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IHE WHITEPAPER SERIES

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IHE-WP-01

# Foundations of Seduction Science

*A Multilevel Framework for Attraction, Bonding, and Relationship Loss*

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## Abstract

This paper sets out the conceptual foundations of the IHE whitepaper series on *seduction*, defined here as consensual, communicative behavior by which one person seeks to elicit or increase another person's romantic or sexual interest. Its purpose is to replace a set of confident popular claims (that attraction is predictable, that courtship cues are universal, that attachment style is fixed in childhood, and that heartbreak is the same as drug withdrawal) with a framework that can be tested. The approach is a structured narrative review organized around four levels of analysis: biological, psychological, dyadic and sociocultural, with explicit propositions about how the levels interact. Each major thesis is presented with its best supporting evidence, its strongest objection and a graded verdict. The main position is that attraction and bonding are patterned but only weakly predictable for particular individuals and pairs; that courtship signals are real but noisy, context-dependent and culturally shaped; that adult attachment orientations are moderately stable and open to change; and that romantic loss engages reward-related brain systems that overlap with, but are not identical to, those implicated in addiction. Most people recover from relationship loss without professional help, although some need clinical care. The paper defines its core terms operationally, states what it does not claim, summarizes the evidence in a single table, and proposes a pre-registrable research agenda. Its limits are those of the underlying literatures: small neuroimaging samples, heavy reliance on self-report, and samples drawn mostly from Western, heterosexual university populations.

**Keywords:** *attraction; courtship signaling; attachment; pair-bonding; relationship dissolution; multilevel framework; research ethics*

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# 1. Introduction

Human attraction is often described either as an impenetrable mystery or as a game with rules that can be learned and applied. Neither description survives contact with the research literature. Attraction, courtship, bonding and loss have been studied for decades by social and personality psychologists, neuroscientists, evolutionary biologists, anthropologists and communication scholars. These fields have produced robust regularities, a smaller number of mechanisms that are reasonably well understood, and a large number of claims that have weakened under better methods. What they have not produced is a single theory, a set of laws, or a reliable way to forecast whom a given person will desire.

Popular and secondary accounts tend to compress this literature into slogans. It is often said that attraction is "biology" and therefore predictable, that seduction follows a fixed sequence of stages, that the nonverbal signals of interest are the same everywhere, that childhood attachment patterns determine adult romantic behavior, and that heartbreak "is" withdrawal from a drug. Each slogan contains a grain of evidence. Each also overstates it in ways that matter for anyone who wants to understand, teach or study human relationships.

This paper is the first in a five-part series published by the Institute for Human Evolution (IHE) and serves as its conceptual anchor. It defines the series' central terms and scope (Section 2), proposes a multilevel framework with explicit cross-level propositions (Section 3), and evaluates widely repeated claims about the predictability of attraction (Section 4), courtship signals (Section 5), the neurobiology of love (Section 6), attachment (Section 7), bonding (Section 8), relationship loss (Section 9) and culture (Section 10). It closes with an evidence summary, limitations, ethical considerations and a research agenda that doubles as a roadmap for the later papers.

The scope of the Institute's work is educational and scientific. IHE provides preventive education and skill-building, not treatment. It does not diagnose, it does not replace psychotherapy or psychiatric care, and it refers people who need clinical care to licensed clinicians. The Institute describes tendencies, never laws.

## 1.1 Evidence-strength vocabulary

Every major empirical claim in this paper is graded with the vocabulary in Table 1, which is used consistently across the IHE series.

**Table 1.** Evidence-strength vocabulary used in this paper.

| Grade              | Meaning                                                           |
|--------------------|-------------------------------------------------------------------|
| <b>Established</b> | Replicated, convergent methods, large or meta-analytic evidence   |
| <b>Supported</b>   | Consistent findings, but limited replication, samples, or methods |
| <b>Preliminary</b> | Few or small studies, or a single method                          |
| <b>Contested</b>   | Credible evidence on more than one side, or failed replications   |

| Grade              | Meaning                                  |
|--------------------|------------------------------------------|
| <b>Speculative</b> | Plausible hypothesis, no direct evidence |

The grades describe the state of the evidence for a claim, not its importance or its plausibility. A claim may be graded Speculative because no one has tested it, and a well-known claim may be graded Contested because careful attempts to replicate it have produced mixed results.

### What this paper does not claim

It does not claim that attraction, courtship or relationship outcomes can be predicted for particular individuals or couples, or that any technique reliably produces another person's interest. It does not claim that any courtship signal has a fixed meaning across people, situations or cultures. It does not claim that romantic loss is a brain injury, a disease, or the same process as drug addiction or withdrawal. It does not claim that childhood experience fixes adult attachment, or that any attachment orientation is a diagnosis. It does not treat heterosexual, reproduction-oriented, two-gender relationships as the norm against which others are measured. It does not claim that the Institute has conducted studies, holds proprietary data, or provides treatment, counseling or matchmaking of any kind.

## 2. Scope and operational definitions

Precise definitions are a precondition for cumulative science. Several terms used in this series have everyday meanings that are broader, vaguer or more value-laden than their scientific use. This section fixes their meaning for the whole series.

### 2.1 Seduction

In this series, *seduction* is an umbrella term for consensual, communicative behavior by which one person seeks to elicit or increase another person's romantic or sexual interest. The term is used because it names a familiar domain of human behavior, not because the Institute endorses its connotations of guile. Three features of the definition matter.

First, the behavior is *communicative*: it consists of signals that the other person can perceive and respond to, such as conversation, humor, gaze, touch, proximity and self-presentation. Second, it is *consensual*: it proceeds only with the other person's ongoing, freely given participation. Consent is not a single event but a process that can be expressed and withdrawn, verbally and nonverbally, and that people sometimes misread (Muehlenhard et al., 2016). Third, it is *bidirectional*: the person whose interest is sought is an agent who evaluates, reciprocates or declines, not a target to be acted upon.

Coercion, deception about material facts (for example about relationship status, identity or health), harassment, pressure after refusal, and manipulation of a person who has not consented fall outside the

definition. They are not studied as "skills" to be improved. Where the literature on these behaviors is discussed, it is discussed as a risk to be understood and prevented.

## 2.2 Attraction and desire

*Romantic attraction* is a person's positive evaluation of, and motivation to pursue, a romantic connection with a particular other. *Sexual desire* is motivation for sexual contact. The two often co-occur but are partly separable: people can feel romantic attachment without sexual desire and sexual desire without romantic attraction, and Diamond has argued that sexual orientation organizes sexual desire more strongly than it organizes romantic love (Diamond, 2003). *Initial attraction* refers to attraction between people who have just met, typically studied in speed-dating paradigms; it is distinct from attraction within established relationships, and the two are predicted by different variables (Section 4).

A related distinction separates three questions that are often conflated: whether a person tends to desire others in general (*actor* effects), whether a person tends to be desired by others in general (*partner* or *target* effects), and whether a particular person desires a particular other more than either person's general tendencies would suggest (*relationship* effects) (Joel et al., 2017; Eastwick & Hunt, 2014). Much of the confusion in popular accounts of attraction comes from treating findings about the first two as if they answered the third.

## 2.3 Bonding and pair-bonding

*Bonding* is the process by which a romantic relationship becomes a durable, selective social and emotional tie, characterized by preference for the partner, distress at separation, and mutual support. *Pair-bonding* is the outcome of that process. In comparative biology the term describes selective, enduring partner preferences, studied most intensively in monogamous prairie voles (Burkett & Young, 2012); in humans it is used more loosely and does not imply sexual exclusivity, cohabitation or reproduction. Fisher's influential proposal distinguishes three partly independent motivational systems, lust, attraction and attachment, each with distinct functions and partly distinct neurobiology (Fisher, 1998). The proposal is a useful heuristic; its neurochemical specifics remain only partly tested (Section 6).

## 2.4 Attachment

*Attachment* in the technical sense refers to a behavioral system, first described in infant-caregiver relationships, that motivates proximity-seeking to a specific figure under threat and uses that figure as a secure base for exploration (Bowlby, 1969). Hazan and Shaver proposed that adult romantic love can be conceptualized as an attachment process (Hazan & Shaver, 1987), and an extensive literature has since examined adult attachment (Mikulincer & Shaver, 2016). Individual differences in adult attachment are best measured along two continuous dimensions: *attachment anxiety* (worry about rejection and abandonment) and *attachment avoidance* (discomfort with closeness and dependence). Taxometric evidence indicates that these differences are dimensional rather than a set of discrete types

(Fraley et al., 2015). Labels such as "anxious," "avoidant" and "secure" are therefore shorthand for regions of a continuous space, not categories into which people can be sorted.

## 2.5 Relationship loss and "heartbreak"

*Relationship loss* refers to the end of a romantic relationship through breakup, divorce, rejection or the partner's death, together with the emotional, cognitive and behavioral responses that follow. *Heartbreak* is used in this series as an everyday label for the acute distress associated with nonbereavement loss, especially rejection by a partner one still loves. It is not a diagnostic category. Responses to loss range from brief distress to, in some people, clinically significant depression or anxiety (Sbarra & Hazan, 2008); this paper treats the clinical end of that range as the province of licensed clinicians and not of education.

## 2.6 Scope and populations

The framework is intended to apply to romantic and sexual relationships regardless of the partners' sexual orientation or gender. In practice much of the evidence reviewed here comes from heterosexual dyads, often university students in North America and Western Europe. Where findings are limited to such samples, the paper says so. The available evidence suggests that the processes predicting relationship quality are broadly similar in same-sex and different-sex couples (Kurdek, 2005), but research on transgender and nonbinary people's courtship and relationships remains sparse, and the generalizability of most findings to them is unknown.

The paper is concerned with descriptive and explanatory science. It does not offer relationship advice, matchmaking, genetic matching or reproductive guidance, and it takes no position on reproductive policy.

# 3. A multilevel framework

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## 3.1 Precedents

The case for studying attraction and bonding at several levels at once is not new. Tinbergen argued that any behavior raises four distinct questions: its immediate mechanism, its development within the individual, its function or survival value, and its evolutionary history (Tinbergen, 1963). Answers to one question do not substitute for answers to another. Engel's biopsychosocial model made a parallel argument in medicine: biological, psychological and social factors jointly shape health and illness, and a purely biological account leaves out much of what matters (Engel, 1977).

Within relationship science, the vulnerability-stress-adaptation model holds that relationship outcomes arise from the interplay of partners' enduring vulnerabilities, the stressful events they encounter, and the adaptive processes (such as communication and support) by which they respond (Karney & Bradbury, 1995). More recently, relationship scientists have summarized the field in a set of core principles spanning individual, dyadic and contextual levels (Finkel et al., 2017) and proposed a framework that models relationships as evaluative trajectories over their whole course, from first

meeting to dissolution (Eastwick et al., 2019). The framework in this paper draws on these precedents.

### 3.2 The four levels

Table 2 summarizes the four levels of analysis used throughout the series, with typical constructs, methods, and the inferential risk most characteristic of each.

**Table 2.** Levels of analysis in the IHE framework.

| Level         | Example constructs                                                       | Typical methods                                                 | Characteristic inferential risk                                     |
|---------------|--------------------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------------------------------|
| Biological    | Reward circuitry, neuropeptides, stress physiology, evolved dispositions | Neuroimaging, endocrine assays, comparative and genetic studies | Reverse inference; small samples; animal-to-human extrapolation     |
| Psychological | Attachment orientation, appraisals, self-concept, preferences            | Self-report scales, experiments, diaries                        | Self-report bias; stated preferences mistaken for revealed ones     |
| Dyadic        | Responsiveness, disclosure, reciprocity, coordination                    | Speed dating, couple studies, interaction coding                | Ignoring nonindependence; confusing person and relationship effects |
| Sociocultural | Norms, gender roles, display rules, partner markets                      | Cross-cultural surveys, ethnography, demographic data           | Generalizing from unrepresentative samples; ecological fallacy      |

The *biological* level concerns the physiological systems through which attraction and attachment are experienced and the evolutionary history that shaped them (IHE-WP-02, IHE-WP-03, IHE-WP-04). The *psychological* level concerns individuals' dispositions, motives, appraisals and learning histories. The *dyadic* level concerns properties that exist only between two people, such as mutual responsiveness, coordination and relationship-specific attraction. The *sociocultural* level concerns the norms, institutions and material conditions that shape who meets whom, what is considered attractive or appropriate, and how relationships begin and end.

### 3.3 Cross-level propositions

A framework that lists levels without specifying their interactions is a taxonomy, not a theory. The following propositions state how the levels are assumed to interact. Each is framed so that it could be wrong.

1. *Biological systems are necessary but not sufficient.* Reward and attachment circuitry is engaged in romantic love and loss, but which person engages it, and how strongly, depends on learning, appraisal and context. Prediction: neural or endocrine measures taken without reference to the specific partner will predict relationship-specific outcomes poorly.
2. *Psychological dispositions act through dyadic processes.* Attachment orientations and preferences influence outcomes mainly by shaping how people interpret and respond to a specific partner. Prediction: the effects of individual-difference measures on relationship

outcomes will be partly or wholly mediated by perceived partner responsiveness and related dyadic variables.

3. *Dyadic properties are emergent.* Relationship-specific attraction cannot be reconstructed from the two partners' separate characteristics. Prediction: pre-meeting measures of two individuals will explain little relationship variance in their mutual attraction (Section 4).
4. *Sociocultural context sets the range of variation.* Norms and conditions shape which signals are used, how they are read, and which partners are available. Prediction: the meaning of specific nonverbal cues, and the size of sex differences in stated preferences, will vary across cultures and historical periods.
5. *Influence runs in both directions.* Relationship experiences alter psychological dispositions (for example, attachment orientations shift with relationship events) and physiology (for example, stress responses after separation). Prediction: longitudinal designs will detect change in attachment orientation following major relationship transitions.
6. *No level is privileged as "the cause."* An account at one level does not refute or replace an account at another. A finding that a brain region is active during romantic love describes a mechanism; it does not show that love is "only" that activity.

### 3.4 Against reductionism

The sixth proposition deserves emphasis because popular accounts so often violate it. Statements such as "attraction is dopamine" or "bonding is oxytocin" treat a neurochemical as the cause of a complex psychological state. Neurotransmitters and hormones act in many systems and serve many functions; dopamine, for example, is more closely tied to motivational salience than to pleasure as such (Berridge & Robinson, 1998). Correlating a neurochemical with a feeling identifies a component of a mechanism, not the feeling's identity. The framework therefore uses biological findings to constrain psychological and dyadic theories, not to supplant them.

## 4. Attraction: patterned, but weakly predictable for individuals

### 4.1 The claim

It is often said that attraction is a predictable biological and psychological process, so that knowing enough about two people would allow one to forecast whether they will be drawn to each other. This claim conflates two different propositions. The first, that attraction is *patterned* at the level of populations, is well supported. The second, that attraction is *predictable* for particular pairs before they meet, is not.

### 4.2 The best evidence for regularity

Several regularities in attraction are robust. People within and across cultures agree substantially in their judgments of facial attractiveness, and attractiveness is associated with a range of social outcomes

(Langlois et al., 2000) (Established). Similarity is associated with attraction: a meta-analysis of 313 studies found large associations for both actual and perceived similarity, although the effect of actual similarity was concentrated in studies with little or no interaction and was not significant in existing relationships, whereas perceived similarity predicted attraction across contexts (Montoya et al., 2008) (Established for perceived similarity; Supported, with important moderation, for actual similarity). Across a 45-country sample of 14,399 participants, sex differences in stated preferences for partners' attractiveness, age and financial prospects replicated earlier cross-cultural findings (Walter et al., 2020) (Established for stated preferences; see IHE-WP-03 for competing explanations).

### **4.3 The best objection: weak prediction for pairs**

Three lines of evidence show that these regularities do not translate into accurate predictions for particular people.

First, stated preferences predict in-person attraction poorly. In a speed-dating study, the sex differences that participants reported in the importance of physical attractiveness and earning prospects did not appear in whom they actually desired after meeting (Eastwick & Finkel, 2008). A meta-analysis found that matching between a person's ideal partner preferences and a partner's traits predicted evaluations of partners people had actually met only weakly (Eastwick et al., 2014) (Supported).

Second, much of the variance in attraction is relationship-specific. Romantic evaluations contain both a consensual component (some people are widely desired) and a substantial unique component that reflects the particular pairing (Eastwick & Hunt, 2014). Even for faces viewed in isolation, a substantial share of attractiveness judgments reflects private rather than shared taste (Hönekopp, 2006). In the most direct test, participants in two speed-dating studies completed more than 100 self-report measures of traits and preferences before meeting. Machine-learning models predicted 4% to 18% of actor variance and 7% to 27% of partner variance, but could not predict relationship variance from any combination of the pre-date measures (Joel et al., 2017) (Supported; the samples were heterosexual university participants in the United States, and different measures or settings could perform differently).

Third, established relationships show a similar pattern. Across 43 longitudinal datasets including 11,196 couples, people's own perceptions of the relationship (for example, perceived partner commitment and satisfaction, and their own appreciation) explained approximately 45% of their current satisfaction, while the partner's reports and either partner's individual traits added little. None of the variables predicted which relationships would improve or deteriorate over time (Joel et al., 2020) (Supported). This parallels a broader finding in the social sciences: even with rich longitudinal data and many competing teams, life outcomes for individual families proved difficult to predict much better than simple baselines (Salganik et al., 2020).

### **4.4 Why population patterns do not yield individual forecasts**

The gap between group-level association and individual prediction can be illustrated numerically. Suppose a predictor and an outcome are jointly normally distributed with correlation  $r$ . The proportion

of outcome variance the predictor explains is  $r^2$ . A second, more intuitive index is the probability that a person above the median on the predictor is also above the median on the outcome:

$$P(Y > 0 \mid X > 0) = 1/2 + \arcsin(r)/\pi \quad (1)$$

where  $X$  is the predictor and  $Y$  the outcome, both standardized so that their means and medians are zero,  $r$  is their correlation,  $\arcsin$  is the inverse sine (in radians), and  $\pi$  is the mathematical constant. Equation 1 is a standard property of the bivariate normal distribution. Table 3 gives values computed for illustrative correlations; they are not estimates of any particular effect in the literature.

**Table 3.** Variance explained and above-median concordance for illustrative correlations (computed, not empirical).

| Correlation $r$ | Variance explained $r^2$ | P(above median on Y, given above median on X) |
|-----------------|--------------------------|-----------------------------------------------|
| 0.10            | 1%                       | 53.2%                                         |
| 0.20            | 4%                       | 56.4%                                         |
| 0.30            | 9%                       | 59.7%                                         |
| 0.50            | 25%                      | 66.7%                                         |

A correlation of 0.30 is respectable by the standards of social and personality psychology, yet it raises the chance of a correct above-median "forecast" from the 50% expected by chance to about 60%. A correlation of 0.50 raises it to about 67%. Even strong population patterns therefore leave most of the uncertainty about any particular person unresolved, and relationship-specific attraction, for which pre-meeting predictors currently show no detectable validity, is harder still.

## 4.5 Verdict

Attraction is *patterned*: some features are widely preferred, and similarity, familiarity and reciprocity matter on average (Established to Supported). Attraction between particular people is *weakly predictable* before they interact, and much of what matters is relationship-specific and emerges in interaction (Supported). The claim that attraction is a predictable process, in the sense of individual-level forecasting, is not supported. This conclusion constrains the probabilistic modeling discussed in IHE-WP-05.

# 5. Courtship signaling and the communication of interest

## 5.1 The claim

It is often said that people communicate romantic interest through a universal repertoire of cues, including eye contact, body orientation, shifts in vocal tone, microexpressions, timing, silence, strategic inconsistency and social proof, and that these cues can be read and deployed reliably. The literature supports a narrower set of claims.

## 5.2 What the evidence shows

Observational studies document recurring nonverbal behaviors in courtship settings. In early field observations of women in social venues in the United States, a catalog of nonverbal behaviors (glances, smiles, grooming and proximity) was associated with subsequent approaches by men (Moore, 1985). In laboratory encounters between opposite-sex strangers in Germany, the degree of behavioral synchronization between partners was associated with women's reported interest (Grammer et al., 1998). These studies established that courtship has observable nonverbal structure, but they were small, culturally specific and limited to heterosexual interactions, and their coding schemes have rarely been replicated across settings (Supported for the existence of recurring patterns; Preliminary for specific cue-interest links).

*Gaze.* Mutual gaze between opposite-sex strangers increased reported feelings of affection in an early laboratory experiment (Kellerman et al., 1989) (Preliminary). Eye contact reliably captures attention and increases arousal in observers from different cultures, but its social evaluation differs: in a comparison of Finnish and Japanese participants, Japanese participants rated faces making eye contact as angrier, less approachable and less pleasant (Akechi et al., 2013). The physiological salience of gaze appears broadly shared; its meaning does not.

*Proximity and orientation.* Preferred interpersonal distance varies substantially across countries and also with individual characteristics such as gender and age (Sorokowska et al., 2017). A distance that signals warmth in one setting may signal intrusion in another (Established for variation; Speculative for any fixed "proximity rule").

*Voice.* Speakers alter vocal characteristics, including pitch, when addressing more attractive partners, and listeners can detect some of these changes (Hughes et al., 2010) (Preliminary; small samples, recorded messages rather than live interaction).

*Microexpressions and facial "tells."* The assumption that brief facial movements reveal hidden emotional states has been seriously challenged. A comprehensive review concluded that facial configurations are neither reliable nor specific indicators of emotion across people and contexts, and that perceivers infer emotion largely from context (Barrett et al., 2019) (Contested for the general claim; no direct evidence supports microexpression reading as a courtship skill).

*Uncertainty and "strategic inconsistency."* In one experiment, college women who were uncertain whether a man liked them were more attracted to him than women told that he liked them a lot, apparently because uncertainty increased how much they thought about him (Whitchurch et al., 2011). This is a single study with a specific population and a profile-viewing paradigm, set against a large literature showing that being liked is generally attractive. It does not license deliberate inconsistency as a tactic, which in established relationships is more plausibly a source of insecurity (Preliminary).

*Timing, silence and social proof.* The Institute is not aware of direct, replicated evidence that particular conversational timing or silences signal or produce romantic interest, and grades such claims Speculative.

### 5.3 How accurately is interest read?

Third-party observers can judge romantic interest from brief clips of speed dates at better than chance, but accuracy is modest and uneven. In one study, observers predicted men's interest more accurately than women's, whose interest was predicted only just above chance; some daters were easy to read and others were not (Place et al., 2009) (Supported). Error management theory proposes, and studies have found, systematic biases in cross-sex inference, notably men's tendency to overperceive women's sexual interest (Haselton & Buss, 2000) (Supported in heterosexual samples). Because nonverbal cues are probabilistic and ambiguous, they cannot substitute for clear, ongoing communication about consent (Muehlenhard et al., 2016).

### 5.4 Universality

The universality claim is best treated as partial. Romantic love itself appears in the ethnographic record of the large majority of cultures examined (Jankowiak & Fischer, 1992), and some features of attraction, such as agreement in facial-attractiveness judgments, hold across cultures (Langlois et al., 2000). Specific courtship cues, however, are shaped by display rules and norms (Akechi et al., 2013; Sorokowska et al., 2017), and most of the experimental literature comes from Western, educated, industrialized, rich and democratic (WEIRD) samples that are unusual on many psychological dimensions (Henrich et al., 2010). A claim that a particular cue is universal requires evidence from diverse societies collected with comparable methods. For most courtship cues that evidence does not yet exist.

### 5.5 Stage models

It is also often said that courtship unfolds through a fixed sequence of stages, from an initial spark through attention, escalation and attachment to stabilization or collapse. Stage descriptions can be useful for organizing observations, but no invariant sequence has been validated across cultures, ages or relationship types. Relationship trajectories vary in shape, speed and fluctuation, and some relationships move quickly from acquaintance to commitment while others develop slowly or never progress (Eastwick et al., 2019). The Institute treats stage models as descriptive hypotheses (Speculative as universal sequences).

**Table 4.** Courtship cues commonly cited in popular accounts, with evidence grades.

| Cue                                     | Evidence grade          | Principal limitation                               |
|-----------------------------------------|-------------------------|----------------------------------------------------|
| Recurring nonverbal courtship behaviors | Supported (existence)   | Small, heterosexual, Western observational samples |
| Mutual gaze                             | Preliminary             | Meaning varies across cultures                     |
| Proximity and body orientation          | Established (variation) | No universal distance norm                         |
| Vocal change toward attractive partners | Preliminary             | Small samples; recorded messages                   |
| Microexpressions                        | Contested               | Facial movements are unreliable emotion indicators |
| Uncertainty or inconsistency            | Preliminary             | Single study; ethical concerns                     |

| Cue                                               | Evidence grade | Principal limitation                     |
|---------------------------------------------------|----------------|------------------------------------------|
| Timing, silence, social proof as interest signals | Speculative    | No direct replicated evidence identified |

## 6. Biological level: neural correlates of love and loss

### 6.1 Romantic love and reward circuitry

Functional neuroimaging studies of people in the early stages of intense romantic love have found activation in dopamine-rich reward regions, including the ventral tegmental area and caudate nucleus, when participants viewed photographs of their beloved (Aron et al., 2005). These findings fit a view of early romantic love as a goal-directed motivational state rather than a specific emotion. The interpretation of dopaminergic activity requires care: dopamine is more closely tied to incentive salience, or "wanting," than to hedonic pleasure, or "liking" (Berridge & Robinson, 1998). Romantic love is therefore better described as engaging motivational systems than as producing a dopamine-driven pleasure.

It is often said that early attraction is driven by elevated norepinephrine, which focuses attention on the desired person. This idea was proposed as part of a broader hypothesis about distinct mating systems (Fisher, 1998), but direct human evidence for a specific noradrenergic signature of romantic attraction is sparse (Speculative).

### 6.2 Oxytocin and vasopressin

The role of oxytocin and vasopressin in pair-bonding is well documented in monogamous prairie voles, where pharmacological manipulations alter partner preference (Burkett & Young, 2012) (Established in voles). Extrapolation to humans is far less secure. Human studies often rely on peripheral measures of uncertain relation to brain levels, or on intranasal administration whose central effects are debated. A critical review of the claim that oxytocin increases trust found that the original findings have not reliably replicated and that the evidence is weaker than commonly believed (Nave et al., 2015) (Contested for human bonding effects). Popular statements that oxytocin "creates bonding signals" in humans substantially overstate the evidence.

### 6.3 Methodological cautions

Two problems limit inferences from this literature. The first is *reverse inference*: concluding that a psychological process is present because a brain region associated with it is active. Because most regions participate in many processes, such inferences are weak unless the region is highly selective (Poldrack, 2006). The second is *low statistical power*: small samples, common in neuroimaging, reduce the chance of detecting true effects and inflate the size of those that are detected (Button et al., 2013). Several widely cited imaging studies of romantic love and rejection have had fewer than 20 participants; one study of rejection in love, for example, scanned 15 people (Aron et al., 2005; Fisher

et al., 2010). More broadly, a large-scale replication project in psychology found that a substantially smaller share of findings replicated than the original publications implied (Open Science Collaboration, 2015).

## 6.4 Verdict

Romantic love engages reward and motivational circuitry (Supported, with small samples). Human evidence that particular neuropeptides cause bonding is weak (Contested). The neurochemistry of romantic love is the subject of IHE-WP-02, which evaluates these claims in detail.

# 7. Psychological level: attachment and interpretation

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## 7.1 The claim

It is often said that childhood attachment patterns are encoded early and then predict adult romantic behavior, intimacy and emotional tolerance, so that "avoidant," "anxious" and "secure" people can be identified and their behavior forecast. The evidence supports a weaker and more interesting claim.

## 7.2 The best evidence for continuity

Attachment orientations do show continuity. A meta-analytic and modeling study found that attachment security is moderately stable from infancy through the first 19 years of life, and that the pattern of stability fits a model in which early representations continue to exert some influence rather than being entirely overwritten (Fraley, 2002) (Supported). Adult attachment orientations are associated with how people seek support, handle conflict and respond to threats to the relationship (Mikulincer & Shaver, 2016) (Established as associations).

## 7.3 The best objection: moderate stability and real change

Moderate stability is not destiny. The same meta-analytic evidence implies that a considerable share of individual differences is not carried forward from infancy (Fraley, 2002). Attachment orientations change across adulthood: in a study combining three longitudinal samples followed from adolescence to older age, attachment anxiety declined on average with age, especially in middle and older adulthood, attachment avoidance declined across the life span, and being in a relationship was associated with lower anxiety and avoidance (Chopik et al., 2019) (Supported, with modest and largely US samples). Measurement also matters. Because attachment differences are dimensional, sorting people into types discards information and overstates differences between people near category boundaries (Fraley et al., 2015).

## 7.4 Interpretation and narrative

It is often said that people respond not to reality but to the meanings they assign to it, and that the story a person tells about a relationship determines its course. A calibrated version of this claim is well supported. How people construe their partners affects relationship outcomes: in a study of dating and married couples, people who viewed their partners more positively than the partners viewed themselves

reported greater satisfaction (Murray et al., 1996) (Supported). The stronger claim, that story "shapes reality" or determines outcomes, is not supported. Appraisals and relationship events influence each other over time, and positive construals have limits when they ignore real problems.

## 7.5 Verdict

Adult attachment orientations are meaningful, moderately stable dimensions that change with age and experience (Supported). They are probabilistic influences on relationship behavior, not fixed traits that determine it. Appraisals and construals shape relationship experience in both directions (Supported).

## 8. Dyadic level: from attraction to bonding

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### 8.1 The claim

It is often said that attraction becomes attachment through a "bonding loop" of repeated reward, exchanged vulnerability, shared meaning, intertwined identity and growing emotional safety, and that this loop has a consistent neurological signature. The psychological components of this description correspond closely to well-studied dyadic processes. The claim of a consistent neurological signature does not.

### 8.2 Dyadic mechanisms of bonding

The intimacy process model holds that intimacy develops when one person discloses personal information or feelings and perceives the partner's response as understanding, validating and caring. Diary evidence supports the model: both self-disclosure and partner disclosure contributed to feelings of intimacy, with perceived partner responsiveness partly mediating these effects (Laurenceau et al., 1998) (Supported). The experience that identity becomes intertwined corresponds to the construct of *including the other in the self*, the degree to which a partner's resources, perspectives and characteristics are experienced as partly one's own (Aron et al., 1991) (Supported). These processes are dyadic in the sense defined in Section 3: they depend on what both partners do and on how each perceives the other.

### 8.3 The limits of the "signature" claim

No study has shown that the transition from attraction to attachment has a consistent neural signature across people. The neuroimaging evidence consists mainly of cross-sectional comparisons of small groups at different relationship stages, with the reverse-inference and power problems noted in Section 6.3. The claim is graded Speculative. A more defensible statement is that bonding is associated with changes in motivational, attentional and stress-regulatory processes, which are partly coregulated between partners (Sbarra & Hazan, 2008).

## 8.4 Verdict

Bonding is supported by identifiable dyadic processes, notably disclosure, perceived responsiveness and self-other inclusion (Supported). The existence of a uniform neurological signature of bonding is Speculative.

# 9. Relationship loss

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## 9.1 The claim

It is often said that heartbreak triggers the same neural pathways as withdrawal from hard drugs, producing obsessive thinking, identity collapse, a "dopamine crash," disrupted sleep and appetite, and impaired decisions, and that it should therefore be understood as an injury. Some elements of this description are supported; the claim of identity with drug withdrawal is not.

## 9.2 The best evidence for an addiction parallel

People recently rejected by a partner they still loved showed activation, when viewing the rejecter's photograph, in regions associated with reward, gains and losses, craving and emotion regulation, including the ventral tegmental area and ventral striatum (Fisher et al., 2010). Reviews have identified behavioral, anatomical and pharmacological parallels between social attachment and addiction, particularly in animal models (Burkett & Young, 2012). Philosophers and ethicists have argued that, on a broad view of addiction, intense love can share features with addictive states, while cautioning against pathologizing ordinary love (Earp et al., 2017). Social rejection more generally has been associated with activity in regions also implicated in physical pain (Eisenberger et al., 2003).

## 9.3 The best objection: overlap is not identity

Overlap in gross anatomical activation does not show that two experiences share a mechanism. When physical pain and rejection by an ex-partner were compared in the same 60 participants using multivariate pattern analysis, classifiers distinguished each condition from its control with high accuracy, but the rejection classifier performed at chance on pain and vice versa; the two states were represented by distinct patterns within shared regions (Woo et al., 2014). The same logic applies to the addiction analogy: activation of reward-related regions during rejection is expected, because the beloved remains a highly salient goal, but it does not show that rejection is pharmacologically or mechanistically equivalent to withdrawal from a drug. The neuroimaging studies are small, the reverse-inference problem is acute (Poldrack, 2006), and the Institute is not aware of any human study of breakup that has directly measured a "dopamine crash."

The analogy also obscures differences that matter. Drug withdrawal follows from the pharmacological removal of an exogenous substance; romantic loss involves the loss of a person, a set of shared plans and part of one's self-concept, all of which carry psychological meaning beyond any neurochemical change.

## 9.4 Course, heterogeneity and recovery

The weight of evidence indicates that most people recover from relationship loss over time without professional intervention. In a daily-diary study of young adults after the end of a dating relationship, sadness and anger declined over the following weeks, with considerable variability between individuals (Sbarra & Emery, 2005) (Supported in student samples). Research on bereavement more broadly shows that resilience is the most common response to loss and that sustained, severe distress affects a minority (Bonanno, 2004) (Established for bereavement; extrapolation to breakups is reasonable but not identical). Loss also has identifiable psychological components. Breakups reduce *self-concept clarity*, the degree to which a person's sense of self is clearly defined and stable, and this reduction is associated with emotional distress after the breakup (Slotter et al., 2010) (Supported). The experience that "identity collapses" therefore has a measurable, more modest counterpart.

Integrative models propose that partners in established relationships coregulate one another's physiology and emotion, so that loss removes a source of regulation and requires a shift toward self-regulation (Sbarra & Hazan, 2008). This model offers a plausible account of why sleep, appetite and stress responses can be disrupted after separation, and why most people adapt as they rebuild other sources of support (Supported as a framework; specific physiological mechanisms Preliminary).

## 9.5 Gender and loss

It is sometimes said that men characteristically experience shame, desperation, fragmentation and numbness after separation. The evidence does not support a gendered profile of this kind. In a study of 193 participants, rejectees of both sexes reported more depression, loss of self-esteem and rumination than those who initiated the breakup, and women reported more negative emotions overall than men (Perilloux & Buss, 2008). The sample was small and heterosexual, and the findings concerned average differences with substantial overlap. Rejection status, attachment orientation and the circumstances of the breakup appear at least as important as gender. The Institute treats sex and gender differences in responses to loss as an open empirical question (Contested), not as a basis for gender-specific narratives.

## 9.6 The scope of education

Because most people recover and some do not, the appropriate response is twofold. Education about the typical course of recovery, the role of self-concept and social support, and the warning signs that warrant professional help is within the Institute's scope. Assessment and treatment of depression, anxiety, suicidal thinking or other clinical conditions is not; people experiencing these should be referred to licensed clinicians. The evidence for structured relationship education is itself mixed. A meta-analysis found modest improvements in communication and relationship quality, with smaller effects in unpublished studies and samples drawn largely from white, middle-class couples (Hawkins et al., 2008). Large publicly funded programs in the United States showed weak or null effects, prompting calls for rigorous evaluation before scaling (Johnson, 2012). Any educational program the Institute develops should be evaluated to the same standard, with null results reported.

## 9.7 Verdict

Romantic rejection engages reward-related systems that overlap with those implicated in craving and addiction (Supported, small samples). The claim that heartbreak is the same as drug withdrawal is not supported; overlap at the level of brain regions is not identity of mechanism (Contested for strong versions of the analogy). Most people recover without intervention, and loss of self-concept clarity is one identifiable component of distress (Supported). IHE-WP-02 examines the neurochemistry of loss in detail.

# 10. Sociocultural level

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## 10.1 Culture, norms and partner markets

Sociocultural factors shape attraction and bonding in at least three ways. They determine *opportunity*: who meets whom, through which institutions, and with what freedom of choice. They shape *meaning*: which behaviors count as interest, respect or intrusion (Akechi et al., 2013; Sorokowska et al., 2017). And they shape *preferences* and their expression. Cross-cultural sex differences in stated preferences for attractiveness, age and resources replicate robustly, yet the same large study found that, beyond partner age, neither gender equality nor pathogen prevalence robustly predicted cross-national variation in those differences (Walter et al., 2020). Evolutionary and social-role explanations of these patterns continue to compete, and IHE-WP-03 evaluates them.

## 10.2 Who has been studied

The sociocultural level also concerns the science itself. Most experimental research on attraction has used WEIRD samples (Henrich et al., 2010) and heterosexual dyads, often university students. Evidence that relationship processes are broadly similar in same-sex and different-sex couples (Kurdek, 2005) is encouraging but limited. Research that includes transgender, nonbinary, older, non-Western and socioeconomically diverse participants is needed before the framework can be described as general.

## 10.3 Verdict

Romantic love is widespread across cultures (Supported), but courtship signals, norms and the size of preference differences vary (Established for variation). Claims of universality should be limited to what has been tested in diverse samples with comparable methods.

# 11. Evidence at a glance

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Table 5 summarizes the central claims of this paper, their evidence grades, representative sources, and the principal limitation of each.

**Table 5.** Evidence at a glance.

| Claim                                                                    | Evidenc<br>e<br>strength | Representative<br>sources                                             | Principal limitation                              |
|--------------------------------------------------------------------------|--------------------------|-----------------------------------------------------------------------|---------------------------------------------------|
| Some features of attractiveness are widely agreed upon                   | Establis<br>hed          | Langlois et al. (2000)                                                | Mostly facial ratings; static stimuli             |
| Perceived similarity predicts attraction                                 | Establis<br>hed          | Montoya et al. (2008)                                                 | Actual similarity effects weaken with interaction |
| Stated ideals predict in-person attraction only weakly                   | Support<br>ed            | Eastwick and Finkel (2008); Eastwick et al. (2014)                    | Speed-dating and student samples                  |
| Relationship-specific attraction is largely unpredictable before meeting | Support<br>ed            | Joel et al. (2017); Eastwick and Hunt (2014)                          | Two US speed-dating samples                       |
| Own relationship perceptions predict satisfaction                        | Support<br>ed            | Joel et al. (2020)                                                    | Self-report; concurrent rather than prospective   |
| Courtship has recurring nonverbal structure                              | Support<br>ed            | Moore (1985); Grammer et al. (1998)                                   | Small, Western, heterosexual samples              |
| Specific courtship cues are universal                                    | Conteste<br>d            | Akechi et al. (2013); Sorokowska et al. (2017); Henrich et al. (2010) | Few comparable cross-cultural studies             |
| Observers read romantic interest modestly above chance                   | Support<br>ed            | Place et al. (2009)                                                   | Accuracy uneven across targets                    |
| Romantic love engages reward circuitry                                   | Support<br>ed            | Aron et al. (2005); Fisher et al. (2010)                              | Small fMRI samples; reverse inference             |
| Oxytocin causes human bonding                                            | Conteste<br>d            | Nave et al. (2015); Burkett and Young (2012)                          | Replication failures; measurement problems        |
| Attachment is moderately stable and changes                              | Support<br>ed            | Fraley (2002); Chopik et al. (2019)                                   | Modest, largely US samples                        |
| Attachment differences are dimensional                                   | Support<br>ed            | Fraley et al. (2015)                                                  | Mostly self-report measures                       |
| Rejection shares neural mechanisms with pain or withdrawal               | Conteste<br>d            | Eisenberger et al. (2003); Woo et al. (2014)                          | Overlap at regional level only                    |
| Most people recover from loss without intervention                       | Support<br>ed            | Sbarra and Emery (2005); Bonanno (2004)                               | Breakup data mostly from students                 |
| Breakups reduce self-concept clarity                                     | Support<br>ed            | Slotter et al. (2010)                                                 | Short follow-up periods                           |
| Relationship education improves outcomes                                 | Conteste<br>d            | Hawkins et al. (2008); Johnson (2012)                                 | Small effects; null results at scale              |

## 12. Limitations and open questions

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### 12.1 Limitations of the underlying literatures

The evidence reviewed in this paper shares several limitations. Neuroimaging studies of love and loss are small and cross-sectional, and their interpretations rely heavily on reverse inference (Poldrack, 2006; Button et al., 2013). Much of the psychological evidence depends on self-report, which is vulnerable to memory, social desirability and the limits of introspection; the gap between stated and revealed preferences is a direct illustration (Eastwick & Finkel, 2008). Many celebrated findings in social psychology have replicated less often than their original publications implied (Open Science Collaboration, 2015), and research on human oxytocin illustrates how publication bias and weak measurement can produce a misleading literature (Nave et al., 2015). Correlational designs dominate, so causal claims about, for example, attachment and relationship outcomes remain uncertain. Laboratory paradigms such as viewing profiles or brief speed dates have limited ecological validity for long-term relationships. Samples are disproportionately WEIRD and heterosexual (Henrich et al., 2010). Finally, average effects describe populations and may describe few individuals well.

### 12.2 Limitations of this paper

This paper is a structured narrative review, not a systematic review or meta-analysis. Its selection of sources reflects the judgment of its authors and is limited to English-language publications. The evidence grades are qualitative judgments made against stated criteria and could reasonably be disputed. The framework's cross-level propositions are hypotheses; the Institute has not tested them. The paper deliberately leaves detailed treatment of neurochemistry, evolutionary explanation, chemosignals and formal modeling to the later papers in the series. The principal open questions that follow from these limitations are stated as testable research questions in Section 14.

## 13. Ethical considerations

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### 13.1 Consent and autonomy

Research on attraction and courtship can be misread as a toolkit for obtaining interest from people who have not offered it. The definition in Section 2.1 excludes coercion, deception and pressure, and the Institute treats a person's freely given, ongoing consent as a precondition of everything it studies and teaches. Because nonverbal cues are ambiguous and systematically misread (Haselton & Buss, 2000; Place et al., 2009), education based on this research should emphasize clear communication and respect for refusal rather than skill at reading or producing signals.

### **13.2 Risks of misuse**

Some commercial and online communities present courtship as a set of manipulative techniques, often embedded in hostile accounts of gender relations (Ging, 2019). Scientific findings about uncertainty, social influence or signaling can be selectively cited to support such practices. The Institute does not develop or endorse persuasion or "pickup" techniques, and it reports findings in ways that make their limits explicit. Research designs that could increase the capacity to manipulate others without their knowledge should be reviewed by an independent ethics committee before they proceed.

### **13.3 Dignity and non-pathologization**

Describing ordinary heartbreak as an injury or an addiction risks pathologizing a common human experience and implying that people who grieve a relationship are disordered (Earp et al., 2017). Conversely, minimizing distress can discourage people from seeking help when they need it. The Institute's position is that most distress after loss is a normal response, that some people develop conditions requiring clinical care, and that education should help people recognize the difference and seek licensed care when appropriate.

### **13.4 Privacy of relationship and biometric data**

Relationship research collects some of the most sensitive data people can share: sexual histories, messages, breakup narratives, and in some designs physiological or neuroimaging data. Such data can identify people and their partners, and a partner who is described in a study has not necessarily consented to it. Studies conducted with IHE's partners must minimize data collection, secure and de-identify data, obtain consent from all identifiable participants where feasible, and operate under institutional review board supervision and the oversight of IHE's Independent Ethics Committee.

### **13.5 Cultural sensitivity and inclusion**

Norms of courtship, marriage and partner choice differ across cultures and communities, and research framed around one culture's norms can misdescribe or stigmatize others. Research and education should avoid presenting Western, heterosexual or gender-binary patterns as natural or default, and should include diverse participants in design as well as in data collection.

### **13.6 Prediction and fairness**

Because individual-level prediction is weak (Section 4), tools that claim to forecast whom a person will desire or whether a relationship will last risk misleading users and may perform unequally across groups. The Institute offers no individual predictions and will not deploy consumer prediction tools. IHE-WP-05 sets out the validation requirements that any such model would need to meet.

## 14. Research agenda and roadmap

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### 14.1 Research questions for a young institute

The following questions are aspirations for future work, to be pursued with university partners under ethical oversight. Each is framed so that its predictions could be pre-registered and could fail.

1. *Cross-cultural replication of the predictability gap.* Using a pre-registered speed-dating design with participants from several non-WEIRD societies and including same-sex interactions, test whether pre-meeting self-report measures predict relationship variance in mutual attraction out of sample. The proposition in Section 3.3 (item 3) would be challenged if pre-specified models explained a meaningful share of relationship variance in held-out data.
2. *Cultural specificity of courtship cues.* Adapting the observer-judgment paradigm (Place et al., 2009), test whether observers judge romantic interest more accurately for targets from their own culture than for targets from other cultures, and whether accuracy differs for same-sex and different-sex interactions.
3. *Attachment change after relationship transitions.* In a prospective longitudinal design, test whether attachment anxiety and avoidance change following relationship formation and dissolution, and whether perceived partner responsiveness mediates such change.
4. *Trajectories of recovery.* Using intensive repeated measures after breakups in diverse community samples, estimate the distribution of recovery trajectories and test whether early change in self-concept clarity predicts later distress, as the evidence in Section 9.4 implies.
5. *Overlap versus identity in the neuroscience of loss.* Using adequately powered samples and multivariate methods of the kind applied to pain and rejection (Woo et al., 2014), test whether neural responses to a rejecting partner can be distinguished from cue-reactivity patterns observed in substance use. The strong addiction-identity hypothesis predicts that they cannot.
6. *Evaluation of preventive education.* In a pre-registered randomized trial, test whether brief education about the typical course of recovery, self-concept and social support reduces distress or rumination after a breakup relative to an active control, with all outcomes reported including null results (Hawkins et al., 2008; Johnson, 2012).

### 14.2 Roadmap of the series

The later papers in the series develop individual levels of the framework.

- *IHE-WP-02, The Neurochemistry of Heartbreak*, evaluates the hypothesis that romantic loss resembles withdrawal and what the evidence implies for preventive education.
- *IHE-WP-03, Evolutionary Imperatives in Human Seduction*, examines mate-preference research, its social-structural alternatives and the limits of adaptationist inference.

- *IHE-WP-04, Human Chemosignals and Olfactory Cues in Attraction*, reviews the evidence on body odor and putative human pheromones, a literature that has struggled to meet the standards applied in other species (Wyatt, 2015).
- *IHE-WP-05, Seductics: Toward a Probabilistic Framework for Romantic Outcomes*, sets out the assumptions, model classes and validation requirements for probabilistic models of relationship processes, in light of the limits on prediction discussed in Section 4 (Joel et al., 2017; Salganik et al., 2020).

## 15. Conclusion

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The study of attraction, bonding and loss is a mature, multidisciplinary field with real findings and real limits. Attraction is patterned but weakly predictable for particular pairs; courtship signals are real but noisy and culturally shaped; attachment orientations are moderately stable and open to change; and romantic loss engages reward-related systems without being equivalent to addiction. Most people recover from loss without professional help.

A science of seduction, in the sense defined here, is therefore not a set of laws or techniques. It is a multilevel account of how biological systems, psychological dispositions, dyadic processes and cultural contexts jointly shape consensual romantic interest, with each claim graded by the strength of its evidence. The framework set out in this paper is intended to organize that account, to make its assumptions explicit, and to identify the questions on which the Institute's future work, conducted with partners and under independent ethical oversight, can make a contribution.

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