 (Consonantal stricture direction of training stimuli: inwards, outwards; between) factorial mixed design.

10.1.3 Method

Participants. In Study 7, N = 98 (37 female, 60 male, 1 reporting "none of the above genders"; mean age 32, SD = 9) English speaking participants took part online for a reward of $1.5. They were recruited online via Amazon Mechanical Turk.

Materials. The stimuli from Study 4a (Topolinski et al., 2014, Study 6) for English phonation were again used.

Procedure. Study 7 was an online experiment conducted on Amazon Mechanical Turk and was introduced as two separate tasks: a short-term memory task for nonsense words (training-phase) and a measure of spontaneous evaluation of nonsense words (test-phase).

In the training phase, participants received either 60 inward words or 60 outward words (manipulated between-subjects) randomly sampled from the larger stimulus pool and presented in random order. An established short-term memory task from cognitive psychology was used (e.g., Sternberg, 1966). In the original study by Sternberg, participants were asked to mentally rehearse singly presented stimuli for a few seconds on each trial, rather than holding them in memory for a longer series of trials. In the same manner, in each trial of the current study, the target word was presented and participants were asked to read it silently and to memorize it because they had to type it in an empty textbox on the following screen. Crucially, a copy protection was programmed to prevent participants from merely copying the target words and pasting them onto the next screen. Thereby, participants were required to memorize the word briefly, drawing on internal verbal rehearsal that would trigger a covert pronunciation simulation (Baddeley & Hitch, 1974). Upon clicking on a continue-button the target word disappeared and an empty text box appeared into which participants should type in the memorized target.

In the test phase, participants received 30 inward and 30 outward words different from those in the study phase together with the question How much do you like this word? that had to be answered on an 11-point answering scale ranging from 0 (not at all) to 10 (very much). This is simply a replication of the earlier preference task by Topolinski et al. (2014). Target words were randomly sampled from the stimulus pool anew for each participant and were presented until the participant had provided a rating for them (see Figure 18 and Figure 19). Importantly, stimuli presented in the study-phase did not re-appear in the test-phase, to avoid simple mere exposure effects (Zajonc, 1968). Participants were asked to read the target words in the study-phase as well as in the test-phase silently and to give their answers in the test-phase spontaneously. Finally, participants provided demographics. The task took 15 minutes.

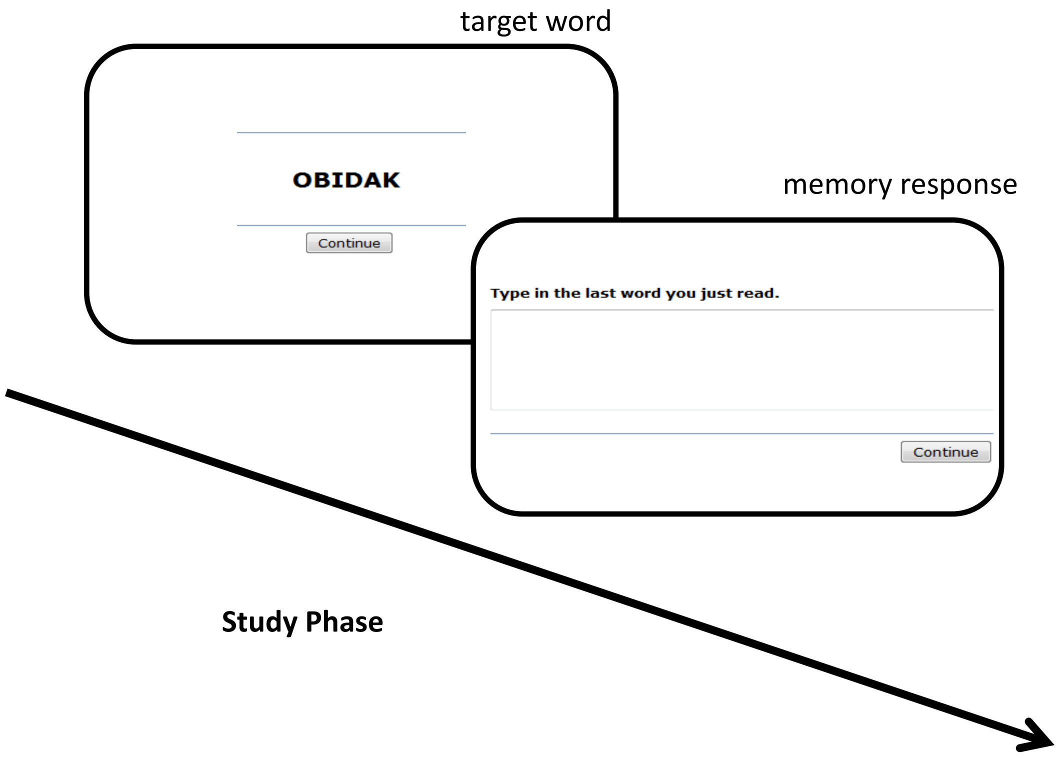

Figure 18. Sequence of a trial in the study phase of Study 7 and Study 8.

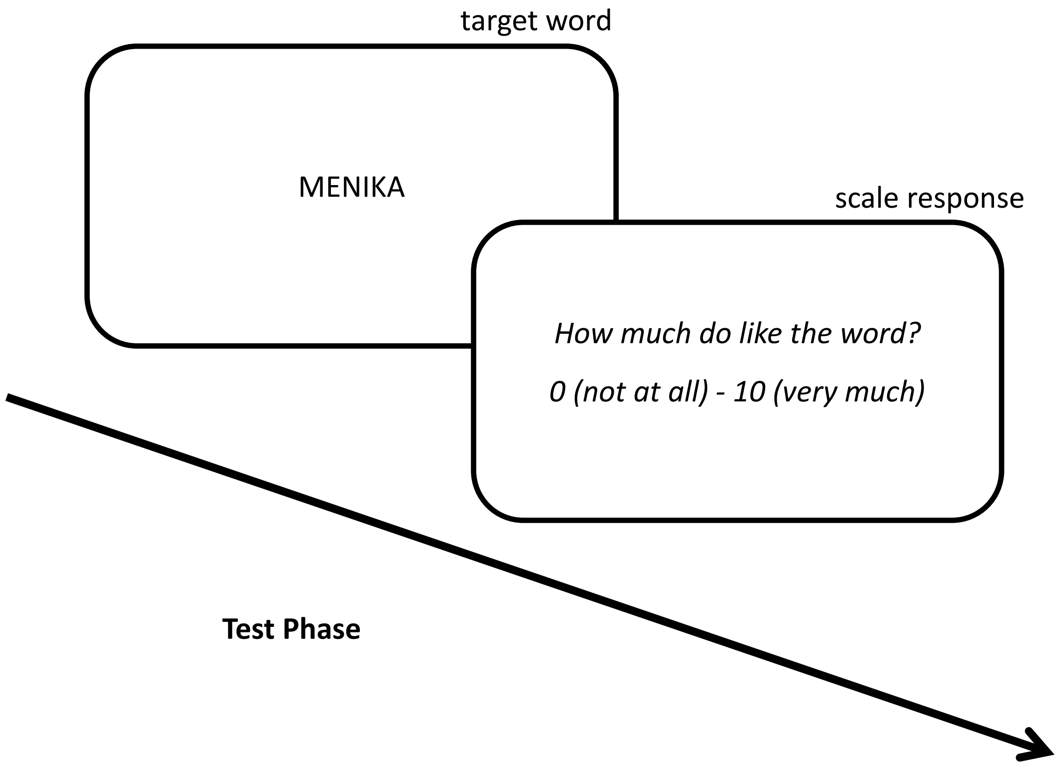

Figure 19. Sequence of a trial in the test phase of Study 7 and Study 8.

10.1.4 Results

A 2 (Consonantal stricture direction of test stimuli: inwards, outwards; within) X 2 (Consonantal stricture direction of training stimuli: inwards, outwards; between) repeated-measures ANOVA found an interaction, suggesting that between the training-groups the inward and outward words were preferred differentially, $F(1, 96) = 5.56$, $p = .020$, $\eta_p^2 = .06$. As can be seen in Figure 20, participants who had rehearsed 60 inward words liked inward words more ($M = 4.86$, $SE = .21$) than outward words ($M = 4.54$, $SE = .18$), $t(45) = 2.99$, $p = .004$, $d_z = 0.44$, 95% CI [0.14, 0.74], replicating the earlier in-out effect. In contrast, for participants who had rehearsed 60 outward words, no explicit liking difference occurred between inward ($M = 4.58$, $SE = .23$), and outward words ($M = 4.54$, $SE = .25$), $t(51) = 0.32$, $p = .749$.

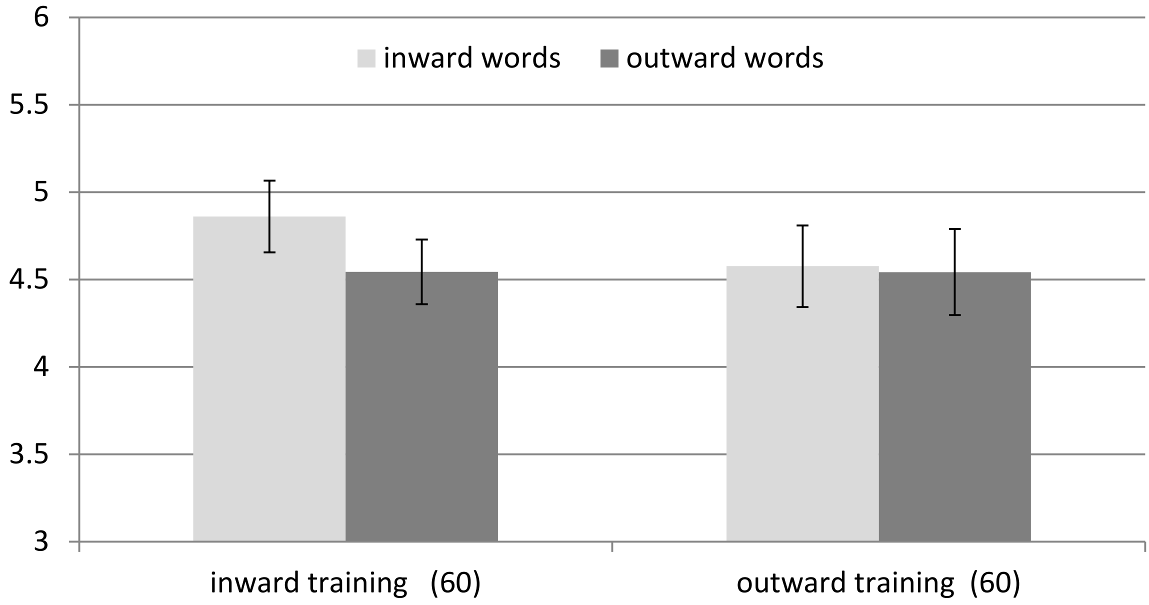

Figure 20. Preference ratings for Study 7. Error bars indicate +/- 1 SEM. For clarity, the scale was cropped. It was originally from 0 to 10.

10.1.5 Discussion

The goal of the present experiment was to indicate whether the in-out effect (Topolinski et al., 2014) can be influenced by motor fluency gains. The motor fluency of articulating consonantal inward and outward kinematics was manipulated by letting participants repeat either the motor simulations of consonantal inward or outward kinematics. Altering the pronunciation ease of either inward or outward consonantal kinematics by verbal rehearsal in a short-term memory task affected explicit liking ratings of inward and outward words afterwards. This suggests that motor fluency plays a major role in the in-out effect found by Topolinski et al. (2014). However, the present manipulation did only attenuate that earlier effect, leading to a null-finding after outward training. The final experiment realized an even stronger training to examine whether a reversal of the in-out effect can be triggered.

10.2 Study 8: Retraining Articulation Fluency II

The previous study successfully attenuated the in-out effect by Topolinski et al. (2014). In contrast, the current study implemented a longer training of either inward or outward articulation kinematics than Study 7 to find out whether the earlier in-out effect for inward over outward words (Topolinski et al., 2014) could even be reversed. One can imagine that the previously applied manipulation of 60 either inward or outward words might not have been strong enough to reverse the in-out effect. Given the fact that in Study 7 the in-out effect completely vanished, it is conceivable that a stronger training might even reverse the classic pattern of inward words being preferred over outward words. This would yield an essential test of the present argumentation that motor fluency can play a major role in the in-out effect.

10.2.1 Hypotheses

Here the same was hypothesized as in Study 7, however, a stronger effect as a result of a stronger training was expected.

10.2.2 Design

The hypothesis was tested using a 2 (Consonantal stricture direction of test stimuli: inwards, outwards; within) X 2 (Consonantal stricture direction of training stimuli: inwards, outwards; between) factorial mixed design.

10.2.3 Method

Participants. In Study 8, N = 98 (41 female, 57 male; mean age 32, SD = 10) English speaking participants took part online for a reward of $2.5. They were recruited online via Amazon Mechanical Turk.

Materials and procedure. Study 7 was replicated with a modified training phase. This time, either 120 inward or 120 outward words (between-subjects) instead of only 60 words were implemented. Because the stimulus pool did not contain enough words, items were presented twice in the training phase in a completely randomized order, in order to save 30 non-presented words for the test phase. The whole procedure took about 25 minutes.

10.2.4 Results

A 2 (Consonantal stricture direction of test stimuli: inwards, outwards; within) X 2 (Consonantal stricture direction of training stimuli: inwards, outwards; between) repeated-measures ANOVA revealed again an interaction, $F(1,96) = 34.46$, $p < .001$, $\eta p^2 = .26$. As can be seen in Figure 21, participants who had rehearsed 120 inward words liked inward words more ($M = 5.19$, $SE = .22$) than outward words ($M = 4.67$, $SE = .21$), $t(49) = 4.65$, $p < .001$, $d_z = 0.66$, 95% CI [0.35, 0.96]. In contrast, participants who had rehearsed 120 outward words preferred inward words ($M = 4.79$, $SE = .22$) less than outward words ($M = 5.26$, $SE = .22$), $t(47) = 3.70$, $p = .001$, $d_z = 0.53$, 95% CI [0.23, 0.83].

To check whether the effect was stronger than in Study 7, a cross study comparison was conducted. A 2 (Training intensity: 60, 120) X 2 (Consonantal stricture direction of test stimuli: inwards, outwards; within) X 2 (Consonantal stricture direction of training stimuli: inwards, outwards; between) repeated-measures ANOVA revealed an interaction, $F(1,192) = 9.82$, $p = .002$, $\eta p^2 = .05$. Separate analyses showed that for participants who had rehearsed inward words, explicit liking of inward words did not differ significantly in the training of 120 words ($M = 5.19$, $SE = .22$) from the training of 60 words ($M = 4.86$, $SE = .21$), $t(94) = 1.10$, $p = .270$. In contrast, participants who had rehearsed outward words liked outward words more after a 120-word training ($M = 5.26$, $SE = .22$) than after a 60-word training ($M = 4.54$, $SE = .18$), $t(98) = 2.16$, $p = .030$, $d = 0.42$, 95% CI [0.03, 0.80].

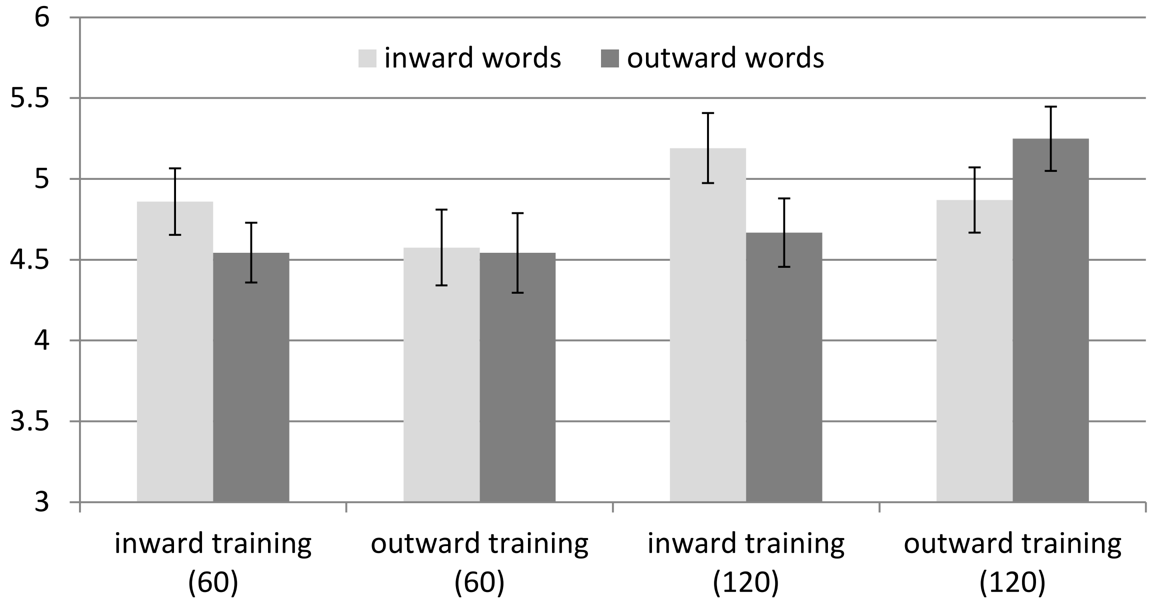

Figure 21. Preference ratings for Study 7 and Study 8. Error bars indicate +/- 1 SEM. For clarity, the scale was cropped. It was originally from 0 to 10.

10.2.5 Discussion

The current study explored whether a stronger simulation training than in Study 7 could lead to a stronger modulation of the in-out effect than in Study 7. For this reason, the simulation training was increased from 60 to 120 rehearsals of either inward or outward words. By realizing a pronunciation training of inward and outward kinematics via verbal rehearsal in a memory task, the present experiment could reverse the preference for inward over outward words. These results suggest that explicit preferences of inward and outward words to a crucial extent can be influenced by motor fluency.

CHAPTER 11 - General Discussion

In the current work, I tested a fluency account of the in-out effect reported by Topolinski et al. (2014). Specifically, I hypothesized that processing fluency might play a critical role instead of motivational states of approach and avoidance being necessarily activated. Across several studies, I found convergent support for processing fluency playing a crucial role in the in-out effect.

In the following sections the present results are summarized and discussed with respect to conclusions for processing fluency as an underlying mechanism compared to approach and avoidance motivations. In the end the role of language as an ecological factor is discussed and future research ideas are elaborated.

11.1 Summary of the Present Results

Study 1a and Study 1b aimed to show that in languages in which the in-out effect has originally been found there might be a source of higher processing fluency for inward over outward words. That is, higher preferences for inward over outward words might be due to the fact that in both languages, German and English, consonantal inward dynamics are more common than outward dynamics, leading to relatively higher processing fluency for inward dynamics. Specifically, articulating consonantal inward kinematics might be more efficient than articulating outward kinematics because they are trained more frequently in natural verbal discourse. The results of Study 1a and Study 1b corroborated the hypothesis that there might be more consonantal inward than outward dynamics in natural language. Specifically, when regarding only words that overall feature purely inward versus purely outward dynamics within a word, in German as well as English it was found that there are about five times more overall inward than overall outward wandering words. These results provide strong support for the hypothesis that language itself features more inward than outward dynamics, and that individuals not only execute inward dynamics more often than outward dynamics, but are also more often exposed to the former than to the latter dynamics (e.g., by reading a book or watching a movie). Given the fact that we simulate the pronunciation of words whenever we encounter them (Stroop, 1935; Topolinski & Strack, 2009a, 2010), one can conclude that consonantal inward compared to outward pronunciation is also practiced more often by merely being exposed to them. On the basis of these results, language could be considered as a natural ecological source of higher motor fluency for inward over outward words. Importantly, these higher frequencies can lead to higher pronunciation fluency which can in turn be seen as laying the ground for higher preferences found for inward over outward words.

The assumption that inward compared to outward dynamics might be more efficient to process was tested directly in experiments that examined objective as well as subjective processing fluency of artificially constructed non-words featuring pure inward or outward dynamics (original stimulus pool by Topolinski et al., 2014). Importantly, the stimuli categories did not differ in frequency of letter occurrences. Merely the order of consonants was reversed for inward compared to outward words, whereas the order of vowels was kept the same. Objective fluency was measured in Study 2a and Study 2b by means of onset latencies of overt pronunciations, because of previous findings that word frequencies have profound influence on the pronunciation efficiency of a word (Balota & Chumbley, 1985). Therefore, it was expected that inward words would be overtly articulated faster than outward words. Supporting this, participants were indeed faster in initiating an overt articulation of inward than of outward words, with a robust advantage of about 27 milliseconds (similar in size to other pronunciation effects, e.g., Bargh et al., 1996; Holle et al., 1997). I argue that this objective pronunciation fluency is probably a consequence of natural motor and sensorimotor simulation training caused by the very features of human language.

As a second objective fluency measure, Study 3 examined whether silent reading durations might differ between inward and outward words. Studying the efficiency of silent reading is important for the argument of the current fluency-account because the original in-out effect by Topolinski et al. (2014) has been demonstrated in silent reading tasks. Therefore, the reaction times of key press responses after finishing reading were measured in this study, which again yielded a processing advantage for inward over outward words. Thus, when measuring pronunciation fluency in a similar silent reading procedure as Topolinski et al. (2014), a fluency advantage for inward over outward words can be inferred. Overall, Studies 2a, 2b and 3 demonstrate that consonantal inward dynamics compared to outward dynamics are objectively pronounced more fluently. Given the fact that generally it has been shown in various ways that objective fluency of stimuli has profound influence on preferences (e.g., Reber et al. 1998; Winkielman, Halberstadt, Fazendeiro, & Catty, 2006; for reviews, see Halberstadt, 2006; Reber et al., 2004), one can conclude that the objective fluency measured in Studies 2a, 2b and 3 can provide a crucial source of higher preferences of inward compared to outward words.

However, there are also studies emphasizing the role of subjective fluency in contrast to objective fluency for explicit preferences (e.g., Forster et al., 2013). Therefore, in addition to objectively measured articulation efficiency it was important to asses subjectively experienced pronunciation fluency. Accordingly, Study 4a and Study 4b explored whether fluency differences for inward and outward words could also be found for subjective fluency experiences, which was the case for self-reported ease ratings of English and German speaking participants. Hence, both objective as well as subjective fluency are higher for inward compared to outward words. Therefore, not only the objective fluency, but also subjective fluency might play a crucial role in the in-out phenomenon.

Examining the causal role of objective and subjective pronunciation fluency in the effect of consonantal stricture dynamics on preferences, in Study 5 mediational analyses (for method see, Preacher & Hayes, 2004) on item-level and across studies were conducted using subjective and objective fluency as possible mediating variables. The goal was to test whether processing fluency would partially or completely mediate the influence of consonantal stricture dynamics on preferences. For subjective fluency, the mediation analysis could not be conducted, because a precondition was not met by the data, which was probably due to power loss. For objective processing fluency, the results were not in line with the hypothesized mediating role of objective fluency. Thus, overall these results speak rather against a mediating role of objective fluency, whereas the role of subjective fluency is not clear yet.

To solve the problem of power-loss, in Study 6 mediation analyses were conducted with data on subject- and trial-level from a within-subject design. For the mediation analysis on subject-level, the difference score of preferences and experienced ease were included into the analysis, as recommended by Judd et al. (2001). A partial mediation of experienced ease on the influence of consonantal stricture dynamics on explicit preferences could be found on subject- as well as on trial-level. Thus, overall these results speak in favor of a partial mediation of subjective fluency.

Although the order of the questions did not interact with any variables, one can still conceive that this way of measuring experienced ease and explicit preferences is problematic. Specifically, answering a question on how easy to pronounce a stimulus was perceived and then afterwards answering how much a stimulus is liked, or the other way round, can have profound consequences on responding (e.g., Schwarz et al., 1991; Strack, 1992). This is especially problematic for questions where there is no right or wrong answer and where participants have to generate an answer by relying on their gut feeling. Another methodological problem is that the stimuli had to be presented twice to participants. This has been done to prevent participants from forgetting the words they are asked about, which could have led to the fact that they more strongly base their judgment on the first given answer. As already outlined extensively in Chapter 5.1.2 about consequences of fluency, the mere exposure of a stimuli does contribute to processing fluency (for mere exposure effect see, Bornstein, 1989; Zajonc, 1968). Overall, the data of the item-based, subject-based and trial-based mediation analyses provide rather mixed results. On item-level the data were found to be against a mediational role of objective fluency, whereas on subject- and trial-level the data were in favor of a partial mediational role of subjective fluency. Therefore, an experimental manipulation of fluency was implemented in the last two studies (for advantages of experimental manipulation over mediation, see Jacoby & Sassenberg, 2011; Spencer et al., 2005).

The strongest support for a fluency account stems from Study 7 and Study 8. They provide evidence that altering fluency actively does indeed modulate the attitudinal impact of consonantal articulation direction. Both studies tested whether higher evaluations of inward over outward words would be influenced by fluency gains. Articulation ease was experimentally induced by letting participants train inward or outward kinematics before the actual evaluation phase by simply rehearsing either inward or outward words in a short-term memory task. Additionally, in Study 8 the simulation training was intensified to see whether a stronger modulation of the in-out effect could be found. For both studies, I hypothesized that a kinematic training of outward words would result in more positive evaluations of outward words compared to training inward words.

In both studies this prediction was supported. Training outward articulation kinematics led to an attenuation (Study 7) and, after more extensive training, even to a reversal (Study 8) of the in-out effect, whereas training inward articulation kinematics led to an enhancement of the classic in-out effect. Note that a mere exposure effect was prevented by using completely different words in the training phase than in the evaluation phase. Specifically, in Study 8 participants preferred outward words over inward words after the training of outward words. Thus, altering the pronunciation ease of either inward or outward consonantal kinematics by verbal rehearsal in a short-term memory task affected explicit liking ratings of completely different inward and outward words afterwards. These two final studies ultimately demonstrate the crucial role of pronunciation fluency in the in-out effect. When the articulation ease of consonantal outward words was increased by motor simulation, the preferences for words of the same category, namely for different words with consonantal outward dynamics, were consequently increased as well. This demonstrates that the explicit preferences of inward and outward words are, at least partially, driven by processing fluency.

Almost all studies (Studies 1a, 1b, 2a, 2b, 3, 4a, 4b, 6, 7, 8), except for one analysis of the item-based mediation analyses (Study 5; objective fluency), speak in favor of the hypothesis that inward words compared to outward words are easier to articulate and probably in turn might also be preferred over outward words. The results are discussed separately in the following section. The conclusions for the two accounts of processing fluency compared to approach and avoidance motivations are elaborated separately in the following sections.

11.2 Conclusion on Fluency as the Underlying Mechanism of the In-Out Effect

Even though the mediational results were not clear-cut, overall the current work shows that processing fluency seems to partially mediate the in-out preference effect reported by Topolinski et al. (2014). On the basis of the current work, it can be assumed that probably because of their higher frequency in natural verbal discourse, articulating consonantal inward kinematics might be objectively and subjectively more efficient than articulating outward kinematics, which tentatively in turn might lead to higher preferences for inward over outward kinematics.

As already mentioned, I assume that the natural ecological source of the fluency advantage in the current work is rooted in language, with consonantal inward transitions occurring more often than outward transitions. The role of language in the current work is discussed more elaborately in Chapter 11.4.

Particularly, the results from Studies 7 and 8 support the essential role of processing fluency. These results are in line with previous studies on the flexibility of fluency effects. For instance, it has been shown that when motor fluency of hand movements is artificially altered, the default association between handedness and laterality valence changes accordingly (Casasanto & Chrysikou, 2011). Performing movements with the dominant (non-dominant) hand is usually associated with positivity (negativity). However, if movements with the dominant hand are manipulated in a way that they become disfluent, this reverses the laterality effect. In the current study the motor fluency of pronouncing inward and outward words has been manipulated which also resulted in reversed evaluations (Study 7 and Study 8). Moreover, on a higher judgmental level of fluency, Unkelbach (2006, 2007) has shown that it is possible to relearn inferences that are drawn from fluency by means of ecological cues (for a discussion of response reversal trainings see, Coutanche & Thompson-Schill, 2012).

Importantly, the statistical methods used in the current work should also be discussed regarding what we can infer from them for the role of processing fluency. Specifically, mediational analyses in comparison to interaction testing should be compared here. For statistical mediational analysis (as used in Studies 5 and 6) it is crucial to note that its explanatory value is often misinterpreted (e.g., Fiedler, Schott, & Meiser, 2011). Mediational analysis is often assumed to test whether a variable can truly be a mediator in a relation of two other variables. However, what it actually tests is the effect size and significance of a hypothesized mediator on condition that the hypothesized mediator is the actual mediator (Fiedler et al., 2011). Therefore, mediation analysis does not find mediator nor does it provide evidence for the causal role of mediators. In contrast, interaction analyses (as used in Studies 7 and 8) are often underestimated in the role of process hypotheses testing (e.g., Jacoby & Sassenberg, 2011; Spencer et al., 2005). Therefore, the current mediational analyses should not be overinterpreted and future studies on the underlying mechanism of the in-out effect (Topolinski et al., 2014) should not only focus on mediational tests but also on translating the process into a 2x2 interaction design (cf. Jacoby & Sassenberg, 2011).

Another point worth discussing is what role the single cognitive components of motor-fluency play for the current results. The fluency experience of a motor simulation can be divided into two causal routes, namely efferent processes involving the central nervous system and re-afferent processes involving the peripheral systems (for traces of neural circuit see, Carlson, 2012). There are studies showing that motor simulations start with activity in the supplementary motor area and are then transferred to the premotor cortex. For a motor action to be executed, the activity would then be transferred to the primary motor cortex, where it would in turn be transferred to the respective periphery (muscles). In contrast, for motor simulations the activity is not transferred further from the premotor cortex, which inhibits an execution of the motor action (e.g., Schubotz, 2007). However, there are also studies showing that for motor simulations covert activity can be found in the periphery (effectors; e.g., Bangert et al., 2006; Baumann et al, 2007; Lotze, Scheler, Tan, Braun, & Birbaumer, 2003). For instance, it has been found that when professional musicians read piano notes, simulation activity can be measured in their vocal chords. Topolinski and Strack (2009a, 2010) have demonstrated that when blocking both routes for covert reading simulations with an interfering motor action (chewing gum), no fluency gains for pronunciation simulations of words can be found. However, a distinction of the causality of the two routes (efferent and re-afferent) is not possible in their studies. There is some partially unpublished work (e.g., Dreier, 2013; Straub, 2015) that suggests that re-afferent routes sending feedback to the central nervous system play a major role in fluency gains. Therefore, one could assume that the re-afferent routes also play a critical role for the pronunciation fluency of consonantal inward compared to outward dynamics.

Overall one can conclude on the basis of the current work that fluency plays a major role in the in-out effect. It has been shown consonantal inward kinematics compared to outward kinematics are indeed objectively and subjectively articulated more efficiently. This higher ease can be routed in the higher frequencies of inward compared to outward kinematics in natural language. Moreover, it is legitimate that this higher efficiency of inward compared to outward words may be the source of higher preferences for inward over outward kinematics.

11.3 Conclusion on Approach & Avoidance as the Underlying Mechanism of the In-Out Effect

The role of processing fluency, which has been demonstrated in the current work, does not necessarily speak against an activation of motivational tendencies of approach and avoidance. This is all the more true given the fact that the current mediation analyses found only a partial mediation. Thus, even though processing fluency contributes to the in-out effect, other causal sources such as the originally proposed affective or motivational routes are at work. Thus, fluency has to be contrasted more specifically against the originally assumed mechanism of orally induced approach avoidance motivations.

First, the role of approach and avoidance motivations has to be tested directly, not in the rather indirect manner of assessing preference (as in Topolinski et al., 2014). If the mere articulation simulation of inward and outward words did indeed evoke approach and avoidance motivations, respectively, then it should work as a manipulation of motivational states of approach and avoidance. This could be operationalized by presenting participants several inward versus outward words and then measure their motivational state more directly by a more direct measure of approach and avoidance orientation (for creativity, see Friedman & Förster, 2001, 2002; for arm pressure, see Förster, Higgins, & Idson, 1998; Studies 1 & 2). If the relation between consonantal stricture direction and explicit preferences for inward and outward words is mediated by motivational orientations, as proposed by Topolinski et al. (2014), it should be hypothesized in such a study that articulating several inward words would lead to a motivational state of approach, whereas articulating several outward words would lead to a motivational state of avoidance. Thus, the mediational role of activated motivational states on the link between sagittal articulation direction and preference should be tested in future research.

Furthermore, interaction effects between motivational states of approach and avoidance and evaluation of inward and outward words should be tested. Here, being in an approach (avoidance) orientation might increase preference for inward (outward) words and/or decrease it for outward (inward) words, because they match the current approach (avoidance) orientation. These results would then suggest that approach and avoidance motivations are a crucial source of higher preferences for inward over outward words. Besides that, one could still assume that motor-fluency plays a role on top of that. Therefore, direct tests disentangling the influence of both accounts would be necessary.

One reason why the two mechanisms are not mutually exclusive is the fact that oral approach and avoidance movements of swallowing and expectorating also differ in their ease of execution. As explained in Chapter 3.1. (Ingestion), in contrast to the smooth peristaltic movements of swallowing, the ejection of substances features involuntary sequential muscle movements wandering from the rear to the front of the mouth, that can be described a strong and long lasting muscle contractions of the diaphragm and the abdomen (e.g., Cummins, 1958; Goyal & Mashimo, 2006; Tintinalli et al., 2010; Watcha & White, 1992). Therefore, high fluency, incorporation, and positive affect on the one hand and low fluency, expectoration, and negative affect on the other hand co-occur frequently. Specifically, this could imply that consonantal inward (outward) dynamics elicit approach (avoidance) motivational states and in turn an experience of high (low) motor fluency that in turn leads to high (low) preferences for inward (outward) words.

The current work did not test the contribution of the two routes, motivational and fluency, two influences against each other. Therefore, the originally proposed mechanism by Topolinski et al. (2014) can still play a role in the influence of consonantal stricture dynamics on word-preferences. In the current work, it has been shown that motor-fluency has a profound influence on the in-out effect; but it has not been ruled out that at the same time approach and avoidance motivations might have been activated by the simulation of inward and outward words, respectively. Even if approach and avoidance motivations were activated, it might have been the case that the motor-fluency manipulations overruled the effect of approach and avoidance motivations on word-evaluations. Thus, it has not been ruled out that approach and avoidance motivations as well as high and low fluency are elicited while simulating the pronunciation of inward compared to outward words, respectively.

Therefore, it is of crucial interest to study the relation between the articulation of inward and outward kinematics and approach and avoidance motivations more directly. So far, this mechanism has only been inferred by the affective consequences without ever being tested directly. This could be done in various ways. From an experimental perspective, the best design would be to manipulate approach and avoidance and high and low fluency orthogonally. Thus, one would have to realize a condition in which consonantal inward dynamics (approach movement) is hard compared to another condition in which it is easy. Moreover, one would have to realize a condition in which consonantal outward dynamics (avoidance movement) is hard compared to another condition in which it is easy. For the approach avoidance account of Topolinski et al. (2014), one would expect that the approach vs. avoidance movements should play a role in the in-out effect. For the fluency account of the current work, one would expect that the ease of the execution should play a role in the in-out effect.

As another test of the fluency account against the approach and avoidance account, a different line of research could investigate the influence of consonantal transitions on the processing of information content. That is, whether consonantal inward and outward transitions could be used as subtle fluency or approach and avoidance manipulations, for instance, in whole text passages. It could be manipulated whether a text passage contains relatively more inward versus outward dynamics. After letting participants read the passages, one could test in how far the perceived content of the text has been affected according to consequences of processing fluency versus approach and avoidance. For fluency, for instance, it could be measured how true the content is perceived, whereas, for instance, for approach and avoidance it could be measured whether pictures with related content are easier to approach or avoid, respectively.

Overall, one can say that the role of approach and avoidance motivation in the in-out effect is not clear yet. It can only be speculated whether it plays a role at all. The current work poses an alternative possible explanation, but leaves the question open whether approach and avoidance motivations actually play a role in the in-out effect. On the one hand the assumed fluency account makes approach and avoidance motivations unnecessary as an underlying mechanism, but on the other hand, it does not exclude it. There are possibilities to disentangle the two accounts in future research.

11.4 Discussion of Role of Ecological Influence

On the basis of the current work it is conceivable that the newly discovered motor-fluency advantage of inward over outward words can be rooted in language. In the English as well as the German language about five times more overall inward wandering words than overall outward wandering words have been found.

At first sight, this influence might not appear very powerful, because the relative amount of purely inward and purely outward words compared to the total amount of words in the corpora might seem rather low. However, given the fact that we articulate about 16,000 words a day (Mehl, Vazire, Ramírez-Esparza, Slatcher, & Pennebaker, 2007), one can imagine that this slight difference can still leave a distinct learning effect. The current findings are in line with literature showing that ecological factors like language frequencies and features shape psychological processes like the efficiency of language processing (Balota & Chumbley, 1985; Brysbaert & New, 2009; Ellis, 2002; Grainger, 1990), as well as evaluations and judgments (Broadbent, 1967; Fiedler, 1996, 2000; Hintzman, 1988; Semin & Fiedler, 1988, 1992; Smith & Semin, 2004; Unkelbach et al., 2008; Zipf, 1932). Coming back to back to the Brunswikian position (Brunswik, 1956) and the according process model of Unkelbach and Greifenender (2013), in the current study language and the frequency of consonantal articulation dynamics serve as distal environmental factors that shaped participants' preferences via proximal cues of fluency. Hence, I assume that the higher frequencies for inward compared to outward words lead to higher pronunciation fluency that in turn serve as a source for higher preferences for inward over outward words.

An important study that is completely in line with the current findings comes from Balota & Chumbley (1985) who demonstrated that word frequencies had profound influence on mere pronunciation of a word. Instead of frequent words, in the current study it was shown that more frequent consonantal kinematics are pronounced more efficiently than less frequent consonantal kinematics.

Regarding the assumed ecological source of the pronunciation fluency it might seem astonishing that such a stable and long-term influence can be overruled by such a short articulation retraining (Studies 7 and 8). The influence of language had a lifetime to exert its influence on our speech organs, whereas the articulation retraining took about 10-15 minutes. Therefore, one might argue that the long lasting training of not only simulation but also actual pronunciations caused by natural language cannot be overruled by a several minutes-long mere simulation training. However, there are also other studies showing that relationships, that had a lifetime to develop, can be temporarily overruled within a task of an experiment. Not only in the previously mentioned study by Casasanto and Chrysikou (2011), but also in studies by Unkelbach (2006, 2007) it has been shown that relations between processing fluency and evaluations can be altered within a several minutes-long task.

Overall, one can conclude that the current work suggests that natural language can serve as a source of higher processing fluency for inward over outward words. Higher frequencies for inward compared to outward dynamics have been found in the English and German languages. In prior studies, frequencies of occurrences in language have been found to influence efficiency of processing. Together with the fact that the efficiency of processing has been shown to influence word evaluations, this can also be assumed to be the underlying mechanism.

11.5 Further Research Ideas

The current work about the newly discovered role of fluency in the in-out effect offers a wide range of more elaborate future studies.

First, regarding the mediational analyses in the current work, future studies could investigate different operationalizations of processing fluency and preferences to obtain more conclusive results. The goal of the current Studies 5 and 6 was to test whether processing fluency would partially or completely mediate the influence of inward and outward consonantal stricture dynamics on explicit preference. However, the effect of experienced ease was not significant - probably due to loss of power when converting data on item-level-, which did not allow for further analysis. Moreover, from the overall effect sizes and significance levels one can infer that statistical power in the analyses was low. Future studies on across study mediations for the in-out effect on item-level should take that into account and, for instance, increase their cell sizes.

In Study 6 mediation analyses were conducted with data on subject- and trial-level from a within-subjects design, including both, ratings of explicit preferences and experienced ease. Both mediational analyses indicated a partial mediation of experienced ease. Even though statistically it was not observed, there might still be a problem with the design of the study, because participants had to answer two questions for each target word. Answering two quite similar questions directly after each other might have led to the fact that the second answer was based on the first. Moreover, the second question might have also had an influence on the first question, because participants could anticipate the second question after having answered both for the first target word. This added confounding influence into the measurements and should be avoided in future studies. This could be done by using implicit measurements, for instance, EMG measures for capturing positive affect and then asking explicitly for experience ease of pronunciation of the target words. This should be informative when first measuring EMG activity while merely reading the target words and then in a subsequent phase measuring subjectively experienced ease. However, when measuring the two variables at the same time, it might again be problematic. When measuring EMG activity while participants make ease of pronunciation judgments, the EMG might also reflect the ease judgment.

Another possibility to disentangle the role of processing fluency from approach and avoidance motivations for the in-out effect might be a study applying a misattribution procedure. Processing fluency effects are known to vanish, when participants are pointed to the fact that they might be influenced in their evaluation by misattributing an experience of ease that in fact should be unrelated to the evaluation (e.g., Schwarz et al., 1991). For approach and avoidance motivations in contrast this seems not to be the case (at least to my knowledge). Therefore, in a future study it could be tested whether the in-out effect is affected when participants are pointed to either the fact that they might be influenced by the ease of pronunciation or the elicited motivational state. It would speak in favor of a fluency account when the in-out effect is affected by the hint at the ease of pronunciation compared to the elicited motivational state, whereas it would speak in favor of an approach and avoidance account when the in-out effect is affected by the hint at the elicited motivational state compared to ease of pronunciation.

A matter of ecological relevance would be, for example, the influence of more complex consonantal transitions on evaluations, because natural language almost exclusively consists of mixed consonantal inward and outward transitions. The first steps have been made by Topolinski and Bakhtiari (2015) who found that words featuring consonantal first-outward-then-inward dynamics (e.g., AKESUMUSEKA; avoidance-then-approach) were preferred over words featuring first-inward-then-outward dynamics (e.g., AMENUKUNEMA; approach-then-avoidance). However, in comparison to a whole sentence or even a whole book, these are still quite simple consonantal dynamics. There is a huge amount of research needed to get more insight about that.

Another matter of ecological relevance concerns the question how wide-spread the inherent consonantal patterns in languages are. Are there other languages that also feature more inward than outward dynamics? If yes, is its distribution related to the origination of a language, thus families of languages? Can we find inherent frequency patterns in other Germanic languages beyond German and English or even other Indo-European languages (e.g., Latin, Persian, Greek, Danish, Dutch). Can it be related to ancient Indo-European migrations? These questions on its own form a gigantic new research area that is definitely worth pursuing in future research.

Also, marketing studies might use consonantal inward and outward dynamics as a marketing strategy for creating brand names or even product descriptions. As Topolinski, Zürn and Schneider (2015) have shown already, inward compared to outward brand names lead to higher product preferences, stronger purchase intentions, and higher amounts of money participants were willing to pay for a product. They concluded that consonantal stricture dynamics in brand names can be used as means to achieve higher monetary gains. Moreover, the authors hold that this strategy fits into the current trend of creating brand names that sound good, rather than choosing names that refer to the name of the founder of the company. In addition to this advice, the current work shows how important the role of pronunciation fluency is in this phenomenon (see also, Song and Schwarz, 2009). Therefore, it should be considered when creating new brand names.

Overall, there are various possibilities for future studies. For linguistic studies, it would be of high interest to get to know more about the distribution of inherent consonantal dynamic structure. For the psychological research area, it would be essential to gain more insight about the underlying mechanism of consonantal inward and outward dynamics as well as its psychological consequences.

11.6 Conclusion

The current studies introduce a completely different account for the phenomenon that words containing consonantal inward dynamics are preferred over words containing outward dynamics. Oral motor fluency seems to play a crucial role in how we evaluate words featuring consonantal inward compared to outward dynamics. The role of motivational states has not been excluded in the current studies and should be addressed in future studies. Overall, it is to conclude that consonantal inward compared to outward dynamics are more frequent in the English and German languages, are therefore probably objectively and subjectively easier to process and in turn can be a source of higher preferences.

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Appendix

Stimulusitem	Wordcategory	Explicit Preferences	Experienced Ease	Overt Reading Onset	Silent Reading Duration	Averaged Speed
BADIKU	inward	5.08	7.33	591.3	921.53	756.42
BALUGO	inward	6.25	8	578.88	940.19	759.53
BANURO	inward	5.5	7.33	688.28	811.53	749.9
BATIKU	inward	5.79	6	633.59	851.44	742.51
BEDURA	inward	5.5	7.42	607.19	785.91	696.55
BENIGA	inward	5.19	7.7	729.66	917.55	823.6
BESIGA	inward	5.24	7.33	689.79	869.06	779.42
BETUGA	inward	5.09	6.82	686.56	833.58	760.07
BIDAGO	inward	5.22	7	629.19	845.84	737.51
BILOKE	inward	4.49	6.85	684.17	892.57	788.37
BITERA	inward	4.49	6.5	597.71	848.83	723.27
BONUKE	inward	4.6	6.58	585.9	932	758.95
BOSIRE	inward	4.47	6.8	716.07	845.93	781
BULARO	inward	5.13	7.36	588.43	849.39	718.91
BUSOKI	inward	5.13	6.89	641.64	884.19	762.91
MADORU	inward	5.63	6.25	670.59	890.71	780.65
MANOGE	inward	5.31	6	647.31	885.44	766.37
MATEGI	inward	5.03	7.27	609.39	947.97	778.68
MENOKU	inward	4.62	6.27	838.18	951.83	895.01
MESAKU	inward	5.21	6.9	706.61	884.66	795.64
MILEGO	inward	5.28	6.88	755.35	797.3	776.32
MISARO	inward	5.25	7.5	671.04	891.45	781.25
MODAGE	inward	4.97	6.45	723.74	861.55	792.65
MOLARU	inward	5.79	6.71	703.25	866.08	784.66
MOSIGE	inward	4.48	8	846.26	856.76	851.51
MOTEKA	inward	5.16	7.53	633.47	931.35	782.41
MUDEKI	inward	5.05	6.36	719.8	828.7	774.25
MULEKA	inward	5.16	6.7	643.51	950.15	796.83
MUNORA	inward	5.7	7.75	849.09	1002.04	925.56
MUTARI	inward	5.26	7.64	633.03	746.95	689.99
PALERU	inward	5.53	7.67	578.75	970.55	774.65
PASOKI	inward	5.43	7.4	630.6	861.09	745.85
PATURO	inward	5.51	6.4	622.71	865.96	744.34
PEDAGO	inward	5.23	7.1	615.38	849.72	732.55
PELUGO	inward	4.97	7.43	615.24	910.7	762.97
PENUKA	inward	4.74	7.5	634.65	800.9	717.77
PIDERU	inward	4.44	6.57	659.76	880.72	770.24
PISEGU	inward	4.26	5.75	631.88	902.5	767.19
PONIRA	inward	5.04	6.73	683.73	812.62	748.18

POTIKE	inward	4.3	7	588.65	870.5	729.58
PUDOKA	inward	4.18	6.64	696.46	926.16	811.31
PULIKA	inward	4.97	6.64	662.34	768.14	715.24
PUNOGE	inward	4.2	6.38	699.37	971.21	835.29
PUSIRE	inward	4.36	6.14	634.81	849.26	742.03
PUTAGI	inward	4.59	6.82	657.52	840.09	748.8
WADURE	inward	3.97	7.4	620	920.39	770.19
WANIKO	inward	5.45	6.17	628.73	879.81	754.27
WASOGE	inward	4.02	7.67	607.39	865.74	736.56
WENOGU	inward	4.21	6.36	722.67	924.52	823.59
WESUKA	inward	4.73	6.36	617.61	845.12	731.36
WIDAKU	inward	3.75	6.88	654.79	800.94	727.86
WILUKA	inward	5.13	7.18	641.94	872.07	757
WITARO	inward	4.39	7.75	766.7	819.76	793.23
WITUGE	inward	3.53	7	752.07	849.97	801.02
WODEGA	inward	4.43	7.36	618.24	908.45	763.34
WOLURI	inward	5.02	7.63	675.33	894.21	784.77
WONURI	inward	4.71	5.57	690	874.77	782.38
WOSIRU	inward	3.86	6.13	771.23	965.03	868.13
WULIGO	inward	4.21	6.92	722.55	959.39	840.97
WUTAKI	inward	5.43	6.5	679.77	746.94	713.35
GALUBO	outward	5	8.11	717.5	956.13	836.81
GANOME	outward	4.18	7.23	888.54	974.86	931.7
GASOWE	outward	3.75	7.1	606.97	789.05	698.01
GATEMI	outward	5.05	6.9	683.85	915.13	799.49
GEDAPO	outward	4.82	6.73	703.38	899.68	801.53
GELUPO	outward	4.79	6.63	652	933.81	792.91
GENIBA	outward	4.89	6.7	762.74	808.33	785.53
GENOWU	outward	3.88	5.55	701.66	969.03	835.34
GESIBA	outward	5.15	7.27	739.92	844.71	792.31
GETUBA	outward	4.75	7	641.2	737	689.1
GIDABO	outward	4.41	6.67	736.43	913.62	825.02
GILEMO	outward	4.95	7.25	785.73	810.94	798.34
GISEPU	outward	4.03	6.13	669.88	816.27	743.08
GITUWE	outward	3.34	5	654.55	947.7	801.12
GODAME	outward	4.48	7.83	605.18	828.37	716.77
GODEWA	outward	4.79	7.83	605.18	928.79	766.98
GOSIME	outward	4.63	5.91	602.61	866.34	734.48
GULIWO	outward	4.44	6.54	849.81	1024.31	937.06
GUNOPE	outward	4.37	6.86	653.84	916.98	785.41
GUTAPI	outward	4.42	7.09	656.86	836.42	746.64
KADIBU	outward	5.08	8.11	677.36	887.96	782.66
KANIWO	outward	5.07	6.89	700.88	903.38	802.13
KASOPI	outward	5.41	6.73	712.58	975.73	844.15
KATIBU	outward	5	6.92	622.93	805.62	714.27

KENOMU	outward	5.09	7.11	849.23	1004.5	926.87
KENUPA	outward	4.76	7.45	670.79	894.75	782.77
KESAMU	outward	4.94	7.08	695.66	902.47	799.06
KESUWA	outward	4.88	7.17	701	889.25	795.13
KIDAWU	outward	4.95	6.6	728.52	1003.05	865.79
KILOBE	outward	4.45	6.7	635.04	789.76	712.4
KILUWA	outward	5.08	7.67	768.72	938.45	853.58
KONUBE	outward	4.32	7.18	695.28	937.92	816.6
KOTEMA	outward	4.25	6.88	623.7	867.58	745.64
KOTIPE	outward	4.37	6.85	650.1	757.21	703.65
KUDEMI	outward	4.57	6.5	712	816.11	764.06
KUDOPA	outward	4.67	7	706.44	917.11	811.78
KULEMA	outward	5.37	7.4	599.37	840.33	719.85
KULIPA	outward	5.31	6.75	670.4	836.69	753.55
KUSOBI	outward	5.11	6.55	671.54	865.76	768.65
KUTAWI	outward	4.64	6.7	633.44	806.13	719.78
RADOMU	outward	4.07	6.58	637.94	1129.73	883.83
RADUWE	outward	3.91	6.14	675	937.85	806.43
RALEPU	outward	4.13	6.25	851.85	1008.92	930.38
RANUBO	outward	4.53	6.83	678.12	952.22	815.17
RATUPO	outward	4.42	7.25	668.76	948.02	808.39
REDUBA	outward	4.89	6.55	749.48	910.35	829.92
RIDEPU	outward	3.54	5.22	812.26	881.35	846.8
RISAMO	outward	4.96	6.75	780.42	789.72	785.07
RITAWO	outward	4.09	7	682.69	810.61	746.65
RITEBA	outward	4.58	6.83	667.8	1060.95	864.37
ROLAMU	outward	3.91	7.56	680.17	875.74	777.95
ROLUWI	outward	4.39	5.67	676.25	890.85	783.55
RONIPA	outward	4.2	6.33	790.69	932.43	861.56
RONUWI	outward	4.24	5.83	739.64	934.31	836.97
ROSIBE	outward	5	5.67	582.42	805.43	693.92
ROSIWU	outward	4.05	6.4	629.76	896.54	763.15
RULABO	outward	4.56	7	689.29	922.42	805.86
RUNOMA	outward	4.95	6.2	712	1020.38	866.19
RUSIPE	outward	3.85	6.45	760.94	907.95	834.44
RUTAMI	outward	4.71	7.86	710.31	914.35	812.33