Behavioral economics applies key principles from psychology and economics to address obstacles to behavior change. The important topic of pediatric firearm injuries has not yet been explored through a behavioral economic lens. Pediatric firearm-related injuries are a significant public health problem in the United States. Despite American Academy of Pediatrics guidelines advising that firearms be stored unloaded, in a locked box or with a locking device, and separate from ammunition, estimates suggest that ∼4.6 million children live in homes with at least 1 loaded and unlocked firearm. In this article, we use behavioral economic theory to identify specific cognitive biases (ie, present bias; in-group, out-group bias; and the availability heuristic) that may influence parental decision-making around firearm storage. We illustrate situations in which these biases may occur and highlight implementation prompts, in-group messengers, and increased salience as behaviorally informed strategies that may counter these biases and subsequently enhance safe firearm storage. We also describe other opportunities to leverage the behavioral economic tool kit. By better understanding the individual behavioral levers that may impact decision-making around firearm storage, behavioral scientists, pediatric providers, and public health practitioners can partner to design and test tailored interventions aimed at decreasing pediatric firearm injuries. Further empirical study is warranted to identify the presence of specific biases and heuristics and determine the most effective behavior change strategies for different subpopulations.

BEHAVIORAL ECONOMICS AND FIREARM STORAGE BEHAVIORS

Behavioral economics applies key principles from psychology and economics to address obstacles to behavior change. Whereas economists describe human beings as logical, rational decision-makers, behavioral economists recognize that predictable and systematic errors in judgment characterize human decision-making.1,2 To adapt to a complex world, humans rely on unconscious cognitive biases and simplifying heuristics. These processing aids and mental shortcuts can be helpful, but they can also lead to decisions not in one’s best interests. For example, the anchoring effect is a cognitive bias that refers to the tendency to rely heavily (“anchor”) on 1 value when making decisions; the initial, irrelevant starting point then influences future estimates.1 By addressing the subtle decision errors that occur in everyday life, behavioral economics offers insights and tools that can support better choices. Although pediatricians and behavioral economists recently have collaborated on ideas to support parental behavior change and boost clinical effectiveness (notably around vaccination),3-5 the important topic of pediatric firearm injuries has not yet been explored through a behavioral economic lens.
Pediatric firearm-related injuries are a significant public health problem in the United States, with firearms as the leading mechanism of injury death for 10- to 24-year-olds in 2017. More than half of child and adolescent firearm deaths were homicides (59%), followed by suicides (35%) and unintentional injuries (4%). From 2007 to 2014, firearm suicides in children trended up, and between 2002 and 2014, 60% of the firearm suicides among children were completed with a handgun. The majority of both younger and older children who died by firearm suicide or unintentional firearm injury received the fatal injury in the home. Firearms are present in approximately one-third of US households. Households, especially those with children, with a firearm present are at an increased risk for intentional and unintentional injury.

Consistent safe firearm storage may meaningfully reduce both fatal and nonfatal pediatric injuries. Safe storage is defined as “practices that limit accessibility to guns by unauthorized users.” The American Academy of Pediatrics (AAP) states that the absence of guns in homes and communities is the most effective way to prevent pediatric firearm-related injuries. If firearms are present in the home, AAP guidelines advise that pediatricians counsel families that firearms should be stored unloaded, in a locked box or with a locking device, and separate from ammunition. Locked boxes include gun safes or cabinets, and locking devices include trigger or cable locks.

Despite these recommendations, approximately one-fifth of gun owners store at least 1 gun loaded and unlocked. Strikingly, only 46% of US adults who own a firearm report safely storing all of their firearms, and nearly 40% of parents wrongly believe that their child does not know where their firearm is stored. Shifting patterns of gun ownership, especially the increase in handgun ownership for personal protection, amplifies the risk of pediatric injury given that handguns are more likely to be stored loaded and unlocked. Estimates suggest that ~4.6 million children live in homes with at least 1 loaded and unlocked firearm. Evidence to date for safe storage interventions is varied. Gun avoidance programs directed to children do not reduce risk, and the effects of child access laws vary by strength and state. Firearm training in its current form is not associated with storing firearms safely. In contrast, pediatrician screening, brief counseling, and distribution of cable locks to firearm-owning parents (bundled with other violence prevention interventions) led to improvements in parental reports of lock use. The development and evaluation of approaches to engage parents in safe firearm storage are urgently needed, especially in light of the Monuteaux et al finding that a modest (20%) uptake of a direct safe firearm storage recommendation among adult firearm owners in households with children could result in meaningful reductions in both unintentional injuries and suicide.

The problem of unsafe firearm storage reflects broad structural challenges but is also an individual behavior driven by individual decision-making. By focusing on individual behavioral levers, the field of behavioral economics offers insights that may complement current public health approaches to increasing safe firearm storage. In this article, we use behavioral economic theory to identify specific cognitive biases that may influence parental decision-making, illustrate situations in which these biases may occur, and propose potential strategies from the behavioral economic tool kit to counter them.

We aim to educate pediatricians about behavioral economic concepts that could inform clinical practice but are still in need of testing to determine if, and in which groups, they are effective. We will explore implementation prompts, in-group messengers, and increased salience as behaviorally informed strategies that may enhance safe firearm storage practices. We will also describe other relevant behavioral science constructs.

**DEPLOY IMPLEMENTATION INTENTION PROMPTS TO COUNTER PRESENT BIAS**

Present bias is the tendency of most individuals to overemphasize the present and discount the future. In health-related decisions, present bias leads to overweighting the immediate costs of following through with an intention and underweighting potential future benefits. Take physical activity for example: individuals will overvalue the short-term costs, such as the time, energy, and financial costs, associated with exercising as opposed to the long-term benefits, such as weight loss, reduced risk of heart disease, and overall improvements in health. The future seems uncertain and unknown, leading individuals to put more value on the present. Although individuals may have strong intentions to accomplish a particular task, present bias may interfere with execution. Implementation intention prompts are a potential strategy to counter present bias. One type of an implementation intention prompt is a commitment contract. Simply asking people to declare, “In situation X, I plan to do Y” can increase achievement of the desired goal.

Developing this intention fosters a connection between the desired action and a concrete future moment. Milkman et al found that employees who received a specific prompt to write down both a date and time for flu vaccination had a significantly higher vaccination rate.
Actual parental firearm storage behaviors may not align with intentions. Parents may indeed intend to store their firearms safely, but logistic issues or obstacles interfere. Hassle factors are the minor inconveniences that interfere with the alignment of intentions and actions. Although yet to be explored empirically, the presence of minor inconveniences may impede consistent completion of safe firearm storage. Furthermore, parents may lack urgency to store firearms safely if they do not believe that their child will actually handle an unsecured firearm. Although storage intentions were not specifically addressed, Baxley and Miller\(^1\) found that parents misperceived their children’s knowledge about firearm storage and how their children would react if they encountered a firearm. Parents may perceive the present risk (fatal or nonfatal injury) as low and the potential future benefits (not being injured) as too intangible or improbable. The low perceived benefits are insufficient to overcome the immediate costs. Cost may also be conceptualized as the time spent developing a safe storage plan, such as selecting the storage device (e.g., specific type of safe), deciding where to locate it in the home, and establishing consensus between caregivers.

As a nudge (that is, an intervention to influence behavior predictably without restricting choice)\(^2\) toward safe firearm storage that would counter present bias through implementation intentions, firearm distributors could offer buyers a commitment contract at the point of sale. In the commitment contract, the buyer commits to following best practices for safe storage. Commitment contracts compel individuals to align future actions with current intentions. They require neither material rewards nor penalties; the writing of the commitment itself is the mechanism that increases the likelihood of completing the desired action.\(^2\) This commitment could include a write-in section for buyers to identify the exact date and time this action would occur; for example, “I am committed to keeping my child safe from injury. I will do this by securing my firearms by [insert storage method] on [insert date] at [insert time].” Additional venues where commitment contracts may be implemented include school functions, pharmacies, and pediatrician practices, which may effectively target the subpopulation of parents that is open to safe firearm storage but needs prompting to take action.

**USE IN-GROUP MESSENGERS TO INFLUENCE SOCIAL NORMS**

Social norms are the common standards for behavior for members of a social group.\(^2\) Descriptive norms relate to perceptions of how others generally behave in a given situation, whereas injunctive norms relate to socially approved or unapproved behavior (i.e., how one should behave).\(^2\) When a particular course of action is unknown or unclear (such as recycling a specific item), descriptive norms provide helpful guidance (recycle X item in Y container). The threat of disapproval for inappropriate behavior or assurance of approval for compliance drives injunctive norms (recycling is expected in our community) and subsequently motivates behavior.\(^2\)

Given that individuals tend to trust individuals within their communities as opposed to outsiders (in-group, out-group bias), engagement of in-group messengers is one strategy to harness injunctive norms by applying social pressure on peers to perform the expected behavior.\(^2\) For example, in their study of teenagers, Atchley et al\(^1\) found that teenagers viewed both driving drunk and driving while texting as irresponsible. Various public health texting and driving campaigns leveraged this injunctive norm to increase disapproval of texting while driving. Promotion of skin protective behaviors, such as applying sunscreen, has been influenced by interventions seeking to harness social descriptive norms.\(^2\)

Multiple stakeholder groups, including shop owners, large retailers, and law enforcement officers, may influence firearm owners’ behaviors. Barber et al\(^\text{31}\) highlight the success of the Gun Shop Project, a collaborative endeavor to engage firearm retailers, gun rights advocates, and suicide prevention groups in an effort to reduce suicide by firearms. Gun owner groups are trusted members within their communities and thus key messengers; building on shared values of protection and responsibility enabled this successful partnership.\(^3\) In a nationally representative survey, Crifasi et al\(^1\) found that firearm owners identified the National Rifle Association, hunting or outdoor groups, active duty military personnel, and law enforcement as the most effective communicators of safe gun storage, in contrast to physicians and celebrities. Jager-Hyman et al\(^1\) noted the opportunity for community-partnered approaches to ensure that firearm safety interventions respect various stakeholders’ needs.

One strategy to target social norms with positive messaging is for socially connected retailers to position gun locks in aisles with baby-proofing safety items, such as outlet plug covers and infant gates. Walmart, one of the nation’s largest firearm retailers, offers hundreds of baby-proofing items and even displays a “safety guards and locks” category on their Web site.\(^3\) Firearm safe, electronic lock boxes, standard lock boxes, firearm cases, and cable locks could be cross-listed in this category. Adding lock boxes and locking devices to the standard baby-proofing checklist not only capitalizes on this parental subpopulation’s desire to...
protect children from harm but also sends a message that the social norm is to secure firearms in the earliest stages of a child’s development. Adding a message (based on previous evidence) that the majority of gun owners report that “all guns should be kept in a locked place when there are children living in the home” further reinforces that the in-group finds safe storage acceptable.

**INCREASE SALIENCE TO ADDRESS AVAILABILITY HEURISTIC**

The availability heuristic refers to the tendency to overweight events that are brought to mind more easily than events that are less easily imagined. This mental shortcut relies on top-of-mind examples when making an evaluation. Individuals may use the number of examples recalled to infer the frequency of broader occurrence. Reliance on example recall can lead to errors in assessing probabilities. Consequently, individuals may base beliefs on the most readily accessible fact or a quick impression rather than fully considering the issue at hand. For example, an individual’s assessment that train travel is increasingly dangerous, based on recall of 2 recent train crashes, may lead to the erroneous belief that car travel is safer. In a study by An, lead to the erroneous belief that car recall of 2 recent train crashes, may increasingly dangerous, based on assessment that train travel is

Individuals who own guns for protection are more likely to store at least 1 gun loaded and unlocked. Furthermore, nearly 40% of owners report that a gun is both loaded and easily accessible to them all of the time at home, consistent with the desire to be prepared in the event of a home invasion. In this subpopulation, the availability heuristic may contribute to gun owners overweighting the risk to their personal safety compared with the risk of their child or adolescent gaining access to the firearm, which could result in injury to self or others. Excess worry about the wrong, but more culturally salient, risk can have major consequences. In a Philadelphia magazine article, Temple University trauma outreach coordinator, Charles Young, attempts to debias threat risk assessments informed by the availability heuristic: “I did the math. You know how many hours a bad guy was in my house last year? Zero…. You know how many hours children were in my house? Several thousand. I’m just playing the laws of probability.”

It is possible to capitalize on the availability heuristic by increasing the salience (ie, the vividness) of an event to promote recall. Interventions that increase the salience of both intentional and unintentional injury due to unsafe storage may be particularly effective for the subpopulation of parents who keep firearms in the home for protection. To cue parents to the importance of safe firearm storage, pediatricians could provide preprinted “prescriptions” with key elements of the AAP guidelines along with the locations of nearby retailers that sell locking devices. Firearm safety prescriptions could be bundled with other routine preventive touchpoints (eg, screenings for lead at a 9-month well visit or substance use in adolescents). The bundling of firearm safety prescriptions with other routine pediatric health interventions could not only increase salience but also change mental models, the identities and concepts that help people make sense of the world, by normalizing conversations around firearm safety. Given that pediatricians may be perceived as an out-group by some firearm owners, local firefighters and law enforcement could also distribute these prescriptions during neighborhood car seat installation safety checks and emphasize a key message: keep your kids safe on the road and at home. These interventions would reframe the idea of safety as more than protection from threats out in the world but also those potentially present in the home.

**LEVERAGING THE FULL BEHAVIORAL ECONOMIC TOOL KIT**

Many other constructs from behavioral science may impact parental decision-making around firearm storage (Table 1). For example, the overconfidence effect is the misreckoning of probabilities in which an individual’s subjective confidence in their ability (ie, adeptness, skill) is greater than their actual performance. Given the Berrigan et al finding that gun owners who reported having received formal firearms training were more likely to store a gun loaded and unlocked, is there a link between training and overconfidence in one’s ability to handle a firearm safely? If so, specific elements of training could be tailored to address this bias. Furthermore, if firearm-owning parents do in fact routinely misjudge their ability to act in a crisis state, training or other interventions could systematically address the hot-cold empathy gap, the tendency to underestimate the influence of visceral states (eg, anger, fear) on one’s behavior.

Optimism bias is the tendency to overestimate the likelihood of positive events and underestimate the likelihood of negative events.
**TABLE 1 Examples of Behavioral Insights to Enhance Safe Firearm Storage**

<table>
<thead>
<tr>
<th>Behavioral Science Construct</th>
<th>Definition</th>
<th>Potential Application to Firearm Storage Behavior</th>
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<tbody>
<tr>
<td>Present bias</td>
<td>Tendency to overemphasize the present versus the future</td>
<td>Poor follow-through on storage due to immediate costs (eg, time, energy) and intangible and/or improbable future benefits</td>
</tr>
<tr>
<td>In-group, out-group bias</td>
<td>Tendency of people to trust individuals within their communities as opposed to outsiders</td>
<td>Increased trust of in-group members (eg, military, law enforcement)</td>
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<tr>
<td>Availability heuristic</td>
<td>Tendency to overweight events that are brought to mind more easily than events that are less easily imagined</td>
<td>Overweighting the risk to personal safety (eg, from home invasion) compared with the risk of accidental child injury</td>
</tr>
<tr>
<td>Mental models</td>
<td>Identities, concepts, and stereotypes that help people make sense of the world</td>
<td>Identity of parents as protectors from outside harms</td>
</tr>
<tr>
<td>Overconfidence effect</td>
<td>Misevaluation of probabilities in which an individual’s subjective confidence in their ability is greater than their actual performance</td>
<td>Overconfidence in one’s ability to handle a firearm safely</td>
</tr>
<tr>
<td>Hot-cold empathy gap</td>
<td>Tendency to underestimate the influence of visceral states (eg, anger, fear) on one’s behavior or preferences</td>
<td>Overestimating the ability to protect oneself in a crisis-hot state</td>
</tr>
<tr>
<td>Optimism bias</td>
<td>Tendency to overestimate the probability of positive events and underestimate the probability of negative events</td>
<td>Belief that one’s own child is unlikely to experience an injury</td>
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<tr>
<td>Information avoidance</td>
<td>Physical avoidance, biased interpretation of information, or inattention to readily available information</td>
<td>Avoidance in attending to child’s increased risk for suicide</td>
</tr>
<tr>
<td>Choice overload</td>
<td>The greater the number or complexity of offered choices, the more likely the individual is to defer the choice</td>
<td>Wide range of firearm storage options and suboptions leading to deferred action</td>
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Individuals tend to view the risks for themselves as lower than for others in similar situations. Optimism bias is more likely to occur if negative outcome is perceived as unlikely. Scott et al.[38] found that a child’s history of risk factors for self-harm does not appear to affect caregiver decisions about whether to keep firearms in the home or store firearms locked and unloaded. Parents or other caregivers may overweight their child’s well-being or underestimate their child’s risk for suicide.[39] Information avoidance (physical avoidance, biased interpretation of information, or inattention) may also factor in.[9,40] Given the difficult topic of suicide, parents may be more likely to avoid information to mitigate anxiety or maintain consonance in their beliefs. Ongoing research on risk communication, particularly related to visual aids,[10] may help counter these barriers.

With choice overload, the greater the number or complexity of offered choices, the more likely the individual is to defer the choice.[7] Given the wide range of storage options (firearm safes, electronic lock boxes, standard lock boxes, firearm cases, and cable locks[31]) and suboptions within all of these categories, are parents ever overwhelmed with choices? If so, a default option might be used to reduce friction around choice; defaults are frequently used in the behavioral economic “choice architecture” tool kit. Alternatively, enhanced active choice is one strategy that promotes the option preferred by the choice communicator by emphasizing losses tied to the nonpreferred alternative.[32] “I want to store my firearm unloaded and locked in a gun safe to reduce my child’s risk of injury” versus “I don’t want to store my firearm unloaded and locked in a gun safe and don’t want to reduce my child’s risk of injury.” Like other firearm safety interventions, use of enhanced active choice would require stakeholder input into the wording and broader implementation to support, rather than undermine, the belief that individuals are making the safe choice for their households.

**CONCLUSIONS**

Although the field of public health has made great strides in reducing the number of childhood injury-related deaths, such as those caused by motor vehicle crashes and drownings, progress to date in preventing firearm-related deaths (specifically intentional injuries) has been more limited.[12] We believe that behavioral economic insights can contribute to injury prevention efforts. Implementation prompts, engaging in-group messengers, and increasing salience are 3 discrete strategies to promote safe firearm storage by addressing present bias; in-group, out-group bias; and the availability heuristic. Mental models, overconfidence effect, hot-cold empathy gap, optimism bias, information avoidance, and choice overload are other relevant behavioral constructs that may factor into the decision-making of parents who elect to keep firearms in the home. Although these behavioral constructs are supported by behavioral economic theory, 1 limitation is that they have not yet been studied empirically in the context of firearm storage. We also recognize that parental decision-making is complex, inevitably value laden, and not cleanly bounded by behavioral science.
We highlight these varied biases and heuristics to underscore that unsafe firearm storage may not be solely motivational in nature. Behavioral economic insights can contribute to the development of approaches that both set intentions and close the intention-to-action gap. By better understanding the individual behavioral levers that may impact decision-making around firearm storage, behavioral scientists, pediatric providers, and public health practitioners can partner to design tailored interventions specific to the most prominent biases within relevant subgroups, such as parents who may intend to safely store their firearms but require additional prompting. Strategies informed by behavioral economics may be particularly appealing to policymakers, who can implement firearm safety interventions as softer-touch nudges that reframe the focus on child safety instead of politics. Further empirical study is warranted to identify the presence of particular biases and heuristics and whether, and in which groups, specific strategies are effective.

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ABBREVIATION
AAP: American Academy of Pediatrics

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### Applying Behavioral Economics to Enhance Safe Firearm Storage

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