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Differences in belief-consistent and belief-inconsistent learning in traditional college students

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ABSTRACT

Beliefs, described as adaptive mechanisms that frame experiences and shield against problems or criticism, impact learning and behavior. With maturation, adolescents and emergent adults are increasingly able to learn information inconsistent with their perspective, analytically and with deliberation. We hypothesized that upper-division traditional college-aged students should be more effective learning belief-inconsistent information relative to first-year college students. In three studies comparing first-year and upper-class traditional college aged students, participants read information about political issues, rated their opinion, and answered questions about issues. Results indicated that older students learned information contrary to their perspective better than consistent information, whereas two studies showed that first-years demonstrated better learning of information consistent with their beliefs. This suggests older students have better ability to control analytical reasoning. Over the span of only a few years, young adults provided age-related behavioral evidence of more complex comprehension and thinking. Our data suggests that experience and/or maturation can decrease the restrictive filter beliefs may have on learning.

KEYWORDS: learning, beliefs, adolescence, emergent adults, political reasoning

The science of behavior analysis often addresses socially important difficulties in children, adolescents and adults' behaviors, studying factors that reliably influence actions and reasoning. Much emphasis is placed on trying to solve problems that create significant issues for living. Not all change involves managing problems, especially in the first two decades where children and adolescents are continuing to grow and develop. In trying to understand challenges of late adolescence and emerging adulthood, one common goal of education is to achieve complex, higher order thinking. Indeed even by middle childhood, inquiry and argument are essential to developing effective habits of mind, related to life-long learning (Kuhn, 2008). With maturation, adolescents show increased ability to process complex ideas (Kuhn, 2006; Piaget, 1957). Decades of research have consistently shown that adolescence brings marked improvements in basic cognitive processes and higher order reasoning, as well as increases in speed, capacity, and expertise (Kuhn, 2006; Steinberg, 2005). Improvements in thinking are more evident with factual content (Blanchard-Fields, 1986) as emotionally involving information is more difficult to integrate. Better behavioral evidence of thinking also occurs when information runs contrary to belief (Klaczynski & Narisimham, 1998). These developmental changes in learning and thought make understanding choices and behaviors more complex.

Over the last two decades imaging research has identified substantial changes occurring in the prefrontal cortical area during the time frame traditional college-age students begin university. Structural changes to brain provide a location for a range of behavior change and analysis (Schlinger, 2002). Between 17 and the early twenties (Giedd, et al., 1995; van der Molen & Molenaar, 1994) neural growth, pruning, and enhanced myelination all occur. Studies consistently find a non-linear reduction in gray matter coupled with a simultaneous increase in white matter in late adolescence and young adulthood (Blakemore & Choudbury, 2006). The decrease in gray matter is generally thought to reflect pruning of early adolescent synaptic proliferation—to remove unnecessary and unused synapses—refining neural communication. The white matter increase is presumed to improve efficiency, integration and regulation of cognitive and affective information. Additionally, while advancing into adulthood, individuals increasingly learn to control impulsive thoughts and drives (van den Bos, Westenberg, van Dijk & Crone, 2010). Indeed, many imaging studies have identified changes affecting areas in the brain regulating behavior and emotions and how we perceive and evaluate information (Paus et al., 1999). Blakemore and Choudhury (2006) speculated that adolescence ushers in a period of brain reorganization, where there is heightened sensitivity to cognitive and socially influenced experience and behavior.

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These structural changes set the stage for new possibilities particularly for emotionally engaging reasoning and behavior. Kunda (1990) explored how belief-motivated reasoning involves thinking about information consistent with one's beliefs, in ways that maintain and support those pre-existing beliefs. People often accept information consistent with their views while rejecting information contrary to perspective. Klaczynski and Narasimham (1998) found early adolescents dismissed evidence contrary to their religious views with analytic arguments. However, participants readily embraced supportive ideology with succinct and uncritical justifications. That is, ideas inconsistent with one's ideology were subjected to more rigorous scrutiny with more effortful deliberations. Similar patterns were found in adolescents' theories of homosexuality with theory-consistent and theory-inconsistent data (Kardash & Scholes, 1996). In a study comparing theories about beliefs and motivated reasoning biases, middle adolescents consistently demonstrated better reasoning than early adolescents, although biased thinking was similar (Klaczynski, 2000). This research underscores the necessity of considering beliefs, inherent theories and assumptions when trying to understand reasoning, at least for a substantial portion of Klaczynki's research sample. On the other hand, Klaczynski found that approximately one-third of his sample were more knowledge-driven and willing to push their personal theories to the side to consider evidence contrary to their perspective.

While there is work investigating early adolescence, it is difficult to find research exploring change in late adolescence (Steinberg, 2005). Further, in spite of the interesting possibilities suggested by imaging research, few studies have explored cognitive or behavioral concomitants. Thus, although there is solid evidence of structural change, changes in cognitive functioning and behavior have not been a focus of extensive investigation. Klaczynski and Cottrell (2004) suggested these structural changes should enhance one's ability to allocate resources. In discussing dual processes, they posited that this new structural foundation should enhance ability to intentionally engage effortful cognition, overriding automatic processes. Entertaining information consistent with one's ideas is likely to elicit automatic processing whereas considering information contrary to one's views normally promotes more analytic processing. Using analytic reasoning typically leads to rejecting evidence, especially with theory-inconsistent information due to cognitive dissonance mismatch. Essentially, Klaczynski and Cottrell suggested late adolescents have more control over whether or not they fully engage in critical thinking with the advent of this structural enhancement. While earlier development might have encouraged more focus on information that is readily available and consistent with one's knowledge, this increased biological substrate putatively provides the advantage of being able to more effectively engage information contrary to one's perspective, which requires more attention and effort. Taking a related tack, Kuhn (2006) noted the importance of increased intentionality and purposefulness as people develop better coordination of knowledge bases and more focused motivation to seek information and advance goals.

We compared learning performances on first-year and upper-class traditional-aged college students. We operationalized more complex learning by comparing belief-consistent and belief-inconsistent information, with the assumption that the latter requires more cognitive control and response inhibition. We were particularly interested in determining if there were differences in learning for belief-consistent and belief-inconsistent information, reasoning that, given the documented brain changes and experiences of college, advanced undergraduates should be more effective at dealing with more complex information (i.e., belief-inconsistent) relative to beginning undergraduates. To increase difficulty and tap into emotional regulation, we selected politically charged issues, of which most people have opinions. Because socio-political content is affectively charged for many people, it may trigger more automaticity and require more controlled processes and perhaps inhibition to override the initial reactivity (Klaczynski, 2004). Indeed Blanchard-Fields (1986) demonstrated that teens, young adults and middle-aged adults performed similarly when consolidating competing perspectives on neutrally-valenced issues. However, with issues that had more personal salience, such as an unplanned pregnancy, she found older (middle-aged) participants were more effective at balancing different points of view relative to young adults, who in turn were more effective than adolescents. Having the necessary cognitive resources to inhibit reactivity, along with a motivated interest in accuracy, should influence whether participants respond automatically or with greater intentionality.

Given the developmental change brought through experience and maturation in emergent adulthood, we might expect that younger college-aged participants, in comparison to older participants, would be more disadvantaged in a task that requires them to use controlled processes. Younger participants may have more difficulty selectively attending to relevant information, in part because they fail to inhibit their preferred response. They may also be less effective at learning and integrating content, especially when it is inconsistent with their beliefs. Here, beliefs reflect one's interpretation and response to environmental experiences and can be defined as behavioral phenomena that serve an adaptive function in helping us manage information or shield us from problems or criticism (Taylor & Brown, 1988). Beliefs also influence what information we attend to. When information differs from these interpretive frameworks, younger participants may be less effective in shifting from automatic to more controlled processing. Even in a traditional college sample, older college aged students may demonstrate more proficient comprehension of belief-inconsistent information from politically oriented vignettes, relative to younger college aged students.

Recognizing that if there were any differences between these closely related age groups they would be small, and variability between individuals would be great. We were concerned that individual differences would obscure subtle differences between groups. Individuals have different tendencies in how they structure their experiences to be meaningful; specifically, people vary in their disposition to evaluate and think (Cacioppo, Petty & Kao, 1984). Because willingness to comprehend politically oriented material might be affected by motivation for learning, we assessed interest in information seeking. We also were concerned about individual willingness to explore alternative perspectives. Closed mindedness may also impact how much effort would be expended on comprehending perspectives different from one's

own (Rokeach, 1954). As a consequence we also measured dogmatism, recognizing that political ideology is sometimes related to complexity in thinking (Tetlock, 1984).

» STUDY 1

Method

Participants. Seventy-four undergraduate students were recruited to participate from an introductory psychology class for course credit at a selective liberal arts college. Participants ranged from 17 to 24 years of age. A median split was used to divide our sample into two age groups, with the average age of our 43 younger participants being 18.64 (SD = 0.31) and 31 older participants' mean age was 20.77 (SD = 1.03, n = 31).

Materials

Dogmatism. Dogmatism has been described as a relatively closed system of beliefs about reality and absolute authority, which provides a framework for tolerance and intolerance of others (Rokeach, 1954). Behavior often labeled dogmatic is characterized by rigidity and inflexible methods of handling information, events, and people. We used the Trodahl and Powell (1965) 20-item dogmatism measure, where respondents rated how accurately each statement reflected their opinion on a 7-point Likert scale. A sample item representative of these items was "Most people just don't know what's good for them." Lower scores indicate more dogmatic styles.

Need for cognition. Need for cognition has been described as one's relative interest in engaging in thinking relative to an intuitive or experiential approach (Cacioppo & Petty, 1982). Behavior labeled as high need for cognition is characterized by more searching and attention to details and distinctions in categories. Cacioppo, Petty and Kao (1984) revised the original measure to 18-items, including statements such as "Thinking is not my idea of fun." Higher scores indicate more need for cognition.

Issue ratings. A brief description of a political issue was presented. After reading the description, participants answered three questions with Likert scales. The first question was (1) how much they agreed or disagreed with the issue (1 = high disagreement; 7 = high agreement), which we labeled 'belief.' The remaining questions asked (2) how important the issue was to them (0 = not important; 3 = very important), and (3) how much prior knowledge they felt they had about the issue (0 = low prior knowledge; 3 = high prior knowledge).

Eight political issues. Eight 250-word positions were written describing topical political issues. These vignettes covered an array of topics receiving media coverage in 2008, including presidential powers, health care reform, and immigration. Content included information and data that was not well known, and presumed to not already be known by participants. Half of the vignettes were written from a traditionally liberal viewpoint, half were written from a traditionally conservative viewpoint based on concepts discussed in newspapers and publications at that time (e.g., *Wall Street Journal, New Republic*). A variety of professionals representing both ends of the political spectrum provided feedback and suggestions to maximize the appearance of reasonability and even-handedness regarding the persuasive content of the vignettes.

Assessment questions. Five free response questions were used to assess information described in each vignette as a measure of comprehension. It was unlikely that participants could answer these questions without reading the vignettes.

Procedure

After providing informed consent, participants completed two pre-test assessment measures, a need for cognition scale and a dogmatism scale. Participants sat in front of a computer, presented with descriptions of eight political issues. Participants were asked to rate each issue on three descriptive questions. Participants were then presented with a series of eight vignettes, presented in a randomized and counterbalanced order. Comprehension was assessed after all vignettes were presented.

Learning assessment. After participants had read all vignettes, a series of follow-up free response questions were displayed. For example, after reading the vignette focused on presidential powers, participants typed in responses to questions such as "Besides the Constitution, what other documentation by the Founding Fathers supports the executive branch's power? How does this policy provide flexibility for governance?"

Data coding. Raters coded individual responses to follow-up questions on a 0 to 4 point scale, with higher numbers representing better quality, more inclusive answers, that incorporated material presented in each vignette. The first author created a scoring codebook with conceptual examples of five levels of performance and detailed descriptions of representative answers particular to each vignette. A total of five undergraduates were trained and two raters were assigned to score items from each of the vignettes. Coding responses were compared with κ. Rater reliability was good, with an inter-rater agreement of 0.81 (Landis & Koch, 1977); disagreements were resolved through discussion between raters. Scores from all items assessing a particular vignette were summed, divided by the number of items and converted to a percentage.

We were interested in comparing comprehension of issues most strongly consistent and most strongly inconsistent with each participant's beliefs. As it would be expected, participants found different issues more or less compelling. Participants' initial rating of their perspective was used as the criteria. That is, the most extreme rated vignettes (strongest agreement, strongest disagreement) represented the most positive and negative issues for that individual and their respective learning score on that particular vignette was entered as a dependent variable. All extreme issues were also rated as having importance. Rated importance was also considered, but as a check to be certain the respondent viewed the issue as salient. After determining the appropriate issues for each participant (based on their rating), a *learning assessment score* (LA) was created which represented their percent correct score for that issue. This involved summing up scores for each item assessing that vignette, so that a maximum score of 20 points was possible (5 questions × 4 points), which was then converted to percent correct. Overall percent correct was initially used to look at comprehension of the eight issues. When agreement and importance ratings were identical on more than one issue, the vignettes' performances were averaged to create the LA, which was used as the dependent variable.

Table 1. mean ratings of political commentary descriptors

	correct %		rating		importance			
issue	*M*	*SD*	*M*	*SD*	*M*	*SD*	knowledgeability	time
estate taxation*	67.67	18.31	5.60	1.39	1.29	0.75	0.57	93.871
assisted suicide*	58.94	15.89	4.02	2.12	2.03	0.67	1.22	65.186
stem cell*	52.76	19.58	3.48	2.08	2.31	0.78	1.31	102.36
environmental protection	56.90	16.99	5.14	1.59	2.36	0.81	1.26	80.734
presidential powers*	53.13	19.70	3.52	1.82	1.86	0.81	1.17	83.240
health reform	32.87	18.86	5.38	1.12	2.26	0.72	0.91	113.85
immigration	47.24	16.17	5.19	1.59	2.05	0.66	1.16	91.464
affirmative action	58.30	15.15	4.50	1.74	1.79	0.77	1.34	81.437

Note: Personal ratings ranged on a Likert scale from 1 (strongly disagree) to 7 (strongly agree). Personal ratings of issue importance ranged from 0 (not important) to 3 (very important). Ratings of knowledgeability on each issue ranged from 0 (not informed) to 3 (very informed). Time spent on each issue was recorded in seconds. *Vignette content conveyed a more traditional, conservative perspective. The non-asterisked vignettes were framed from a progressive, liberal stance.

Two learning assessment scores were created: *LA-A (agree) and LA-D (disagree).* The former represented learning about 1) the issue with which a given participant reported was most consistent with belief (most strongly agreed issue, LA-A) and 2) a second issue which was most inconsistent with belief (most strongly disagreed issue, LA-D). Dependent variables (LA-A, LA-D) were distinct for participants, and were based on their stated position on vignette issues they most strongly agreed, or disagreed with. As described in the previous paragraph, a maximum score of 20 was converted to a LA-A and LA-D percentage. Because of individual vignette variations in quality of responses to follow-up questions, performance scores were converted to *z*-scores. This method allowed comparison of performance on issues most consistent and most inconsistent with their personal beliefs.

Results

There was considerable diversity of opinion on the issues we targeted. Estate tax, assisted suicide, presidential powers, and stem cell research funding were framed from a conservative point of view whereas affirmative action, environmental protection, health reform and immigration reform were framed from a liberal point of view. There was a very limited range of ratings about pre-existing knowledge, with participants being least knowledgeable about estate tax laws ($M = 0.49$; $SD = 0.55$) and most knowledgeable about stem cell technology ($M = 1.3$; $SD = 0.61$), with an average informed rate of 1.05 ($SD = 0.42$). Health reform was the most poorly understood issue although more time was spent trying to comprehend its content than any other issue. The taxation issue was best understood although participants studied it an average amount of time. See Table 1 for additional information.

To assess whether type of content was handled differently with increased age, we used a mixed ANOVA design with age (first-years, seniors) as a between subjects factor and belief (LA-A; LA-D) as a within subjects factor. We found a main effect for age, $F(1, 64) = 6.96$, $MSE = 0.9498$, $p = 0.011$, $\eta_p^2 = 0.09$, with older students performing better than younger students. We also found an interaction between age × belief, $F(1, 64) = 6.00$, $MSE = 3.26$, $p = 0.0171$, $\eta_p^2 = 0.09$, such that younger participants substantially improved when challenged with content inconsistent with their beliefs. Nevertheless, older participants were more effective with both belief-consistent and especially belief-inconsistent content. Comparing time spent on task, the groups were similar, $F(1, 73) = 1.48$, $p = 0.23$.

There were differences between older and younger participants in terms of need for cognition, $t(68.94) = 2.43$, $p = 0.01$, $d = 0.55$, with older respondents indicating a higher need for cognition ($M = 90.31$, $SD = 9.67$) than younger respondents ($M = 83.58$, $SD = 13.67$). Partitioning need for cognition into three levels (high, medium, low) also yielded differences in overall learning performance, with individuals with higher need for cognition showing better comprehension, $F(2, 64) = 2.97$, $MSE = 0.366$, $p = 0.05$, $\eta_p^2 = 0.09$. Level of dogmatism also differed between groups, $t(66.712) = 2.18$, $p = 0.03$, $d = 0.49$, with younger participants averaging lower scores ($M = 74.21$, $SD = 10.92$) relative to older participants ($M = 78.92$, $SD = 7.00$), suggesting less flexibility in younger participants' values. Learning performance did not differ between median-split groups of high and low dogmatism. Both groups learned equally content consistent and inconsistent with their reported belief ($F(1, 65) = 0.22$, $p = 0.64$). See Table 2 for additional information.

Discussion

As suggested by Klaczynski (2004), our data show that older college students were better able to respond to questions about information that was contrary to their own point of view. Older respondents demonstrated better learning of contrary information, relative to information congruent with their pre-existing perspectives, and as compared to younger participants. Also, younger students benefited more from the incongruent information relative to information consistent with their beliefs. Perhaps as Klaczynski has repeatedly suggested, belief-incongruent content is generally more engaging at least in the case of motivated emergent adults who have chosen a liberal arts environment for study. While these results were promising, we were interested in developing a more strategic upper-class (junior/senior) sample, as opposed to simply studying people finishing their general education classes in introductory psychology. Also, we were concerned about the amount of time required to complete the survey and respondent fatigue, so the number of vignettes was reduced to six. (Selecting

Table 2. descriptive information about primary measures

group	age	total %	*SD*	belief-con	*SD*	belief-inc	*SD*	dogma	*SD*	needcog	*SD*
younger	18.6	49.26	13.66	41.96	24.24	49.19	23.84	74.21	10.92	83.57	13.67
older	20.8	55.46	13.92	49.70	25.73	54.72	24.86	78.92	7.02	90.31	9.670

which vignettes to exclude also reflected a change in government stem cell policy and lower perceived importance of tax reform.) Two additional questions were added to better assess learning of each vignette. Study 2 repeated the procedures used in Study 1, except it included fewer (six) vignettes, two additional questions per vignette, and we specifically recruited upper-class students and first-years for our sample. As before, vignettes were presented to participants in a randomized and counter-balanced order and all questions pertaining to a vignette were grouped together.

» STUDY 2

Method

Participants

Eighty-three college undergraduates volunteered to participate in a psychology study for course credit at the same liberal arts institution. Participants were drawn from undergraduate psychology courses and upper-division seminar courses. Although efforts were made to make each vignette plausible and reasonable, participants had to show variability in beliefs to provide data for analyses. Those who had little or no range in agreement ratings were omitted. That is, respondents had to have at least three different ratings across all six vignettes to meet criteria for inclusion so that a belief-consistent (positive) and belief-inconsistent (negative) issue could be contrasted (from a middle or neutral agreement rating). Additionally, because some subjects did not demonstrate the willingness to read, think and provide thoughtful responses critical in this study, we dropped participants whose overall performance was poor ($z < -1.5$). Removing unmotivated participants and those without opinions left 36 younger students ($M = 18.6$, $SD = 0.31$) and 17 older students ($M = 21.2$, $SD = 0.98$) in the sample. Since we were focused on learning, omitting those who chose not to engage in this demanding task was both reasonable and necessary to test our hypothesis.

Measures and procedure

After participants had read all the vignettes, a series of follow-up free response assessment questions were asked (seven questions per vignette). As before, agreement rating was used to determine which vignettes' scores were used to represent the independent variable of belief, with belief-consistent (agree) and belief-inconsistent (disagree) providing the two levels of comparison. If more than one issue was rated extremely, importance ratings discriminated which vignettes' performance was used. In the case of equal issue ratings (agreement and importance), percent correct was averaged across the appropriate vignettes.

Learning assessment

As before, using an updated and substantially revised scoring codebook, raters coded responses from 0 to 4, with higher numbers representing better quality, more inclusive answers. Rater reliability was acceptable, $\kappa = 0.84$ and disagreements were resolved through rater discussion. Once the belief-consistent and belief-inconsistent issues were determined, that vignette's items were summed, divided by the number of items and converted to a percentage.These percentages, LA-A, and LA-D, were treated as dependent variables and converted into *z*-scores.

Results

To assess the relationship between belief, age and performance, we conducted a repeated measures ANOVA with age (2: first-years, upper-class students) as a between subjects factor and belief (2: LA-A; LA-D) as a within subjects factor. This revealed an belief × age interaction ($F(1, 40) = 3.97$, $MSE = 3.08$, $p < 0.05$, $\eta_p^2 = 0.09$). First year students performed similarly on content that was consistent with their perspective whereas more advanced students' performance was relatively higher when answering questions based on vignettes with which they disagreed. Younger students performed similarly on both types of content but older students were more effective with information inconsistent with their perspective. Interestingly, this suggests that approximately two and one-half extra years of experience may help motivated performers direct their attention to content that requires more effort to comprehend. In comparing time spent on task, the older group spent significantly less time on task, $F(1, 40) = 10.25$, $p < 0.05$, $\eta_p^2 = 0.19$ although no statistical difference was identified between the time spent on belief-consistent information as compared to the belief-inconsistent information.

Because of concerns about other individual differences between groups, dogmatism and need for cognition were also assessed and evaluated. The repeated measures ANOVA was evaluated with dogmatism and need for cognition as covariates. Neither of these measures differed in this sample of younger and older college participants, nor did these measures of individual differences affect learning performance. Table 3 presents additional descriptive information contrasting the two age groups.

Discussion

As suggested by other researchers' data and theorizing (Klaczinski, 2000; 2004; Klaczinski & Cottrell, 2004; Kuhn & Pease, 2006), first-year students were more proficient learning content that was consistent with their perspective and easier to cognitively digest. Content that was belief-inconsistent was handled more effectively by more advanced students. There was no main effect for age in this sample.

This study provides behavioral evidence of more effortful learning in traditional upper-class undergraduates relative to their first-year peers on belief-inconsistent information. Differences emerged such that slightly older undergraduates handled content contrary to their perspectives better than content congruent with their beliefs and much better than first-years. In contrast, first years learned most effectively information consistent with their personal beliefs. Other individual difference measures did not consistently predict performance, pointing to the critical nature of motivation and effort as Kuhn (2006) underscores.

Table 3. subject variables and belief-consistent and belief-inconsistent *z*-scores (*SD*)

group	belief-con	time	belief-inc	time	dogma	need cog
younger	0.033 (0.94)	101.6 (37.26)	0.02 (0.87)	94.57 (45.22)	75.54 (8.56)	71.43 (5.61)
older	0.140 (1.10)	80.86 (34.13)	0.26 (0.78)	75.51 (31.74)	78.20 (10.4)	71.19 (6.28)

Although impossible to separate experiential learning (which we believe college provides) from maturation, our findings provide evidence for cognitive advancements that fit with biological changes reported by others (Blakemore & Choudury, 2006; Giedd et al., 1995; Giedd et al., 1999; Paus, et al., 1999). Data from study 2 also found more complex thinking in a relatively homogeneous traditional college-aged sample comparing young and slightly older students.

Study 3 utilized similar materials and procedures. In this study we added a political party affiliation item to our demographic questions. Because both working memory and verbal comprehension could mediate relationships previously seen between age and belief-based learning, a working memory measure, and a verbal intelligence measure were added. As well, there may have been valence-specific processes which were engaged due to the emotional nature of the content in the vignettes (i.e., strong beliefs, both in agreement and disagreement). Neutrally-rated issues might engage differential learning processes or differential motivation to spend time and energy reading and answering questions about specific issues, so in study 3 we planned to compare the most neutral issue with those issues that elicited the strongest opinions. Dogmatism and need for cognition scales were omitted since they were ineffective in study 2.

Research indicates that conceptual content should be more accessible to more mature learners (Chapman, Gamino, & Mudar, 2012; Kuhn, 2006). We varied type of question (factual/conceptual) with at least 3 conceptual and 3 factual questions assessing learning about an issue. After determining which issues best characterized belief-consistent, belief-neutral, and belief-inconsistent perspectives for a given individual, we separated factual and conceptual items to assess whether conceptual content was better handled by older students.

» STUDY 3

Method

Participants

One-hundred and five college students participated in this study to complete course requirements, however eighteen participants were excluded from the analysis because they failed to complete the task satisfactorily using criteria from study 2 (z-score for total performance < −1.5). Younger students (n = 42; M = 18.9, SD = 0.6) were recruited from a student pool made up of introductory psychology students, and older students (n = 45; M = 21.5, SD = 0.7) were recruited from upper-division courses. In both instances participants received class credit. Forty-seven percent self-identified as Democrats, 14% as Republicans, 10% as Independents, 5% marked Other and 24% claimed no party affiliation.

Additional material

N-back test of working memory capacity. In the n-back test of working memory a test trial was included to familiarize participants with the procedure. Participants were presented with a series of words and were told that they would have to type when a word was presented "n" words prior to the current word. This task involved keeping a running list of words "in mind" in order to check current word presentation against prior word presentation. For example, a participant completing a 2-back task would signal a response on the second presentation of the word "flower" in the four-word series block-***flower***-computer-flower. Following the trial test, participants encountered four series of 20 words presented in serial order. For the first two word sets participants were instructed to indicate when a word was presented "2-back", whereas participants were instructed to indicate when a word was presented "3-back" for the latter two word sets. To reduce the possibility that visual representations of the words would enhance n-back performance, words similar in meaning were selected using Thesaurus.com and all words were verbs. N-back task performance was assessed using three variables; (1) the number of correct responses, (2) errors of commission (false response), and (3) errors of omission (no response).

Quick test (verbal intelligence measure; Ammons & Ammons, 1962). This vocabulary measure involves reading a vocabulary word and clicking on one of four pictures which best represents the concept. After three consecutive misses, the measure ends; otherwise, there are 24 possible matching items.

Procedure

As in study 1 and 2, after providing consent, participants rated their belief towards a variety of political issues & rated their existing knowledge and interest. Participants then responded to the n-back working memory test. Next, participants read six political perspectives presented in randomized and counterbalanced order on a computer screen. After completing these measures, participants were asked factual and conceptual follow-up questions on each political perspective. After responding to the follow-up questions, the Quick Test verbal intelligence measure was presented.

As in the previous studies when measuring the follow-up questions, raters coded responses on a 0 to 4. Higher numbers represented better quality, more inclusive answers, that incorporated material presented in each vignette. In addition to comparing belief-consistent and belief-inconsistent performance, we also included performance on the issue rated most neutral and at least of some importance. Inter-item consistency within political perspective was reasonable (κ = 0.81), so items were separated into percent of factual content that was correct and percent of conceptual content that was correct. Percent correct scores were sorted by belief (agree, disagree, neutral) and converted into z-scores.

Results

To assess the relationship between belief and age, a repeated measures ANOVA with age (2: first-years, upper-class undergraduates) as a between subjects factor and belief (3: LA-A; LA-D; LA-N) and Content (2: factual, conceptual) as within subjects factors. Using the n-back commission score as a covariate, there was an interaction between belief × age, $F(2, 83) = 3.15$, $MSE = 2.10$. $p = 0.05$, $\eta_p^2 = 0.05$. First-years did relatively better on content that fit with their perspectives, whereas upper-class students did better on content contrary to their point of view. Contrary to Kuhn and Pease (2006), conceptual content was not differentially remembered in this content comparison nor were there other interactions. Only the commission working memory measure was an effective covariate in this analysis.

Table 4. descriptive statistics and *z*-score learning averages by group

group	belief-con	belief-neu	belief-inc	verbal IQ	*N*-back correct	*N*-back omiss	*N*-back commis
younger	–0.11 (0.92)	–0.27 (0.94)	–0.18 (1.01)	15.31 (2.60)	18.68 (2.73)	7.44 (2.65)	2.31 (2.31)
older	0.33 (0.98)	0.01 (1.07)	0.41 (0.87)	17.51 (2.68)	16.82 (2.41)	8.26 (2.36)	2.00 (2.05)

In a secondary analysis of age groups, *t*-tests were used to compare age groups. Older students scored higher on verbal intelligence, $t(85) = -2.40$, $p = 0.02$ while younger students scored higher on *n*-back hits, $t(85) = 2.69$, $p = 0.01$. *N*-back omission rates also differed, $t(85) = -2.56$, $p = 0.01$ with older students having more errors. Errors of commission were similar for both groups.

Discussion

Similar to study 2, study 3 also found younger students did more poorly on content that was contrary to their opinion relative to belief-consistent information, whereas older students consistently did better on content that was contrary to their perspective. Neutral content was handled relatively similarly to agreed-with content for first years, but was remembered least well by older students. This difference in handling neutral information suggests interest in any particular issue is central to performance, especially for upper-class students.

Working memory showed little relationship to political issue learning. Only one of three *n*-back measures was predictive of learning performance. It is not clear why commission mattered but it could be interpreted as an indication of whether or not working memory was fully deployed to the task at hand. In general there are several indicators that the older students were less engaged in the task (e.g., incomplete responses to questions, *n*-back hits, *n*-back omissions). On the other hand, perhaps this would be expected given the relatively homogeneous group of participants, particularly when poor performers were removed from the sample.

While we expected that factual content would be easier to remember and would be more easily recalled by both age groups, our operationalization of factual content did not yield age differences. As well, it was expected that conceptual content would be better processed by older students, and this too, did not appear to exert significant influence on learning ability. The failure to find a difference in performance was likely due to insufficient distinctions in these divisions with our questions. Contrary content once again inspired better performance from slightly older students even though they did not demonstrate better working memory relative to their marginally younger counterparts.

Although it is not possible to separate experiential learning from maturation, our findings are suggestive that at least experiential advances are associated with more complex thinking in a relatively homogeneous traditional college-aged sample. As developmental scholars increasingly embrace the notion of emergent adulthood, these changing potentials highlight the distinctiveness of this time frame and the importance of systematic developmental study (Arnett, 2000).

» GENERAL DISCUSSION AND SUMMARY

In three studies exploring learning about emotionally-charged political information in traditional college-aged students, we found that first-years and upper-class undergraduates differed in the kind of content they learned best. Our inquiry was inspired by the structural changes in brain identified in young adults that should result in improved ability to self-regulate, monitor, and decide whether or not to allocate additional resources to comprehending effortful content. We created tasks that we hoped would correspond to skills that emanate putatively from these structural changes. As suggested by developmental researchers using imaging technologies, we found that slightly older traditionally-age college students had the potential to be more effective at dealing with political information contrary to their opinion, relative to younger students.

While using college students as a prototype for adult cognition and behavior is generally recognized as problematic, substantial developmental milestones occur during the time frame of college years. Imagery-identified brain changes during these periods make it even more important to reconsider sampling issues based on age (i.e. first year students vs. more advanced students), in addition to generalizability to adult samples. It is more than a bit ironic that college students have provided samples for many advances in psychological knowledge and yet it is difficult to find any behavioral or cognitive data comparing development or maturational changes during this time frame. There are several reasons for this. Of course, one reason is that no one looked—for many decades the assumption was that the brain was more or less fully developed in adolescence with only informational and experiential updates. The other issue is that even if behavioral and development changes were scrutinized, there is so much variation within a group of individuals that it is difficult to sift through. These issues are further amplified by participant interest in optimizing performance, especially when tasks are difficult and require substantial cognitive resources. Additionally, performances on difficult tasks are especially affected by many other situational variables. Indeed, one might reasonably expect to find small but predictable developmental differences only on more challenging tasks.

In a younger adolescent sample, Klaczynski (2000) found three common patterns in the paradigm he used to study how pre-existing beliefs might affect reasoning in younger adolescents. Some adolescents were biased towards groups to which they were affiliated, others were biased towards groups to which they were *not* affiliated, and a third group's interest in knowledge superseded commitment to a particular belief. Except for this knowledge-based group, Klaczynski (2000) stated that identifying patterns in reasoning was highly dependent on knowing adolescents' assumptions and beliefs. Consistent with Kuhn's and

Klaczynski's theorizing, our data suggest that maturation might increase the likelihood of people choosing to consider evidence from an analytical perspective, especially when it runs contrary to their existing perspective. While individual differences might seem important, in terms of preferences, approaches, values, intelligence (Stanovich & West, 1997) and scientific reasoning competence (Klaczynski, 2000), these factors did not appear to be a consistent predictor of learning outcomes. Additionally, political issues are not of interest to everyone, and this is particularly true for many emergent adults. Longitudinal data or more homogenous samples may provide a better assessment of how belief-consistent and inconsistent information is handled.

Consistent with Kuhn's and Klaczynski's theorizing, our data suggest that maturation might increase the likelihood of people choosing to analytically consider evidence, especially when it is contrary to their existing perspective. While individual differences might seem important, in terms of preferences, approaches, values, intelligence (Stanovich & West, 1997) and scientific reasoning competence (Klaczynski, 2000), these factors did not provide a consistent predictor of learning outcomes. Additionally, political issues are not of interest to everyone, and this is particularly true for many emergent adults. Longitudinal data or more homogenous samples should provide a better assessment of how belief-consistent and inconsistent information is handled.

One limitation of this study is that it requires participants to work. The effect does not consistently occur without attention to the task. We recognize there may be other salient parameters as well, but motivation is key, as Kuhn (2006) notes. Second, the results could be driven more by experiential factors associated with advancement though a rigorous college curriculum than by neurodevelopment. It seems likely that the experience of attending college enhances one's ability to deal with contradictory information simply through a practice effect. To further explore this possibility, it would be necessary to include a sample of similarly aged participants who had little post-secondary education but were also highly motivated to learn.

It is also useful to consider age-independent effects (i.e. practice effect) that might be associated with attending college. There likely exists an interaction between age and the experiential factors associated with the college curriculum. Akin to visual development, there could be certain specific inputs that are required while the brain is in a "critical" developmental period. Given that substantial plasticity exists in the prefrontal cortex of developing young adults, the college experience could provide the necessary input that might foster further development of prefrontal circuits involved in emotion inhibition and learning. The cumulative action of all of these factors might culminate in older college students performing better on tasks that require them to attend to information contrary to their own opinion.

We believe this information could be utilized by those in the business of training, persuasion, or education. For instructors designing college curricula, it could be utilized to shape content presentation. While the lower- and upper-division course distinction already informally recognizes these developmental learning changes in young adults, an argument can be made for introducing belief-inconsistent information earlier. The way information is framed could theoretically make those in lower-division classes more effective at learning belief-inconsistent information and more engaged in taking apart weak arguments or poorly constructed evidence. Even though belief-inconsistent information is not as well attended to by these younger students, framing belief-inconsistent information in a way that is more congruent with existing beliefs could facilitate learning and critical thinking skills.

The implications for how adolescents handle information contrary to belief, are suggestive. Younger people are more likely to disregard belief-inconsistent information, instead selectively attending to information that is consistent with their existing beliefs. Individual differences in working memory, verbal intelligence, need for cognition and dogmatism did not explain these learning performances. Unfortunately, disregarding contrary information can lead to errors in reasoning and decision-making, resulting in less-than optimum behaviors. Emerging adults, on the other hand, are better equipped to navigate contrary opinions and information, thus making better choices possible.

Additional attention should be focused on behavior and thinking during this critical age where young adults are emerging as new, and increasingly influential members of society. Cross-sectional comparisons here yielded small differences whereas longitudinal data, especially when paired with imaging research, would be more illuminating. Decision making involves two different yet related cognitive processes—information search and information integration. After information is perceived and learned, it must be interpreted and either integrated into an existing belief, or discounted. In research on intelligence tests, Frey (1981) found that some participants engaged in compensatory behavior—changing self-judgments due to belief-incongruent information—as an alternative to confirmation bias. While Frey (1981) explained this phenomenon as a way to avoid cognitive dissonance, it can also be seen as integrating conflicting information into a new or existing belief.

Our research focused on navigating and learning belief-consistent and belief-inconsistent information in late adolescence and emergent adulthood. While increased maturation does not necessarily mean more effortful processing will be chosen, experience and identified structural change (e.g., Giedd et al., 1995; 1999) makes the opportunity for critical thinking more available. Given individual differences, some individuals will choose to bypass thinking and respond automatically, but others will decide to navigate the flow of contrary information, thereby increasing the likelihood of an optimized choice and behavior. ■

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