



# FRAME WORKS INSTITUTE



## **Plasticity's Promise:**

Moving Public Thinking Beyond  
the Container and Other  
Unproductive Models

**MAPPING THE GAPS ON DEVELOPMENTAL PLASTICITY**

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# I. Introduction

Developmental scientists are centrally concerned with change and define their discipline in relation to this concept. Within the field, there are a group of researchers who focus specifically on the capacity of the brain and other biological systems to change over the life course — what has become known as the science of *Developmental Plasticity*. The term itself is a nod to the importance of metaphor in thinking about and describing what scientists have come to know about the evolved capacity of biological systems to adapt in response to our experiences and environments. As the study of this capacity, and the timing of, and forms in which, change takes place, the science of plasticity holds powerful implications for those working to improve developmental outcomes.

This report constitutes another step in a decade-long collaboration between the FrameWorks Institute and Center on the Developing Child at Harvard University. The collaboration aims to communicate developmental science to improve the public's access to research and public policymakers' abilities to act on it. In the fall of 2011, FrameWorks was tasked by the Center and scientists affiliated with the National Scientific Council on the Developing Child to undertake an in-depth examination of the translational hurdles associated with communicating the science of plasticity. In particular, these scientists wished to understand how the existing Core Story of Early Child Development might be used to communicate fundamental principles from the science of plasticity, and what aspects of this science might elude comprehension and therefore require new translational strategies and frame elements.

We here examine how the science of developmental change and plasticity compares to the ways that members of the public reason about concepts of change over the life course, and brain change more specifically. It should come as no surprise that the public brings a rich set of cultural models — implicit, but shared, understandings, assumptions and patterns of reasoning — to thinking about how people change. Many of these ways of thinking are, at some level, consonant with the science of plasticity, while others are distinctly at odds with the science of change and work as impediments to the communication of scientific perspectives. This report focuses on these two perspectives on development, brains and change, and the gaps and overlaps that become apparent through their comparison.

## II. Summary of Findings

The following consensus points emerged from the analysis of a set of interviews conducted with scientists specializing in developmental plasticity. This constitutes what FrameWorks has called “the untranslated core story,” or the gist of what scientists wish to communicate, unaided by a framing strategy.<sup>1</sup>

### Expert Interviews

#### *What is Plasticity?*

- Plasticity is the brain’s capacity to change in response to environmental stimuli.
- There are two types of plasticity: *structural plasticity*, which is the generation, modification or elimination of neural circuits and systems; and *functional plasticity*, which is the ability of existing structures and circuits to change based on patterns of use.
- Plasticity is an adaptive process, in that it underlies learning, memory, and the ability to respond to changing environmental demands. However, this plasticity is costly in that it requires resources. Optimal functioning, therefore, requires a balance between stability and plasticity — systems need to be able to change, but change must be the exception to a more general tendency for system stability.

#### *How Does Plasticity Work?*

- The concept of plasticity is based on the idea that different systems in the brain, and different connections between these systems, underlie and enable different functions and capacities. In short, different systems in the brain do different things.
- To a certain degree, the brain retains the ability to change and adapt throughout life, but different brain systems are particularly changeable at different times, in response to different stimuli, and for different lengths of time.
- Periods of heightened plasticity are linked. Changes that happen in the brain during earlier periods of heightened plasticity influence how the brain is shaped during subsequent periods of heightened plasticity.
- Early childhood and adolescence are periods of high plasticity, but they involve different brain systems.

### *What are the Implications of this Science?*

- **Context is Key:** Because the brain changes in response to environments and experiences, changing/improving those contexts can alter/improve developmental outcomes.
- **Early Matters...:** The brain's ability to change and the long-term impact of these changes are particularly pronounced in early childhood.
- **... but so Does Later:** Different systems remain plastic to different degrees, which means that there are significant periods of plasticity after early childhood.
- **Plasticity can Inform Strategic Policymaking:** The science of plasticity allows policymakers to focus the right resources at the right times, increasing the efficiency of investments.

## **Cultural Models Interviews**

In thinking about how people and brains change, members of the public draw on a complicated set of cultural models. One broad pattern of reasoning, and two more-specific understandings, are used think about change in general; three additional cultural models are used think about how brains might change; and there are a set of four more-recessive models — less top-of-mind and pervasive across the sample — that also shape thinking. Together, these models constitute what FrameWorks calls “the swamp of cultural models” on this issue.

A meta cultural model with two embedded assumptions emerged as highly dominant in shaping how public informants talked and reasoned about change and development in general. The second two models were embedded or “nested” in the first most general assumption.

### **A Meta Model of Change: The *Distinct Change Model***

Informants drew on an assumption that there are different ways in which people change. They divided these types of change into physical change and “everything else.” Informants drew on different underlying models to reason about these two types of change.

**A) A Model of Physical Development and Change: The *Just Add Water Model*.** In thinking about physical change and development, informants drew on a “*Just Add Water*” cultural model. According to this model, physical change is assumed to mean “growth” and is understood to be a natural and inevitable “process of life.” Physical changes happen with limited inputs and these inputs are understood to be physical — mainly nutrients. Employing this model, informants reasoned that there are “cycles” of growth — particular periods in life when growth is dramatic, or of different types.

Often, this model was expressed metaphorically and a person's physical growth was compared to that of a plant or tree — proceeding naturally from the seed and requiring only (limited) provision of physical nutrients.

**B) A Model of Non-Physical Development and Change: The *Container Model*.** In thinking about non-physical change, informants drew on a shared understanding in which people were compared to containers and change was understood as the process of filling this container. There were a number of specific assumptions that compose the model. According to the model, experiences and content are understood as external materials that are incorporated internally, leading to change. Every person is conceptualized as a container, and all containers are understood to start “empty” and “open.” As the individual has experiences, these experiences accumulate as layers on top of previous experiences. As these layers accumulate, each subsequent layer has relatively less impact on change than the previous layer. There are, however, rare exceptions in which the enormity of an experience lays down an inordinately thick layer and causes significant change. These containers are understood as bottomless, as individuals “can always take on more change until the day they die.” Despite this limitless capacity, the degree to which the container is open is assumed to become — sometime in early adolescence — manipulable and under a person's control. Before this time, the container is understood to be open, and change, therefore, passive and beyond a person's control.

### Implications of the Dominant Models of Change

- When thinking that there are different types of change that work in fundamentally different ways, people are ill-positioned to appreciate information about common, underlying biological processes and mechanisms.
- As with cultural models of development more generally, the dominant models employed here do not provide a way for people to think about **how** change happens.
- At some level, aspects of these models correspond with the science message that different systems change and are plastic at different times. However, the public's model is limited in terms of the content that it maps onto this general assumption — in short, there is little understanding of **what develops when**.
- The *Just Add Water* model limits people's thinking about developmental complexity and the need for intervention. Importantly, this research provides evidence arguing against the productivity of the commonly used metaphor of children as plants as a tool in translating developmental science and the concept of plasticity.
- The *Container* model focuses attention on *context* and *control* as the exclusive determinants of change, and obscures the role of *biology* both as a mediating variable and the medium of change. Given the fact that people tend to assign responsibility for controlling the container at around the age of adolescence, this model is likely to

cause problems in getting people to see how experiences and environments, rather than individual choices, shape adolescent development.

### Three Cultural Models of Brains and Change

When people are asked to think about developmental change within the context of the brain, they draw upon three models:

1. **The Brains Grow Bigger Model.** According to this model, people assume that, when a child is born, their brain is small and “wiggles” “loosely” around in their head. Brain development, according to this model, is primarily about the brain growing in overall size. Drawing on the *Just Add Water Model*, this growth is assumed to happen naturally and without significant input.
2. **The Brains Solidify Model.** At other times, informants employed an understanding in which brains were assumed to begin as “mushy” and “soft” and then, at around 5 to 8 years of age, to become “set,” “hard” and “fully-formed.”
3. **The Brains are Always Open Model.** Finally, and many times in close proximity to one of the other two brain change models, informants reasoned that the brain is “always changing” and remains “open” until “the day you die.”

### Implication of Brains and Change Models

When applying either the *Brains Grow Bigger* or the *Brains Solidify* cultural models, people are predisposed to think of brain change as something that ceases at some point in childhood. From this perspective, communicating about the *continued* capacity for neural change becomes difficult. On the other hand, both of these models facilitate a perspective in which child development is an important period of change, and therefore an opportunity to influence later outcomes — an understanding that is in line with at least part of the expert story. The *Always Open* model has similarly mixed implications. On the one hand, the notion of continued opportunity for change is consonant with the continued-capacity-for-change dimension of the expert story, and seems, therefore, to constitute a productive translational tool. On the other hand, the expert message about the variability of plasticity over time and the generally diminishing capacity for change is obfuscated by the model, making the idea of particular sensitive periods difficult to communicate. The challenge for communicators is to figure out a larger structure which can “hold” productive aspects of these cultural models and temper their unproductive elements. Put another way, science translators need to find a different way of helping people think about brains, change and time — one that will allow people to incorporate the early importance of the *Solidify* and *Grow Bigger* models along with the continued capacity for change of the *Always Open* model.

## Recessive Cultural Models of Change and Development

In addition to the models described above, informants drew on several other shared and patterned assumptions in thinking about development and change. Although these models were not as frequently employed nor used with the same degree of automaticity as those dominant structures described above, they are nonetheless important features of the cognitive landscape on this issue, and important considerations for science communicators.

1. **The *Construction Model*.** Considerably more recessive than the *Container* model, but still in play, informants used a *Construction* model to conceptualize change as a process whereby environmental factors — represented as “materials” — are used to “build” or “build up” and modify a person.
2. **The *Periods of Transition Model*.** A second promising, but recessive, cultural model was the implicit understanding that periods of transition are times during which people are especially “likely” to change. The most frequent “life transitions” mentioned included: going from middle school to high school, going to college, graduating college and getting a job, going from being single to being married, and going from not having kids to having kids.
3. **The *Changing Times Model*.** When answering open-ended questions about how people change, and more specific questions about how young children and adolescents change, informants occasionally drew on a particular view of change as the differences between the experiences of *generations* — more specifically, differences between the informant’s generation and that of the current generation of American youth. In discussions structured by this model, change was viewed from a nostalgic perspective and informants focused on the dangers associated with “kids today,” which included high rates of violence, a dangerous dependence on technology, and a general breakdown in the moral fabric of society.<sup>2</sup>
4. **The *Hyper-Individualism Model*.** Thinking through the *Hyper-Individualism* model, informants questioned whether there was “really anything that you can say about how *people* change” — reasoning that each individual (“like a snowflake”) is “so different from everybody else” that generalizations about determinants, processes and results of change are inappropriate.

## Implications of Recessive Cultural Models

- The *Construction* model is considerably more process-rich — that is, it is potentially more helpful in giving people a way to think about *how* change happens — than the *Container* model, and therefore more productive from a science translation perspective.
- The existence of a recessive model in which people implicitly associate periods of transition with periods of pronounced change is in line with a similar science focus.



Although this model is missing any notion of biological process, it may serve as an opening into which science communicators can fit expansionary explanations of *how* transition might create change, and of the specific changes associated with particular periods of transition.

- The associations that became active when informants were thinking through the *Changing Times* model were largely unproductive, and structured a perspective in which change = bad and where children today were seen as destined to be “messed up.”
- Notions of *Hyper-Individualism* function as barriers to communicating science messages about *common* processes.

## Overlaps in Understanding

Research identified the following overlaps between the ways that the general public and developmental scientists understand issues related to change. These overlaps suggest ripe areas to explore in future prescriptive communications research, but communicators should keep in mind that many of these high-level overlaps reveal, upon closer inspection, deeper conceptual gaps. That is, without careful attention to the other models available and strategies for maneuvering through this swamp of understanding, these overlaps can backfire and quickly morph into gaps.

- **Continued Capacity for Change:** Both experts and members of the general public acknowledged the continued ability of people to change over time — although some of the public’s available models facilitate this realization more than others. This suggests the need for communicators to pay close attention to the specific models cued by their messages.
- **Change Changes:** Thinking through the *Container* model, with its propositions of diminishing marginal change, but with the ability for particularly important events to have inordinate impact, members of the public also seem to be in line with experts. The lack of integration between layers in the public’s model constitutes a gap discussed below.
- **Early Childhood and Adolescence are Key Periods of Change:** Expert messages and public models also converge on the importance of early childhood and adolescence as periods of significant change. However, despite this similarity, scientists and members of the public differ dramatically in *how* they understand change during these periods, and therefore arrive at different understandings of the actions that should be taken to improve outcomes.

## Gaps in Understanding

In addition to high-level overlaps, a set of conspicuous gaps emerged between expert and public understandings. These gaps are likely to impede the public's ability to access science explanations of developmental plasticity.

- **Starting Point: *Comes with Constitution vs. Blank Slate.*** While experts discussed the importance of genetic constitution and neurobiological systems in explaining that change is not a from-scratch process, members of the public displayed the opposite assumption — reasoning from a dominant model in which children are understood to be empty vessels.<sup>3</sup>
- **Process: *Articulated vs. Assumed.*** While expert understanding is equipped with clear causal processes, members of the public have thin understandings of why people change — reasoning about this question through limited and vague notions of “filling” and “control.”
- **Types of Change: *Structural and Functional vs. Physical and Everything Else.*** Both experts and members of the public recognize that there are different types of change. However, while experts talk about structural modifications in systems and functional adaptations to existing structures, members of the public draw their distinction between “physical changes” and “everything else.”
- **Capacity for Change Over Time: *Punctuated Plasticity vs. Diminishing Capacity.*** Experts have a particularly nuanced understanding of the relationship between change and time — explaining that, while there is a generally diminishing capacity for change over time, there are punctuated periods of particular plasticity that complicate a neatly negative linear relationship between change and time. Members of the public have a less nuanced understanding of the way that the capacity for change changes — reasoning that change is always possible, but becomes less likely over time.
- **The Role of Biology: *The Central Change Agent vs. an Absent Actor.*** Biology and the brain featured, not surprisingly, prominently in expert messages. For members of the public, biology was almost entirely absent from discussions, and the brain was an infrequent feature in conversations.
- **What Causes Changes: *Biology and Context vs. Context and Control.*** Experts placed biology, and the contexts that interact to shape biological structures and functions, in the role of protagonist. Members of the public place an individual's control over the degree to which they are “open or closed to change” in the leading role, giving context an important, but supporting, position as the things over which individuals must exert this control.

- **How Brains Change: *Different Systems at Different Times vs. Quickly Closing or Always Open*.** Experts define plasticity as the brain’s continued, but variable, capacity to change — a message that requires holding simultaneously in mind ideas of ongoing openness *and* variability in this capacity over time. On the one hand, members of the public think of brains as initially small or soupy but quickly grown or set, and on the other as having infinite and unbridled capacity for change. The gaps lie between the experts’ nuanced explanation of continued, but variable, capacity for change, and the more categorical nature of the public’s understanding as quickly closing *or* always open.

## Initial Recommendations

There are a number of frame elements and strategies that emerge from the existing Core Story of Early Child Development that have been developed to solve conceptual challenges similar to those observed on the issue of plasticity. With some modification, these framing strategies can be deployed to improve people’s ability to grasp concepts that are fundamental to the science of plasticity. However, there are also challenges associated with communicating about plasticity that are not assailed by existing tools in the Core Story arsenal — these challenges point to the need for new framing strategies and tools. We enumerate both aspects of the communications challenge below.

1. Use *Brain Architecture* to draw on the power of the recessive *Construction* model to make the point that early matters (i.e., building the foundation) but so does later (adding and modifying spaces and developing secondary systems, such as electrical and plumbing).
2. Deepen people’s association between periods of transition and periods of change by explaining what it is about transitional periods that makes them particularly important as periods of change. A metaphor that explains how the brain changes and how different systems become changeable at different times would be helpful in this regard.
3. Find a way of knitting together productive aspects of the three models that people use to think about how brains might change, while inoculating against problematic entailments that they carry.
4. Use *The Outcomes Scale* to strengthen people’s understanding of dynamism and continued capacity for change.<sup>4</sup>
5. Use existing parts of the core story (*Brain Architecture*, *Levelness* and *The Outcomes Scale*) to put context, biology and constitutional factors in leading roles, and inoculate against narrow senses of control and individual responsibility for change.
6. The research strongly underscores the need for an Explanatory Metaphor that can perform one or more of the following tasks:

- i. Communicate the idea that different skills/capabilities/brain systems develop and change at different times.
- ii. Clarify the concepts of structural and functional plasticity as a way of encouraging an appreciation for multiple concepts of change over time.
- iii. Allow people to hold in mind and work productively with the nuances of sustained, but diminishing, capacity for change punctuated by periods of plasticity.

In sum, science communicators face a decidedly tough challenge in overcoming existing public patterns of thinking about plasticity. While frame elements can be recruited from the Core Story of Early Child Development to address some of the challenges identified here, there are significant gaps and traps in the “swamp” of public thinking that require new science translation tools. Currently, scientists are left with an outline of a story, but not the fully developed toolkit that promises to overcome these hurdles. Ironically, some of the same tools that have proven potent in educating the public about the brain and early biological development have the potential to occlude an understanding of plasticity; that is, if the brain’s architecture is perceived as fully foundational, then later periods of change, such as adolescence, will seem like “add-ons” rather than central to the story of development.

### III. Methods

To explore and distill expert messages on plasticity, FrameWorks researchers conducted 10 one-on-one, one-hour phone interviews with developmental scientists. These interviews were conducted in mid to late 2012 and, with participants' permission, were recorded and subsequently transcribed for analysis. To locate experts, FrameWorks surveyed a prominent group of developmental scientists, who provided separate lists of leading researchers working on plasticity. These lists were compiled and cross-referenced to form an initial list of interviewees. As members of this initial list were interviewed, snowball sampling procedures were employed to identify other leading experts in this area. Observations gathered from participant observation at several scientific meetings where plasticity research was discussed were also included as data in the analysis.

In order to document and describe patterns of public thinking about developmental change and plasticity, FrameWorks anthropologists conducted a set of 20 one-on-one, two-hour Cultural Models Interviews<sup>5</sup> with members of the general public. Interviews were conducted in October, November and December 2012, and drew from rural, suburban and urban residential locations in four geographical locations: (1) San Diego, Calif., (2) Philadelphia, Pa., (3) Chicago, Ill., and (4) San Jose, Calif. FrameWorks' researchers also analyzed Cultural Models Interviews that were conducted for previous phases of its ongoing work to explore public understanding of developmental science, drawing from over 80 additional interviews conducted in over 15 locations throughout the U.S.

“Cultural models” are those broadly shared patterns of implicit understandings and assumptions that organize people's thinking across a cultural population.<sup>6</sup> Consistent with methods employed in psychological anthropology,<sup>7</sup> Cultural Models Interviews use a set of open-ended questions to elicit ways of thinking and talking about target issues — in this case, of change and developmental periods.

Informants were recruited by a professional marketing firm to represent variation in ethnicity, gender, age, residential location (rural, suburban, urban), educational background and self-reported political identification. Individuals working in fields involving developmental science were excluded from the sample to avoid expertise bias. With informants' verbal and written consent, interviews were audio recorded and transcribed for analysis.

This report focuses on seven gaps between expert messages on plasticity and public understandings of this issue. These gaps represent the targets for prescriptive research, with the goal of developing and testing messaging tools that make expert perspectives on plasticity more accessible to members of the public. In discussing these gaps, several key overlaps — areas where expert and public perspectives are productively aligned — are also identified. Past FrameWorks research has found that overlaps in understanding are

sites that communicators can leverage, deepen and build upon in reframing issues and developing communications strategies.

We first present the expert messages that comprise an Untranslated Expert Account of Developmental Plasticity. This is followed by an analysis of the cultural models that average Americans bring to understanding issues of change and development across the lifespan, and of brain change more specifically. We then compare these expert and public understandings in order to identify key overlaps and gaps. We conclude with a set of recommendations and areas of future research.

## IV. A Science Perspective on Developmental Change and Plasticity

Below, we present a distillation of the themes that emerged from the analysis of expert interviews and field notes taken at scientific meetings. These themes are organized along the following questions: *What is plasticity? How does plasticity work?* and *What are the implications of this science?*

### What is Plasticity?

**Plasticity is the brain's capacity to change.** Experts described brain plasticity as the brain's ability to change in response to experiences. They explained that this ability to adapt is not inherently good or bad — that this capacity can result in negative outcomes in the presence of negative environments and experiences, or positive outcomes in the presence of positive exposures.

Experts explained that plasticity occurs at the level of the brain's neural circuitry, and that the brain's capacity to change represents an evolved mechanism — that this capacity has been selected for over time as it conferred advantages to organism fitness by allowing adaptation to changing environmental demands.

Experts distinguished between two types of plasticity. They described *structural* plasticity as the process of building (or eliminating) connections within the brain, and *functional* plasticity as the process of changing how those connections are used.

**Optimal functioning requires a balance between *plasticity* and *stability*.** While experts emphasized that plasticity is a critical mechanism for learning and adaptation, they also noted that optimal functioning requires a certain level of stability over time. They described how the brain is built in a hierarchical manner, and that each successive structure depends on stability and reliability in the neural connections that were built earlier. For example, brain circuits involved in advanced cognitive functions — such as evaluating social interactions — require reliable input from the brain regions involved in recognizing the features of human faces. They also talked about how plasticity is a “costly” process — that it requires resources to change and that, therefore, periods of high plasticity are not sustainable over the life course. In short, experts explained the need for general systems stability punctuated by periods of particular plasticity.

### How Does Plasticity Work?

**Different parts of the brain have different trajectories of plasticity.** Experts explained that almost all regions of the brain go through “sensitive periods” when they are *particularly* plastic, but emphasized that different parts of the brain go through

sensitive periods at different times. Experts explained that brain regions involved in lower-level functions go through periods of high plasticity much earlier than those involved in higher-level functions. Regions of the brain associated with these lower-level functions require particular types of experiences very early on in development in order to be wired correctly. In contrast, parts of the brain concerned with higher-level functions, such as learning and memory, tend to go through sensitive periods later in development and to retain a greater degree of plasticity throughout life.

**Early childhood and adolescence are periods of heightened plasticity.** Experts emphasized that the brain is much more malleable than scientists previously thought, and that some degree of plasticity is maintained throughout life. As one expert put it, “development itself is a lifespan process and therefore plasticity is also a lifespan process.” However, experts also noted that early childhood and adolescence are periods in which the brain is *particularly* apt to be shaped by experience. Early experiences wire the brain in ways that “set the stage” for what happens later in development, while experiences during adolescence serve to “fine-tune” the brain’s neural circuitry in important ways. Experts further described adolescence as a period of reorganization in the brain, in which connections are being built across regions that allow different parts of the brain to “collaborate” in processing information.

**Periods of change are connected and interdependent.** Experts explained that periods of heightened change are not discrete or independent; rather, the ways in which experiences shape brain development during early periods have implications for how the brain responds to experiences later in development. Put another way, early experiences affect how the brain is shaped by later experiences. Experts described, for example, how experiences of adversity during early sensitive periods configure the brain to be more vulnerable to the effects of negative environments and experiences later in development.

Experts emphasized, in particular, the connections between heightened periods of plasticity during early childhood and adolescence. They explained that early experiences initiate developmental trajectories that can be either shifted or further solidified as a result of how experiences shape brain development during adolescence.

## What are the Implications of the Science?

1. *Context is key.* All experts emphasized, either explicitly or implicitly, that a key implication of the science of plasticity is the importance of environments and experiences in shaping development. They stressed that plasticity can lead to either positive or negative outcomes — depending on the nature of the experiences that are shaping the brain. The concepts of plasticity and sensitive periods, therefore, underscore the importance of providing children and adolescents with positive, supportive and healthy environments that provide opportunities in which to learn and grow. When these environments and experiences are absent, healthy development is compromised.



2. *Early matters...* Experts repeatedly emphasized the importance of early experiences, noting that it's always easier to "get it right the first time." Echoing the idea that sensitive periods are linked across development, they described how providing the brain with the right types of experiences early on in development makes positive outcomes later in development substantially more likely.
3. *...but so does later.* Even as they explained the importance of early experiences, experts described the brain's continued capacity for adaptation and change. Put another way, experts used the principle of plasticity to explain why experiences beyond early childhood matter enormously, too. The transition into school, for example, can provide a new set of experiences and environments that can either further harden a negative developmental trajectory or shift a child towards more positive developmental outcomes. Experts also noted that adolescence provides particularly potent opportunities to intervene and change negative or unhealthy developmental trajectories.

Experts also drew upon their understanding of plasticity as a life-long process to explain why positive experiences during early childhood are critical, but not entirely sufficient, for helping children become healthy and fully functional adults. In other words, the brain's capacity to change in response to external stimuli means that the types of experiences and environments to which it is exposed are *always* important.

4. *Providing the right kinds of experiences at the right times is critical.* A core theme in the expert story was the understanding that the brain needs certain kinds of experiences at certain points in development. There are periods in development during which the brain is particularly susceptible to the effects of certain types of experiences. Experts were consistent in emphasizing that policies and programs designed to support healthy development are most effective when they are aligned with an understanding of when particular brain systems are most plastic, and to what types of experiences and environments these systems are susceptible.

## Un-Translated Story of Developmental Plasticity

### What is plasticity?

- Plasticity is the brain's capacity to change.
- Plasticity is neural adaptations in response to changing environmental demands.
- There are two types of plasticity.
  - Structural = changing the "set up" of circuits and systems
  - Functional = changing the way that existing structures work/are used
- Plasticity underlies learning, memory and ability to respond to changing demands. However, plasticity is costly. Optimal functioning requires a balance between *stability* and *plasticity*.

### How does plasticity work?

- Different systems in the brain do different things.
- To a certain degree the brain retains the ability to adapt throughout life, but different brain systems are particularly changeable at different times.
- Periods of heightened plasticity are linked — changes during earlier periods of heightened plasticity influence subsequent periods of heightened plasticity.
- Early childhood and adolescence are periods of high plasticity, but involve different brain systems.

### What are the implications of this science?

- *Context is Key:* Because the brain changes in response to environments and experiences, improving contexts can improve developmental outcomes.
- *Early Matters...:* The brain's ability to change is greatest in early childhood — focusing resources early is important.
- *...but so Does Later:* Systems remain changeable and there are significant periods of plasticity after early childhood — early childhood is not the only place for policy and it may be harder, but it's never too late.
- *Plasticity Can Create More Strategic Policymaking:* Focusing the right resources at the right times increases investment efficiency.

## V. Cultural Models of Change and Development

To interpret the results presented below, it is important to review the approach taken in the interviews with members of the general public. Public informants were first asked a number of open-ended questions about how people change — questions such as: “What are some ways in which people change?” “What causes people to change?” “How do these changes happen?” “What happens as a result of these changes?” “When do changes occur?” and “Do people change in different ways at different times in their lives?” These questions were followed by more specific questions about two developmental periods: “early childhood” and “adolescence.” Finally, informants were asked questions about the brain and its ability to change; about what might cause the brain to change; about how the brain changes; about what the effect of these changes might be; and about specific periods when the brain might change.

We first discuss three broad and foundational cultural models that emerged from the analysis of data resulting from these interviews. These were general models of “change” that informants drew on in answering questions throughout the interview — whether about change in general, change in reference to specific developmental periods, or about change and the brain. We then present three additional models that informants employed when asked to reason specifically about brains and change. Finally, we discuss four recessive cultural models, or those that were not as top-of-mind or pervasive but still patterned through the data. We use quotes from informants where they are particularly effective in illustrating an implicit assumption or aspect of a complex cultural model. Overlaps and gaps between these cultural models and the untranslated expert story of developmental plasticity are then discussed, followed by a set of conclusions and communication recommendations.

### **Dominant Cultural Models of Change**

One meta organizational model emerged across our interviews. Within this meta-model were two more-specific understandings that informants used to reason about different types of change. This meta-model and its constituent assumptions was highly dominant during interviews, shaping general views of how, why, when and in what ways people change.

#### **A Meta Cultural Model of Change: The *Distinct Change Model***

At the deepest level, informants drew on the general assumption that there are different types, or ways, in which people change. Informants divided these types of change into physical change and “everything else.” Physical change was understood primarily as physical growth — height, size and sexual development. “Everything else” included what can be roughly characterized as social, cognitive and emotional development. As discussed

below, informants drew on *different underlying models to reason about these two types of change*.

### **Implications of the *Distinct Change Model***

When thinking categorically about change, people are not well positioned to appreciate messages about common, underlying biological processes and mechanisms. The existence, therefore, of this deep categorization of change into “types” makes messages about *common* principles of plasticity difficult to grasp. Science communicators will have to develop ways to message about common processes that unite what the public views as fundamentally different aspects of change and development — for example, a way of understanding physical and emotional development that relies, at some level, on a common process. Focusing on underlying neural systems, and connecting changes at this level to the array of outcomes on which people focus, seems a promising strategy. If processes of neural plasticity can be clearly communicated and connected to outcomes, some of this unproductive compartmentalization may be circumvented.

#### **A) A Cultural Model of Physical Change: The *Just Add Water Model***

In thinking about physical change, informants drew on an understanding referred to here as the “*Just Add Water*” cultural model because of its frequent use of comparisons between the physical changes of a person and the growth of a plant or tree. According to the model, physical changes are *natural* and *inevitable* parts of life, which require only limited *physical* inputs. Working with this model, informants explained that there are cycles of growth (again, drawing from the deep plant metaphor) — that different things happen at different times. They explained that, in early childhood, the brain and body are growing in size. In adolescence, there is another cycle of growth in which sexual development initiates. And finally, in a much later cycle, physical components begin a natural and inevitable movement towards breakdown and “decay.”

The *Just Add Water* model had a number of constituent propositions:

- *Physical change = growth*. Informants assumed that physical change is primarily about *growth*.
- *Growth is largely automatic*. Informants understood physical change to be largely automatic and requiring only limited outside inputs. Put another way, given that certain basic criteria (the provision of physical nutrients) are met, growth is inevitable.
- *Growth requires only physical inputs*. For growth to proceed in its natural way, individuals require minimal amounts of physical inputs — “nutrients” as informants said.
- *There are cycles of growth*. Finally, informants reasoned that individuals go through cycles of growth. During these cycles they either: A) grow more or faster or B) grow

in different ways. Informants applied the model to reason that early childhood is a period of rapid physical growth — both in body and brain size (see section below on understanding of brain growth), while adolescence is a cycle of rapid sexual growth.

### **How the *Just Add Water* model was used:**

Use of the model was evident in the way that informants talked about growth as proceeding “naturally,” without much thought to process, or input for that matter. Informants saw physical growth as *important*, but understood this type of change largely as a given — an aspect of change that did not require much thought or special consideration. As one informant said, “Of course people grow ... as long as they have the basics.”

Below are several quotes in which the *Just Add Water* assumption is visible:

*I would say that there is no such thing as a “good” early childhood, but there could be a “bad” early childhood. It’s good if it’s not bad at that point — they just need to be fed and taken care of to grow.*

—  
*Interviewer: Tell me about that physical development that you’re talking about?*

*I always think of the food they’re getting. That would make more of a difference than anything else.*

—  
*It’s [physical change] happening at that point. There’s really nothing you can do to stop it ... except maybe **if** you don’t have the right vitamins that the body needs.*

### **Implications of the *Just Add Water* Model**

1. *Limits complexity and obscures key science messages.* Thinking that physical growth proceeds naturally and requires only basic physical inputs obscures the notion that outcomes, even physical ones, are dependent on, and mediated by, multiple factors and can be affected through intervention. This feature of public understanding is symptomatic of a previously identified need to more clearly communicate about the role of gene-environment interaction as a basic process of development. The results of recent communications research on developmental outcomes is therefore promising in overcoming this challenge.<sup>8</sup>
2. *Missing process.* As with reasoning about development more generally, the *Just Add Water* model is light on process — it does not provide a way for people to think about *how* physical development happens. The underlying construction metaphor employed in *Brain Architecture*<sup>9</sup> should be useful here in providing a more robust sense of developmental process. However, communicators should avoid falling into the trap of *only* explaining physical growth and physical

outcomes, as this activates the *Distinct Change* model described above and its negative communications implications.

3. *Growth Cycles is potentially promising.* At some level, the assumption that changes happen at different times corresponds with the scientific notion that different systems become plastic at different times. However, the public's model is limited in terms of the content that it maps onto this general assumption — in short, there is little understanding of *what develops when*. If communicators are to leverage this “cycles of growth” understanding, they will need to build on the idea that different changes occur at different times by providing a way for people to understand *why* this is, which systems are involved, which inputs are integral and what outcomes result. The incipient metaphor of “cycles” is curiously shallow here in performing this function.

## **B) A Cultural Model of Non-Physical Change: The *Container* Model**

In thinking about non-physical change, informants drew on another deep and highly metaphorical cultural model.<sup>10</sup> Informants shared an understanding in which people were compared to containers and change was understood as the process of *filling the container*. According to the model, the experiences and content that a person encounters are “taken in” and “build up” as “layers.” The accumulation of these layers, according to the model, explains how people change.

There are a number of more specific assumptions that compose the model.

- *Experiences and content are external materials that are incorporated internally and cause change.* The core of this model is the understanding that experiences in the worlds in which people live move from an exterior position to an interior position inside the individual. This process of internal accumulation of external experiences is understood as how people change.
- *Every container starts empty.* Informant discussion of change evidenced a proposition that the filling process starts from scratch when an individual is born — that every individual begins as an empty vessel or blank slate, or, as one informant explained, an “empty slate.”
- *Experiences and content accumulate stratigraphically.* Another part of the *Container* model is the idea that layers get laid *on top of* other layers derived from past experiences. These layers maintain their discreteness, and informants explained that, as experiences or content come “on board,” they are layered “on top of” previous experiences rather than mixing with them.
- *Each subsequent layer has less impact on change than the previous layer (with certain specific exceptions — see below).* As a part of the *Container* model, informants explained that early experiences “really matter a lot” because there is “really nothing there.” In short, the percentage of change derived from early experiences is

greater than that derived from later experiences because the later the layer, the smaller the percentage of increase it represents. Put another way, early experiences were understood to cause “dramatic” change because they account for a larger percentage of the contents of the container.

- *Sometimes a layer can be particularly thick and cause significant change.* There was an occasional exception to the notion of diminishing marginal change. Informants reasoned that there are some experience of such importance (the birth of a child, for example) that the layer they add to the container can have a greater impact than previous layers.
- *The container is limitless.* There was also a shared understanding that the container is limitless — that there is *always* the potential to add new layers (although the effects of these additions become less dramatic as time goes on).
- *Early in life the container is wide open and has no top.* In early childhood, the container was understood to be wide open. Young children were understood as not having the capacity to control what went into their containers. This led to a heightened focus on children’s experiences, because these experiences were understood to be taken on board in a direct, passive and unmediated way.
- *The container’s openness comes under a person’s control.* Informants shared the understanding that, at some point in early adolescence, an individual gains the ability to control the aperture of the container’s opening and can adjust the degree to which they are “open or closed to change.” At this point, the individual has control over, and responsibility for, the ways in which they change.<sup>11</sup> In the case of negative experiences, the individual is responsible for reducing his or her openness in order to avoid negative change. In the presence of positive experiences, the individual is responsible for “opening” up and “allowing” experiences to create positive change.

#### **How the *Container* model was used:**

The *Container* model undergirded many of the most prevalent opinions expressed in the interviews. Below, we provide a set of quotes that illustrate aspects of the *Container* model, and then highlight five frequently expressed opinions that were structured by the model.

*The moments that I feel really change people are the most trying times in the life. I think the majority of times that’s the really important stuff and it’s probably the negative things that change people more.*

*The teens are when the blueprint of who you are has been finished. Now what do you do with the things around you? What do you decide to let in or keep out?*

*A baby is a vessel that gets filled up as it goes ... It's like a blank canvas ... it has autonomic functions and that's pretty much it. So at that point it's a super impressionable, blank canvas, sponge thing.*

*A lot of change happens in the teens, but it's different. We're getting pummeled by all this stuff that is coming in to us ... we're becoming an adult, we're responsible for our own choices and understanding what those choices mean and what the ramifications of those choices are.*

*Obviously things change as you start to amass and accumulate different things and stuff. I think having a kid is a like a catalyst that speeds up the change ... like a turbo boost to maturity.*

*It's like an inverted tower of Hanoi, right? The sphere of things you have to worry about is this big at the bottom [indicates something small with hands] and they just keep getting added onto and layered onto, and by the time you're done your sphere of things that you're adding onto has gotten really big and you're really not adding much.*

*It becomes their [an adolescent's] choice to fill it, so some people get influenced by other teens to fill it in bad ways, and some choose to fill it in good ways.*

*When you are younger, you're an open slate. When you start getting older, you get to decide how much of the openness are you going to have. It goes back to where your core is.*

*I think that in the younger years you are much more open to shaping and molding. I'm absolutely certain that when you come out of the womb it's not determined whether or not you are going to become a hardened criminal. I think your family life as a child ... the type of neighborhood you grow up in, the external influences you experience .... Those are all things that you just take on because they are around you.*

*The early 20s is a period of major change:* Elements of the *Container* model can be seen in what was one of the most prevalent views in the interviews — the tendency for informants to focus on the early 20s as “the most important period of change in a person’s life.” Analysis of these responses showed that these opinions were undergirded by the *Container* model. Informants explained that the 20s are when the major events (the thickest layers) in a person’s life accumulate — graduating school, going out on one’s own, getting a job, getting married, and having children. Drawing on the model and its focus on experiences, informants explained that a person’s 20s were a particularly important period of change *because of the importance of the layers of experience that were being added.*



*Early childhood is a period of dramatic change.* The idea that early childhood is a period of *dramatic* and *rapid* change was frequently expressed in the interviews. It was an opinion that was again structured by the *Container* model. Drawing on the model and its specific propositions related to early childhood (that the container starts empty and that young children have no control over its aperture), informants reasoned that, because young children are relatively “empty,” each experience that they have constitutes a dramatic change. Furthermore, because young children do not yet have control over how open or closed they are to change, experiences are seen as passively incorporated and directly causing change. In short, children are empty and open vessels that change significantly with each new experience. The earlier the experience, the more effect it has to change the child and the less control the child has over its effects.

*The teenage years are when people start being responsible for how they change.* Working again with the *Container* model, informants identified adolescence as an important period of change. They reasoned that the experiences to which a person is exposed change dramatically during this period, as children enter new and more complicated social situations and encounter new levels of danger and risk (driving, drugs, sex and violence). This change in experience affects the layers that are being added — layers which informants reasoned have a higher potential to significantly change a person (normally for the worse). This focus on adolescent change is amplified by the understanding that it is during this time that a person develops the ability to control the degree to which they are open or closed to change — becoming responsible for holding themselves open to positive change and guarding themselves against what informants saw as a litany of negative experiences.

*Change is different at different points in people’s lives:* The *Container* model structured another highly patterned opinion — that change is different in different periods of life. Informants explained this opinion using the following two parts of the *Container* model. First, the exposures which are taken in and laid down as layers differ across the life course. That is, the things to which young children are exposed and take in are different than those of a 28-year-old. In short, the content of the layers differs, based on changing experiences over the life course. Second, the development of control over the container and its aperture accounts for how people change. Young children have no control, so change is a simple and one-way process of being passively filled. Adolescents have some control over change and can regulate, to some degree, which experiences get taken on and laid down as layers and which do not. Adults are understood to have full and complete control over the filling process — “choosing” whether an experience is taken on board or whether it is rejected and not allowed to precipitate change.

*You can always change ... but it gets hard the older you get:* Finally, informants expressed a common opinion that “people can always change” — with the caveat that

this propensity decreases with age and time. Employing the *Container* model, informants explained that, “If you are willing to be open to change, you can always change.” They reasoned that, if a person is open to change, new layers can always be added. However, they reasoned that the impact of each subsequent layer is less and less as its percentage of the whole grows smaller and smaller.

## Implications of the *Container* Model

- 1. A thin understanding of process.** As with the *Just Add Water* model, the *Container* model is “process-light.” While informants easily and comfortably fell back on the model to arrive at cursory explanations of change, the model was unhelpful for reasoning about *how* the introduction of some experience was connected to a specific change in the person. In short, “filling” was as close to understanding process as this model was able to take people. This is yet another symptom of what FrameWorks has called the *Black Box* of development — a hole in public understanding of how development happens that continues to be deeply problematic in efforts to translate the science of child development.<sup>12</sup> FrameWorks research has shown that the *Black Box* can be filled with metaphors developed to concretize scientific explanations. Plasticity is another concept that requires process explanation in order for public and science thinking to be aligned.
- 2. The *Container* model focuses attention on context and control as the determinants of change.** Perhaps the most significant implication of the *Container* model is the way that it directs attention at two determinants of change — context and control — and obscures the importance of other factors. Thinking about people as containers, and change as the process of filling these containers, trains people’s focus on the experiences that are doing the filling. As the role of context in development is a prominent feature of the expert account of plasticity, and development more generally, this may appear productive. However, *the way* in which the model focuses attention on context is problematic. The direct relationship between context and change obfuscates the role of *biology* in this process. In addition, by positioning “control” as the only mediating factor of change, the *Container* model places heavy responsibility for change on the individual. While the focus on context somewhat tempers this preoccupation, the notion of control taps into a deep American sentiment of individual responsibility for outcomes which previous research has found to be problematic in people’s ability to see the role and importance of public policies and programs in addressing individual outcomes.<sup>13</sup> This is likely to be exacerbated as it applies to adolescent development.
- 3. Early change is buried and untouchable.** The stratigraphic discreteness of layers of change suggests that early experiences are unreachable under subsequent accumulation — that early experiences, and the changes in which they result, are permanent and indelible. The application of this assumption creates obvious

problems for communicating about the science of plasticity, which holds that structures and functions do — to various degrees — remain open to modification and change over time. On the positive side, this assumption can be used to emphasize the importance of early experiences, but communicators must be aware that, in so doing, the model inhibits the ability to think about the “... but so does later” part of the science account.

- 4. Limitless layers but diminishing returns is potentially productive.** The notion that the container of change is never full, but, at the same time, that subsequent experiences have diminishing opportunity to create change, may have potential in communicating about this part of the science of plasticity. This feature of the model should enable some understanding of the idea that there are aspects of systems that remain plastic, to various degrees, over the life course, but that this capacity, in general, decreases with time. Future research should explore if, and how, the deliberate evocation of this aspect of the model affects people’s receptivity to key science messages.

## VI. Cultural Models of Brains and Change

As the interview grew more specific, researchers introduced the idea of the brain into the discussions of change. Prior to its introduction as an explicit line of questioning, the brain was largely absent from discussion and emerged only fleetingly for some informants during the portion of the interview that covered change in early childhood (where informants reported cursorily that “brains grow a lot during the early years”). When the interview turned to focus explicitly on the brain, informants were asked questions such as, “Does the brain change?”, “If so, how?” and “How might the brain be involved in the ways that people change?”. Informants were uniformly unable to answer the third question — how the brain is involved in how people change — but had some general notions of how the brain itself might change over time. There were three patterned assumptions that ran across the interviews.

### 1. The *Brains Grow* Model.

The most dominant way that public informants thought about how brains change was through the assumption that brains “start pretty small and grow *a lot* over the first couple of years” (up until somewhere between ages 5 and 8). According to this model, brain change and development are primarily about the brain growing in overall *size*, such that it “starts to take up more room” in a child’s head.

### 2. The *Brains Solidify* Model.

At other times, informants employed an understanding in which brains were assumed to begin as “mushy” and “soft” in the first years of life and then, at around 5 to 8 years of age, to become “set,” “hard” and “fully formed.” In short, brains go through a rapid process of solidification in early childhood, after which they are understood as stable and set.

### 3. The *Always Open* Model.

Finally, and many times in close proximity to one of the other two brain-change models — both of which entail a period where the brain *stops* changing — informants explained that the brain is “always changing” and “always open.” The assumption underlying these commonly expressed opinions is related to the *Container* model — in this case, the idea of limitless capacity.

Below are several quotes in which these models can be seen:

*Babies’ brains are just loose. They’re small and early on there’s lot of room in there.*

*The brain is literally growing with age ... just developing naturally. It’s literally a physical thing.*

*Brains get bigger physically. It just happens when a child gets older. I know that. I don’t know how but it does get bigger.*

*I would certain say that in the first five years or so your brain is going absolutely bananas. It's growing so much and getting so much bigger.*

*I'd say that probably that infant to 5 is the active time of brain development. And I would imagine that the brain is hardening during this time ... it's toughening, it's solidifying ... it's forming.*

It is also interesting to note that the change from general discussions of change to “brains and change” was frequently accompanied by strong anti-science sentiments. Informants seemed to associate “brains” with “science,” and many resisted bringing their understanding of “science” and “scientists” into discussions of how people change. This resistance can be seen in the following quotes.

*The more we learn about the brain, the more harm I can see coming out of it. What other purposes would you need to study the brain for than controlling a certain part of the brain? Why do I want to learn more about your brain when your decisions in life don't have to be my decisions? Until they prove to me why it's beneficial for our society, our country, the world, jobs, the development of the kid, I will not support this brain science.*

*I read something recently about science being a methodology for control. But at the end of the day who cares about all this science? The world is still here. Stuff still happens, it still works exactly the same way whether we understand it or not.*

## Implication of Brains and Change Models

- 1. Rapid growth with a hard stop and quick calcification are double-edged swords.** When applying either the *Brains Grow* or the *Brains Solidify* cultural models, people are predisposed to think of brain change as something that ceases at some point in early childhood. From this perspective, communicating about continued capacity for change becomes difficult. On the other hand, both of these models facilitate a perspective in which early child development is an important period of change and an opportunity to influence long-term outcomes. The problem is that, even though these models contain this productive “early matters” entailment, they contain other elements that make the “... but so does later” plasticity message difficult to communicate.
- 2. Always Open is similarly mixed with respect to communications implications.** The *Always Open* cultural model has similarly mixed implications. On the one hand, the notion of continued flexibility and opportunity for change is very much in line with the “... but so does later” aspect of the expert story, and seems, therefore, a productive translational tool. On the other hand, the nuance around the fact that the capacity for change changes over time is obfuscated by the model, making the point about particular sensitive periods difficult to communicate.

- 3. Selective synthesis may be possible.** While each of these brain models is partially consonant with part of the science, none of them account for the full complexity of this science. The challenge for communicators is to figure out a larger structure which can “hold” productive aspects of these cultural models and temper their unproductive elements. Put another way, science translators need to find a different way of helping people think about brains, change and time — one that will allow people to incorporate the early importance of the *Solidification* and *Growth* models along with the continued capacity for change of the *Always Open* model.
- 4. Science pushback shows the importance of clearly explaining science implications, and the need for carefully tested science presentations.** The connection that many informants drew between brains and science, and their resistance to science-based discussions of change, presents a vital implication for science communicators. This observed resistance was primarily aimed at a perceived lack of the applicability of science and science findings to things in the “real world.” In the words of one informant, “understanding for the sake of understanding is pointless.” This points to a pressing need to explain the applications and implications — implications that appear in the untranslated science story presented above — of the science of developmental change and plasticity. Without such explanations, people struggle to see why a science perspective on change matters and become skeptical and unwilling to consider science messages.

## VII. Recessive Cultural Models of Change and Development

In addition to the models described above, informants drew on several other patterned assumptions in thinking about development and change. Although these models were not as frequently employed and were not used with the same degree of automaticity as those more dominant structures described above, they are nonetheless important features of the cognitive landscape on this issue and present considerations for science communicators. We call these “recessive” models, as they can be thought of as ways that are *available* to the public to think about change and development, but that are not *readily* employed. These recessive models require specific cuing to become active in the mind. If activated, two of these recessive models offer considerable promise in translating the expert account laid out above. The two remaining recessive models are more concerning from a communications perspective.

### 1. The *Construction* Model.

Considerably more recessive than the *Container* model was another metaphorical construct that informants employed to think about change. According to this model, change is a process of building — whereby environmental factors are represented as “materials” used to “build” and modify a person. This model has many of the same sequential entailments as the *Container* model — that what happens early/lower matters most — but is more dynamic and active, and has more robust process and outcomes understandings. According to this model, the result of change is a structure, which varies based on inputs and assembly. Employing this model, informants emphasized the importance of “the foundation” for “all that comes after”; the significance of the materials (environmental factors) that are used to build the structure; and the potential to “add to and change what you’ve got.” In short, reasoning from this model, people understood that early matters, environments are key and there is continued potential for modification. The presence of this model offers an explanation for the success of *Brain Architecture* and the ability of this Explanatory Metaphor to help people think productively about various aspects of development. It appears that *Brain Architecture* helps people understand development by activating and building on this *Construction* model. Whether this Explanatory Metaphor can perform the additional tasks required to explain plasticity remains an empirical question best suited to prescriptive methods, and beyond the purview of the research described here.

### 2. The *Periods of Transition* Model.

A second promising recessive cultural model was the implicit understanding that periods of transition — when someone “moves from one stage in life to another” — are times during which people are especially prone to change. The most frequent “life transitions” discussed by informants included: going from middle school to high school,

going to college, graduating college and getting a job, going from being single to being married, and going from not having kids to having kids. These transitions were most frequently introduced in response to open-ended questions such as “What are some times in a person’s life when they might change more than other times?” When asked to talk about why these periods were important times of change, informants explained that there was “something special” going on — but struggled to provide any further explanation about why these were particularly important periods of change. This model largely functioned at the level of association (these periods are when change happens) and salience (these are important periods of change) rather than process (this is *why* these periods cause a person to change). This, again, reveals a general lack of robust models for people to draw on in thinking about developmental process — of *how* change happens, and — in this case — *why* it might happen in certain periods more than in others.

### 3. The *Changing Times* Model.

In addition to the two more-promising recessive models discussed above, analysis revealed a more unproductive recessive pattern of thinking associated with the issues of change and development. When answering open-ended questions about how people change, and more specific questions about how young children and adolescents change, “change” was sometimes understood in terms of the differences between the experiences of *generations* — more specifically, between the informant’s generation and that of the current generation of American youth. Working with this model of change, informants compared their own childhoods to that of “kids today,” and focused on all the aspects of early childhood and, particularly, adolescence which are different now than they were (perceived to be) when the informant passed through these life stages.<sup>14</sup> Technology featured prominently as a source of this generational difference. Informants saw the increased reliance and reach of technology as a “change” which has negatively influenced the development of children.<sup>15</sup> When using the *Changing Times* cultural model, people understood change in relation to generations rather than life courses.

### 4. The *Hyper-Individualism* Model.

Finally, analysis revealed a recessive connection between the idea of change and a *Hyper-Individualism* cultural model. Thinking through the *Hyper-Individualism* model, informants questioned whether there was really anything that could be said about change — reasoning that each individual is “so different from everybody else” that generalizations about determinants of change, processes of change and results of change are inappropriate. In short, because each individual is unique and changes in unique ways, there are no common processes or “blanket statements” that can be made about concepts of change.



## Implications of the Recessive Cultural Models

- 1. The *Construction* model has promise.** The *Construction* model is considerably more process-rich — that is, it is more helpful in giving people a way to think about how change happens — than the *Container* model. The presence of this model, despite its recessiveness, goes a long way in explaining why *Brain Architecture* has been such a successful Explanatory Metaphor and an important part of the Core Story of Early Child Development.<sup>16</sup> Furthermore, the presence of this model suggests the utility of the *Brain Architecture* Explanatory Metaphor as a way of making processes of change and plasticity more explicit — particularly the idea that early matters but so does later, and the notion that development and change are active and contextually dependent processes. Whether this Explanatory Metaphor can be tweaked in such a way as to play a role in supporting the communication of plasticity remains to be seen.
- 2. The *Transition* model is promising, but is missing process.** The existence of a recessive model in which people implicitly associate periods of transition (and share a common understanding of what these periods of transition are) with periods of pronounced change is promising. It should serve as an opening into which science communicators can wedge explanations of *how* transition might create change, and of the specific changes associated with particular periods of transition. However, communicators must understand that, as it currently exists, this model is largely limited to an associative function — that is, it helps people bring two phenomena together. Communicators must develop effective ways of adding process (how and why transitions are important periods of change) to this implicit association; to date, there is little in the Core Story of Early Child Development to help in this regard.
- 3. Preoccupation with *Changing Times* is highly unproductive.** The associations that informants had when thinking about generational changes were largely unproductive. They structured a perspective in which change = bad, where children today are destined to be “messed up,” and where society is “crumbling and falling apart.” When this way of thinking became active, it was difficult for informants to break out of, and get back to thinking about the way that “people” rather than “times” change. Communicators should be aware of the tendency for developmental discussions about “change” to morph into nostalgic and unproductive discussions about “how times have changed.” These discussions distract from the science messages and threaten to derail productive thinking about plasticity and the capacity for change. It is also likely that this model will be especially available when people think about adolescents, making it all the more important that plasticity be anchored in a complete, redirective communications strategy.
- 4. *Hyper-Individualism* makes it hard to communicate about common process.** As in other FrameWorks research where this model has emerged,<sup>17</sup> applied to the issue of change and development, notions of *Hyper-Individualism* threaten to block science messages about common processes. It is interesting to note, however, that this model,

which has emerged as a *dominant* feature in public thinking on other related issues, is significantly less dominant in people's thinking about the capacity for, and types and timing of, change. A potential explanation is that the *Just Add Water* and *Container* models structure some notion (although thin) of common processes of change (for example "filling" and "control"). In the fight for cognitive prominence, the dominance of these models seems to push *Hyper-Individualist* sentiments, and the resulting resistance to accepting *common* processes, into the relative background.

## VIII. Overlaps and Gaps in Understanding

The goals of this analysis have been to: 1) document the way experts talk about and explain developmental plasticity; 2) establish the way the American public understands this and related issues; and 3) compare and “map” these explanations and understandings to reveal the overlaps and gaps between the perspectives of these two groups. We now turn to this third task.

Comparative analysis suggests key areas of overlap between expert and public understandings. These overlaps represent features of the cognitive landscape that communications can strategically leverage to improve the accessibility of expert information. Future communications research can be deployed to empirically test how to undertake this activation, and the degree to which activating these common patterns of thinking can help translate developmental science.

### Overlaps in Understanding

- **Continued Capacity for Change:** Both experts and members of the general public acknowledge the continued ability for people to change — although some of public’s available models facilitate this realization more than others.
- **Change Changes:** Thinking through the *Container* model, with its notions of diminishing change yet the ability for particularly important events to have inordinate impact, members of the public also seem, at least partially, in line with experts on the idea that the capacity for change changes.
- **Early Childhood and Adolescence are Key Periods of Change:** Expert messages and public models also come together around the emphasis on early childhood and adolescence as periods of significant change. Again, despite this general confluence around the salience of these periods, there are significant differences that emerge when it comes to the determinants, processes and outcomes of this change, as well as attributions of responsibility.

In addition to these high-level overlaps, comparative analysis revealed a key set of gaps between the ways that experts and the American public think about plasticity and developmental change. Below, we describe each of these gaps and discuss its communications implications.

## Gaps in Understanding

- **Starting Point: *Comes with Constitution vs. Blank Slate.*** While experts discussed the importance of genetic constitution and neurobiology in explaining that change is not a from-scratch process, members of the public displayed the opposite assumption — reasoning from a dominant model in which children are understood to be empty vessels.<sup>18</sup> This is a familiar gap in FrameWorks’ communications research on children’s issues.<sup>19</sup> As such, this is a gap that has been addressed through the development of Explanatory Metaphors — particularly *The Outcomes Scale* — which provides a way for people to understand how constitutional features act as “starting points,” which mediate the effect of environmental experiences to influence outcomes yet remain open to change. We hypothesize that this metaphor should have utility in communicating aspects of the science of plasticity — particularly the idea that change is dynamic, but always occurs in relation to some preexisting state.
- **Process: *Articulated vs. Assumed.*** Perhaps the most important gap from a communications perspective is that, while expert understanding is equipped with clear causal processes, members of the public have thin understandings of *why* people change — understandings which are limited to vague notions of “filling” and explanations of “control.” It is this process — explaining how brains change and how this change changes and affects other outcomes — that future communications research should take as its central, explanatory charge. As long as this gap exists, members of the public will have difficulty understanding key aspects of the science of plasticity, and development more generally.
- **Types of Change: *Structural and Functional vs. Physical and Everything Else.*** Both experts and members of the public recognize that there are different types of change. However, the “types” differ markedly between these groups. Experts talk about two dimensions of a brain’s capacity for change: *structural* modifications in networks and systems, and *functional* adaptations to existing structures. Members of the public draw a line between physical changes and “everything else.” This gap not only directs attention towards different conceptions of variation, but the public’s distinction between physical growth and all the other ways people change obscures the science message that the same principles of plasticity underlie all change. Devising ways to effectively communicate about the difference between structural and functional plasticity is, therefore, an important communications task for future research.
- **Capacity for Change Over Time: *Punctuated Plasticity vs. Diminishing Capacity.*** There is also an important gap between experts and members of the public when it comes to how change changes over time. Experts have a particularly nuanced understanding of this point — explaining that there is a generally diminishing capacity for change over time but, at the same time, that there are particularly punctuated periods of plasticity throughout the life course that violate this trend. Members of the public have a simpler understanding of the way that the capacity for change changes —

reasoning through a negative linear relationship between the variables of time and change. In short, they reason that the capacity for change decreases with time. As discussed in the conclusion, bridging this gap, such that members of the public are able to think simultaneously about the diminishing capacity for change over time *and* punctuated periods of plasticity, is a central communications task.

- **The Role of Biology: *Central Change Agent vs. Absent Actor*.** Another notable gap exists between the role of biology in expert messages and public understanding. Biology and the brain featured, not surprisingly, prominently in expert messages about change and plasticity. For members of the public, biology and the brain were almost entirely absent from the discussion. When responding to open-ended questions, biology came up only infrequently in discussions of children’s brains forming and “growing” early in life or in the “raging hormones” of adolescents. Even when brains were introduced explicitly by the interviewer, informants quickly exhausted their understandings of how brains might change and why this change would be important, and went back to the more comfortable script of containers and control. Future communications research will need to focus on ways of getting biology firmly and concretely into the discussion of change and development. Existing parts of the Core Story of Child Development may prove useful, but may not be sufficient in this regard.
- **What Causes Changes: *Biology and Context vs. Context and Control*.** There was a considerable expanse between the way that these two groups looked at responsibility for change. Experts placed biology, and the context that interacts to shape it, in the role of protagonist, while members of the public placed an individual’s control over decisions in the leading role. This responsibility gap is another familiar expanse, and thus represents a translational feature where existing parts of the core story of development should be useful. *The Outcomes Scale, Brain Architecture and Levelness*, as well as the values of *Collective Prosperity* and *Ingenuity*, with their demonstrated ability to inoculate against narrow senses of individual responsibility, should be of utility in bridging this gap.
- **How Brains Change: *Different Systems at Different Times and Functional Openness vs. Quickly Closing or Always Open*.** Finally, when informants were pushed to think specifically about the brain and how it might change, another interesting gap emerged. This is a complex gap; it lies not neatly between one public model and expert message but, rather, between competing public models and the core of the expert story of plasticity. Experts define plasticity as the brain’s continued, but changing and generally diminishing, capacity to change — a message that requires holding simultaneously in mind ideas of ongoing openness *and* changes in openness. Members of the public have competing models between which they oscillate when thinking about how brains change. On the one hand, they think of brains as initially small or soupy but quickly grown or setting, and on the other as having infinite and unbridled capacity for change. The gap lies at the nexus between the “setting” notion of the first two models, the wide-open capacity of the third, and experts’ nuanced explanation of continued but variable

capacity for change. Herein lies the central task that remains unaddressed by existing communications tools — how can science communicators pull forward, integrate and deepen productive features of people’s existing understandings of brain change, while muting aspects of understanding which impede science translation, in order to create a perspective from which people can at once see brains as changeable, but in which this flexibility can change over time and in type.

## IX. Conclusions and Recommendations

The research presented here reveals a challenge for science communicators that is at once promising and problematic. Americans have default perspectives from which they *can* appreciate, at a very general level, several of the points that comprise the expert account of plasticity — that people have the ongoing capacity to change, that this capacity changes over the life course, and that both early childhood and adolescence are key periods in which change occurs. The devil, however, is in the details, as a major finding of this research is that, while experts have clear causal mechanisms and a process-based understanding of *how* and *why* brains change, members of the public struggle to understand these processes. From a science translation perspective, these difficulties in thinking about process are problematic, and require attention.

The picture becomes even more complicated due to the fact that some of the public's models create gaps between expert perspectives, while others create overlaps. The result is a moving target for communicators, as the model that is active in the public's thinking will determine people's ability to understand, and work with, science messages. This suggests the importance of strategic communications in translating this aspect of developmental science, and suggests a meta strategy for communicating this science. If communicators can understand the array of models available to members of the public to think about change, see which of these models are more productive than others, and become proficient in cuing these productive models and muting less productive ones, they should be able to establish perspectives from which Americans can appreciate many of the science messages around plasticity. FrameWorks' researchers are cautiously optimistic that plasticity can be translated effectively into the Core Story of Early Child Development, and play a strong role in advancing public understanding of the science and its relationship to policies and interventions.

Despite this promise, there remains a significant hole in this landscape: *process*. This is not a new hole, and some of the existing parts of the Core Story of Child Development will have utility in helping people understand change and flexibility. For example, *Brain Architecture* should be effective in communicating the idea that “early matters ... but so does later” and *The Outcomes Scale* should help people think about the ability for continued change over time. The utility of these metaphors in communicating this science should be confirmed and the particular use of these metaphors refined in future research. However, the notion of *changes* in plasticity — of the ebbs and flows in both the degree of plasticity and of the different systems that are plastic at different times — is a complex message that is not likely to be translated by existing communications tools. Communicating about the non-linear relationship between change and time, and the moving target of the systems that are changeable, requires new framing tools. The goal of any new communications work should be to help members of the public appreciate the fact that *there are multiple ways that people's capacity for change changes*. Over time, systems generally become less plastic; there are exceptions to this linear relationship, however, as there are periods during the

life course where brains are particularly apt to change. Furthermore, there are different systems that are plastic at different times. Because of the central importance of the concept of plasticity to the science of development, allowing the public to access and work with these nuanced perspectives of change is vital to the larger task of translating the science of early child development.

Based on this descriptive research, we offer the following preliminary communications recommendations:

1. Use *Brain Architecture* to draw on the power of the *Construction* model to make the point that early matters (i.e., building the foundation), but so does later (adding and modifying spaces and secondary systems such as electrical and plumbing).
2. Focus on descriptions that help people deepen their association between periods of transition and periods of change. Explain what it is about transitional periods that make these times in life particularly important periods of change.
3. Find a way of knitting together productive aspects of the three models that people use to think about how brains change, while inoculating against problematic entailments that each carries.
4. Use *The Outcomes Scale* to strengthen people's understanding of dynamism and continued capacity for change.
5. Use existing parts of the Core Story of Early Child Development (*Brain Architecture*, *Levelness* and *The Outcomes Scale*) to put context, biology and constitutional factors in leading roles, and inoculate against narrow senses of control and individual responsibility for change.



## About The FrameWorks Institute

The FrameWorks Institute is an independent nonprofit organization founded in 1999 to advance science-based communications research and practice. The Institute conducts original, multi-method research to identify the communications strategies that will advance public understanding of social problems and improve public support for remedial policies. The Institute's work also includes teaching the nonprofit sector how to apply these science-based communications strategies in their work for social change. The Institute publishes its research and recommendations, as well as toolkits and other products for the nonprofit sector, at [www.frameworksinstitute.org](http://www.frameworksinstitute.org).

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Kendall-Taylor, N., & Haydon, A. (2013). *Plasticity's promise: Moving public thinking beyond the container and other unproductive models: Mapping the gaps on developmental plasticity*. Washington, DC: FrameWorks Institute.

<sup>1</sup> Shonkoff, J., & Bales, S.N. (2011). Science does not speak for itself: Translating child development research for the public and its policymakers. *Child Development*, 82(1), 17-32.

<sup>2</sup> Amundson, D., Lichter, L., & Lichter, R. (2005). *What's the matter with kids today: Television coverage of adolescents in America*. Washington, DC: FrameWorks Institute.

<sup>3</sup> Past FrameWorks research has also found that Americans apply a *Genes are Set in Stone* cultural model to reason about developmental outcomes. The focus on “change” in the current interviews, and the *Set in Stone*'s assumption of the lack of change, likely explains why this model did not emerge as part of the current project. For more information, see: Kendall-Taylor, N. (2012). Conflicting models of mind: Mapping the gaps between expert and public understandings of child mental health. *Science Communication*, 34(6), 695-726.

<sup>4</sup> Kendall-Taylor, N. (2012). *The resilience scale: Using metaphors to communicate a developmental perspective on resilience*. Washington, DC: FrameWorks Institute.

<sup>5</sup> For an introduction to cultural models theory, see: Holland, D., & Quinn, N. (1987). *Cultural models in language and thought*. Cambridge, England: Cambridge University Press.

<sup>6</sup> Holland, D., & Quinn, N. (1987). *Cultural models in language and thought*. Cambridge, England: Cambridge University Press.

<sup>7</sup> Quinn, N. (2005). *Finding culture in talk: A collection of methods*. New York, NY: Palgrave Macmillan.

<sup>8</sup> Kendall-Taylor, N. (2012). *The resilience scale: Using metaphors to communicate a developmental perspective on resilience*. Washington, DC: FrameWorks Institute.

<sup>9</sup> FrameWorks Institute. (2009). *Framing early child development Message Brief*. Washington, DC: FrameWorks Institute.

<sup>10</sup> Shore, B. (1996). *Culture in mind: Cognition, culture, and the problem of meaning*. New York, NY: Oxford University Press.

<sup>11</sup> This aspect of the *Container* model is linked to, and embedded in, an even more foundational American model about willpower and individual responsibility, which FrameWorks has documented in research on multiple issue areas — from development to education and health. See the following reports for more detail on this foundational cultural model: Kendall-Taylor, N. (2011). “*Anyone can do it ... Wake up, rise up and get some gumption*”: *Mapping the gaps between expert and public understandings of resilience and developmental outcomes*. Washington, DC: FrameWorks Institute; Chart, H., & Kendall-Taylor, N. (2008). *Reform what?: Individualist thinking in education: American cultural models on schooling*. Washington, DC: FrameWorks Institute.

<sup>12</sup> FrameWorks Institute. (2009). *Framing early child development Message Brief*. Washington, DC: FrameWorks Institute.

<sup>13</sup> FrameWorks Institute. (2009). *Framing early child development Message Brief*. Washington, DC: FrameWorks Institute.

<sup>14</sup> Amundson, D., Lichter, L., & Lichter, R. (2005). *What's the matter with kids today: Television coverage of adolescents in America*. Washington, DC: FrameWorks Institute.

<sup>15</sup> Kendall-Taylor, N., & Lindland, E. (2010). “*Faster and fancier books*”: *Mapping the gaps between the expert and the public understandings of digital media and learning*. Washington, DC: FrameWorks Institute.

<sup>16</sup> FrameWorks Institute. (2009). *Framing early child development Message Brief*. Washington, DC: FrameWorks Institute.

<sup>17</sup> Lindland, E., Kendall-Taylor, N., Baran, M., O'Neil, M., & Simon, A. (2012). *Mapping the gaps on skills and learning: A core story of education report*. Washington, DC: FrameWorks Institute.

<sup>18</sup> Kendall-Taylor, N. (2012). Conflicting models of mind: Mapping the gaps between expert and public understandings of child mental health. *Science Communication*, 34(6), 695-726.

<sup>19</sup> Lindland, E., Kendall-Taylor, N., Baran, M., O'Neil, M., & Simon, A. (2012). *Mapping the gaps on skills and learning: A core story of education report*. Washington, DC: FrameWorks Institute; Kendall-Taylor, N. (2011). "Anyone can do it ... Wake up, rise up and get some gumption": *Mapping the gaps between expert and public understandings of resilience and developmental outcomes*. Washington, DC: FrameWorks Institute.

