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Neural sensitivity to conflicting attitudes supports greater conformity toward positive over negative influence in early adolescence

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A B S T R A C T

Adolescents often need to reconcile discrepancies between their own attitudes and those of their parents and peers, but the social contexts under which adolescents conform to the attitudes of others, or the neurocognitive processes underlying decisions to conform, remain unexplored. This fMRI study assessed the extent to which early adolescents ($n = 39$, ages 12–14) conform to their parents' and peers' conflicting attitudes toward different types of behavior (unconstructive and constructive) and in response to different types of influence (negative and positive). Overall, adolescents exhibited low rates of conformity, sticking with their pre-existing attitudes 65 % of the time. When they did conform, adolescents were more likely to conform to their peers' attitudes towards constructive than unconstructive behaviors, exhibiting decreased activation in the ventromedial prefrontal cortex, dorsal anterior cingulate cortex, insula, and inferior frontal gyrus during peer conformity toward constructive over unconstructive behaviors. Adolescents were also more likely to conform when their parents and peers endorsed relatively more positive influence than negative influence, exhibiting increased activation in the temporoparietal junction when considering conforming to negative over positive influence. These results highlight early adolescents' ability to stick with their own opinions when confronted with opposing attitudes and conform selectively based on the social context.

1. Introduction

Learning how to balance being themselves and fitting in with their social group can be particularly challenging during adolescence, a developmental period during which the need to establish a unique identity coincides with the desire to find belonging within social groups (Steinberg and Monahan, 2007; Steinberg and Silverberg, 1986). What determines if and when adolescents resist or conform to social pressures? When there are potential conflicts between their own and others' opinions, adolescents may need to weigh the decision to stick with their pre-existing attitudes (i.e., resist) against the potentially beneficial effects of shifting their attitudes toward group norms (i.e., conform) (Deutsch and Gerard, 1955). When they do conform, adolescents are highly attuned to the social context in which social influence unfolds, flexibly shifting their attitudes toward the person or behavior that is most salient for that decision context (Biddle et al., 1980; van Hoorn et al., 2014). Parents and peers are two important sources of influence that shape everyday attitudes and behaviors during adolescence, but their relative influence changes based on both external factors (e.g., type of behavior at hand) (Brittain, 1963; Sebald and White, 1980) and internal factors (e.g., personal values toward a behavior) (Padilla-Walker and Carlo, 2007). What remains unknown, however, is the underlying neurocognitive processes that guide decisions to conform across different social contexts, particularly when adolescents are confronted with parent and peer opinions that differ from their own.

Prevailing conceptions of adolescence suggest conformity is monolithic and unidimensional, such that youth will be excessively susceptible, particularly to negative influences from their peers (DiGuiseppi et al., 2018; Munoz Centifanti et al., 2014; Sumter et al., 2009). However, this perspective may be oversimplified because prior research has mostly examined social influence in isolation, focusing on only one type of influence or type of behavior (Choukas-Bradley et al., 2015; Knoll et al., 2015; Widman et al., 2016). In addition, the absence or attenuation of unconstructive behaviors (e.g., less reckless driving) is often conflated with the positive effects of social influence, such as the encouragement of constructive behaviors (e.g., driving safely in peer contexts) (Cascio et al., 2015a), with few studies comparing social influence on both constructive and unconstructive behaviors (but see

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Berndt, 1979). This constrains our ability to assess how conformity decisions unfold across a wide range of social contexts, thereby perpetuating negative stereotypes of adolescence that may inadvertently shape future attitudes and behaviors (Qu et al., 2020).

Value-based decision making models provide a useful conceptual framework for understanding how conformity decisions may be driven by neural signals that encode the motivational value of various stimuli from the environment (Falk and Scholz, 2018; Pfeifer and Berkman, 2018). The brain's valuation system, which includes the ventromedial and orbital subregions of the prefrontal cortex (vmPFC, OFC) and striatum, has been hypothesized to compute the subjective value of possible choices before determining the most valued option to enact in a given context (Bartra et al., 2013; Clithero and Rangel, 2014). Insofar as the decision to conform represents a value-based choice, the relative value of a set of choices (e.g., conform or resist) is compared before selecting the choice that is most valued and consistent with the goal at hand. Indeed, increased activity of the ventral striatum and OFC is associated with greater value-guided choices in adolescents relative to adults (Barkley-Levenson and Galvan, 2014) and predicts the extent to which adolescents adopt others' attitudes as their own (Cascio et al., 2015a, 2015b; Welborn et al., 2015). Importantly, such value-based computations vary across individuals and social contexts.

The extent to which social information from others is salient to an individual's self-interests and social goals can change the value of conformity decisions (Falk and Scholz, 2018). Indeed, a recent meta-analysis found that decision making in social contexts not only robustly recruits the vmPFC and ventral striatum, but also the dorsomedial PFC (dmPFC), dorsal anterior cingulate cortex (dACC), insula/inferior frontal gyrus (IFG), and, depending on the social context, other regions implicated in social cognition (e.g., temporoparietal junction (TPJ), posterior superior temporal sulcus (pSTS)) (van Hoorn et al., 2019). The so-called mentalizing brain network, which includes the dmPFC, TPJ, and pSTS, is involved in simulating the mental states of others (Dufour et al., 2013), with individual differences in TPJ and pSTS activation positively associated with adolescents' susceptibility to peer influence across social contexts (Cascio et al., 2015b; van Hoorn et al., 2016). The insula, dACC, and IFG are commonly involved in encoding the salience of internal and external cues that motivate and regulate behavior (Menon and Uddin, 2010), including monitoring cognitive inconsistencies between one's own and others' choices (Apps et al., 2016; Izuma, 2013). For example, dACC activity increases when individuals' opinions conflict with the group opinion, which predicts subsequent adjustment of behavior (Berns et al., 2005; Klucharev et al., 2009). Collectively, neural processes related to valuation, mentalizing, and salience monitoring may support how adolescents balance self- and social-relevant considerations during conformity decisions.

2. Current study

The aim of the current study was to examine how conformity decisions are evaluated in the developing brain and unfold across social contexts, particularly when adolescents' own opinions conflict with the opinions of their parents, peers, or both. We focus on early adolescence (12–14 years), a developmental period marked by increased susceptibility to both antisocial and prosocial influence (Foulkes et al., 2018; Knoll et al., 2017), significant changes in the salience of parent and peer relationships (Steinberg and Silverberg, 1986), and a social reorientation of the brain that renders social contexts particularly salient (Blakemore and Mills, 2014; Nelson et al., 2016). To probe the neurocognitive processes underlying decisions to conform toward conflicting influence, early adolescents completed an experimental task during a functional magnetic resonance imaging (fMRI) scan, in which they were shown parent and peer attitudes that conflicted with their own attitudes and were instructed to indicate who they agree with. We manipulated the social influence in two ways so that we could examine whether participants conform (1) to their parents' or peers' attitudes toward constructive (e.g., working hard in school) versus (vs.) unconstructive (e.g., smoking a cigarette) behaviors and (2) when their parents and peers endorsed attitudes that reflected relatively more positive influence (e.g., rating "smoking a cigarette" as more "bad" than the participant) vs. negative influence (e.g., rating "smoking a cigarette" as more "good" than the participant). By measuring conformity across different types of behavior (i.e., constructive and unconstructive) and types of influence (i.e., positive and negative), we thus were able to capture how conformity unfolds across varying social contexts, particularly when adolescents were confronted with conflicting influences from their parents and peers.

Prior research suggests that the extent to which adolescents conform to parent or peer influences depends on the social context (Brittain, 1963; Sebald and White, 1980). For instance, one study found that adolescents increase their prosocial behavior following prosocial peer feedback and decrease their prosocial behavior following antisocial peer feedback (van Hoorn et al., 2014). However, less is known about how adolescent conformity is affected when different types of behaviors or influences are pitted against each other. Thus, while we hypothesized that parent and peer conformity would differ between the types of behavior (i.e., constructive and unconstructive) and types of influence (i.e., positive and negative), we did not have predictions regarding the directionality of these behavioral effects. Given neural evidence in adolescents (Cascio et al., 2015b; Welborn et al., 2015) and adults (Klucharev et al., 2009) suggesting conformity may be a type of value-based decision, we hypothesized that greater conformity to a specific behavior or influence type would be supported by increased activity in neural regions associated with valuation (e.g., vmPFC, OFC, VS), mentalizing (dmPFC, TPJ, pSTS), and salience monitoring (e.g., dACC, insula, IFG).

In addition to our primary focus on context-dependent differences in conformity rates, we explored the relative influence of parents vs. peers, particularly when both endorsed attitudes that conflicted with adolescents' attitudes. The handful of studies that have compared parent and peer influence during adolescence have yielded inconsistent findings, with reports of no differences (Chassin et al., 1986; van Hoorn et al., 2018) or one source outweighing the other, for unconstructive behaviors (Cook et al., 2009; Sawyer and Stevenson, 2008) and constructive behaviors (Malonda et al., 2019) alike. To investigate how adolescents reconcile opposing attitudes from both their parents and peers, we leveraged our unique study design to explore whether there were differences in overall rates of conformity toward parents' or peers' conflicting attitudes at the behavioral and neural level. Since we examined conformity decisions across different social contexts (i.e., types of behavior and influence), we did not have a priori hypotheses about whether parents or peers would exert a stronger influence on adolescent attitudes overall. Similar to the neural hypotheses above, we expected that conformity to a specific person would be positively associated with neural activity in valuation-, mentalizing- and salience monitoring-related brain regions.

3. Material and methods

3.1. Participants

A total of 44 adolescents and their parents was recruited from a Midwestern community in the United States, but five participants were excluded: 2 had technical errors, 1 did not comply with task instructions, 1 had extreme ratings at the behavioral session that precluded creating balanced social influence manipulations for the fMRI task, and 1 had unusable fMRI data. The final sample included 39 adolescents (M_{age} = 13.48 years, SD_{age} = .63, range = 12.16–14.77 years; 20 females). The race/ethnicity of adolescent participants included White (n = 17), Black/African American (n = 8), Asian (n = 3), Other (n = 1), and multi-ethnic (n = 3 Black/White, n = 2 Hispanic/Other, n = 1 Hispanic/White, n = 1 Hispanic/Black, n = 1 Asian/White, n = 1 Asian/Other, n = 1 White/Other). Mothers reported their highest levels of education as high school ($n = 2$), some college ($n = 8$), college ($n = 16$), some medical, law, or graduate school ($n = 1$), and medical, law, or graduate school ($n = 12$). All participants were free of MRI contraindications (e.g., metal in body). Adolescents and their parents provided written assent and consent in accordance with the university's Institutional Review Board.

3.2. Behavioral session

During a behavioral session, adolescents and their parents reported their baseline attitudes toward everyday behaviors in which adolescents might engage (Fig. 1A). Using a 10-point Likert scale (1=very bad, 10=very good), parents rated 100 behaviors, whereas adolescents rated 200 behaviors to ensure there were sufficient trials to manipulate for the fMRI task (described below). Half of the behaviors involved constructive behaviors (e.g., school habits, healthy behaviors, social interactions) and half involved unconstructive behaviors (e.g., deviancy, health risk behaviors, aggression). Constructive behaviors comprised actions that generally have more desirable consequences (e.g., working hard in school) and unconstructive behaviors comprised actions that generally have more undesirable consequences (e.g., smoking a cigarette; Table S1). Behaviors were presented in a random order and ratings were self-paced.

3.3. fMRI session

Participants underwent fMRI approximately two weeks after the behavioral session. Before the scan, participants were introduced to an age- and gender-matched peer who they were told was also participating in the study and had rated the same behaviors. Participants were shown a profile page for the peer which displayed a picture (drawn from the NIMH Child Emotional Faces Picture Set; (Egger et al., 2011)), information about their hobbies, and a self-description handwritten by the peer. During a separate task, they also spoke to and heard the peer talk to them (van Hoorn et al., 2018). In reality, the peer was a confederate, and was not actually present at the scan.

3.3.1. Attitude conformity fMRI task

Participants completed the Attitude Conformity task during fMRI. On each trial, participants first viewed a behavior they previously rated (but were not reminded of their original ratings) (2 s). Following a jittered inter-stimulus interval ($M = 2$ s), participants were then shown their parents' and peers' ratings on each behavior and instructed to choose which person they agreed with most (maximum of 5 s). Participants pressed the left index finger when they agreed with their parent or right index finger when they agreed with their peer. Participants' choices were self-paced, such that the task advanced to the next behavior upon participant response. Behaviors were presented in random order and were separated by jittered inter-trial fixation periods ($M = 2$ s). Conformity was operationalized as choosing the person whose rating conflicted with the adolescent's original rating, whereas resistance was operationalized as choosing the person whose rating was the same as the adolescent's original rating (described below).

In order to examine decisions to conform in the face of conflicting attitudes, we tailored the task to each participant based on their ratings assessed during the behavioral session. Although we collected the parents' actual ratings during the behavioral session, and ostensibly collected peers' ratings, such ratings were not used as we carefully manipulated the ratings to fall within the attitude conflict and social influence conditions described below. Of the 200 behaviors that participants originally rated at the behavioral session, 120 behaviors were selected for the fMRI task based on two criteria. First, the participant's rating for a behavior needed to fall between minimum and maximum plausible ratings determined for each behavior based on pilot data, thereby maximizing ecological validity and checking for deviant responding (e.g., rating "cheating on a test" as 10=very good was outside the range of plausibility). Second, given that extreme ratings may be less likely to change (Lin et al., 2018), the participant's rating for a behavior could not fall at the extremes of the scale (i.e., 1 or 10), ensuring that their parents' and peers' ratings could be manipulated to be below, above, or centered at participants' original ratings. Thus, the strength of participants' original ratings was relatively moderate across the subset of behaviors included in the fMRI task, with a balanced distribution across constructive and unconstructive behaviors.

3.3.1.1. Source of attitude conflict. To quantify the effect of conflicting influence, we manipulated parent and peer ratings in order to examine conformity when at least one of the influencer's ratings conflicted with the participant's original rating. There were three attitude conflict conditions that differed by the source of conflicting attitudes: Parent Conflict, Peer Conflict, and Mutual Conflict (Fig. 1B). In the Parent Conflict condition, the peer's rating was the same as the participant's original rating and the parent's rating differed. In the Peer Conflict condition, the parent's rating was the same as the participant's original rating and the peer's rating differed. In the Mutual Conflict condition, both the peer's rating and parent's rating differed from the participant's original rating and from each other. Given participants were required to

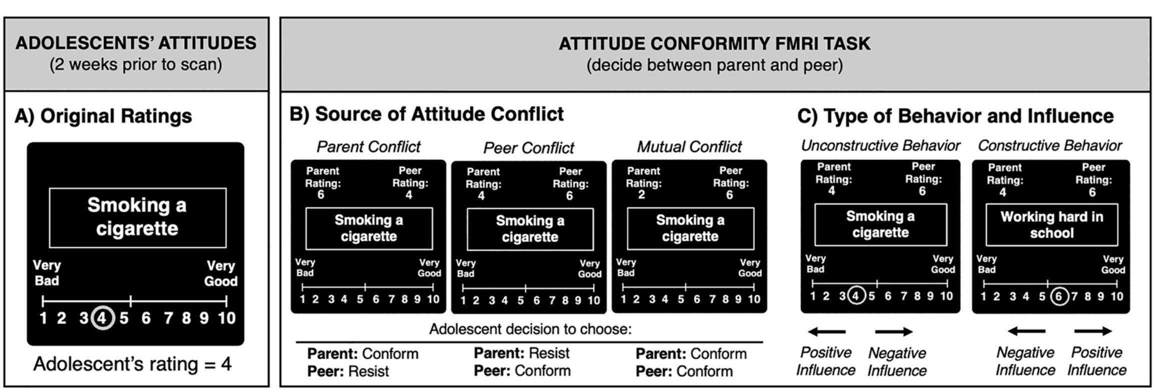

Fig. 1. Attitude Conformity task. A) Two weeks prior to the scan, adolescents rated their attitudes toward everyday behaviors (in this schematic, the adolescent rating is circled for visualization purposes but was not shown during the task). B) During fMRI, adolescents were presented with opposing attitudes from their parent and peer, which were manipulated based on the adolescent's original rating during the behavioral session. On Parent Conflict trials, just the parent's rating conflicted from the adolescent's but the peer's rating matched. On Peer Conflict trials, just the peer's rating conflicted from the adolescent's but the parent's rating matched. On Mutual Conflict trials, both the parent's and peer's ratings conflicted from the adolescent's. Conformity was operationalized as choosing the person whose rating conflicted with the adolescent's original rating, whereas resistance was operationalized as choosing the person whose rating matched the adolescent's original rating. C) Social influence was manipulated in two ways: Parents and peers (1) influenced adolescents' attitudes toward unconstructive and constructive behaviors (i.e., type of behavior) and (2) endorsed attitudes that reflected either more positive or negative influence (i.e., type of influence).

conform on Mutual Conflict trials (i.e., no option to resist), this third condition served as a control against Parent Conflict and Peer Conflict trials. In addition, the Mutual Conflict condition allowed us to explore if participants conform more to their peers' or parents' attitudes on average. Importantly, how the participant's choice on the task (i.e., parent or peer) mapped on to conformity depended on the attitude conflict condition. Conformity was defined as choosing the person whose rating conflicted with the participant's original rating, which could either be the parent (Parent Conflict), the peer (Peer Conflict), or both the parent and peer (Mutual Conflict) (Fig. 1B, "Adolescent decision to choose"). Resistance was defined as choosing the person whose rating matched with the participant's original rating, which could either be the peer (Parent Conflict) or parent (Peer Conflict) (Fig. 1B, "Adolescent decision to choose").

3.3.1.2. Type of behavior and influence. To quantify the effect of social context, we manipulated social influence in two ways in order to examine conformity toward different (1) types of behavior (i.e., constructive and unconstructive) and (2) types of influence (i.e., positive and negative). First, we included an equal distribution of constructive behaviors (e.g., working hard in school) and unconstructive behaviors (e.g., smoking a cigarette) to examine whether participants conform differently based on whether their parents' and peers' attitudes were related to constructive or unconstructive behaviors (Fig. 1C, "Constructive/Unconstructive Behaviors"). Second, we examined the extent to which participants were influenced by their parents and peers when they endorsed attitudes that reflected relatively more positive or negative influence (Fig. 1C, "Positive/Negative Influence"). Positive influence was operationalized as the parent or peer endorsing attitudes that were relatively more positive than the participant's original rating (e.g., rating a constructive behavior as more "good" along the 10-point scale than the participant and rating an unconstructive behavior as more "bad" along the 10-point scale than the participant). In contrast, negative influence was operationalized as the parent or peer endorsing attitudes that were relatively more negative than the participant's original rating (e.g., rating a constructive behavior as more "bad" along the 10-point scale than the participant and rating an unconstructive behavior as more "good" along the 10-point scale than the participant). Notably, positive and negative influence need not be on the opposite side of the scale, but instead were relative to the participant's original rating. Thus, positive influence could still be rating an unconstructive behavior as somewhat good (i.e., ratings above "5" or "6") as long as it was less good than the participant's original rating (and vice versa for negative influence). To create positive and negative influence, parent and peer ratings were manipulated to be 1–5 points below or above the participant's original rating, which was balanced across constructive and unconstructive behaviors. Positive and negative influence were examined only in the Peer Conflict and Parent Conflict conditions, where influence was manipulated in one direction. Positive and negative influence could not be examined on Mutual Conflict trials, where influence was manipulated in both directions (centered at the participant's original rating).

Overall, the task included 120 trials, which were divided equally by the attitude conflict condition (40 Parent Conflict trials, 40 Peer Conflict trials, 40 Mutual Conflict trials). Each attitude conflict condition was equally divided by type of behavior (20 constructive and 20 unconstructive behaviors). Parent and Peer Conflict trials each included 20 positive influence and 20 negative influence trials. Some participants ($n = 9$) had less balanced positive and negative influence trials due to their original ratings; this was mostly attributed to more extreme ratings of constructive behaviors at the behavioral session that made it difficult to generate additional positive influence (i.e., operationalized as even more positive ratings) for the fMRI session ($n = 6$). To compensate, we generated additional positive or negative influence trials within the same behavior type (e.g., we generated more negative influence trials on constructive behaviors for the $n = 6$ who had fewer positive influence trials on constructive behaviors).

3.4. Behavioral data analysis

Two generalized linear mixed-effects models were fitted to trial-by-trial choices on the Attitude Conformity fMRI task. All statistical models were estimated using the GLIMMIX procedure in SAS 9.4. For interpretation, unstandardized model estimates (log-odds) were converted to odds-ratios and predicted probabilities.

3.4.1. Type of behavior analysis

First, we tested how the probability of conforming or resisting changes as a function of the type of behavior. Given the person whose rating conflicted or matched the participant's rating varied across the three attitude conflict conditions (Fig. 1B, "Adolescent decision to choose"), the dichotomous choice to endorse the peer's rating vs. parent's rating was used as the dependent variable in this model. Primary analyses focused on examining differences in aligning with the person whose attitude conflicted with (i.e., conformity) or matched (i.e., resistance) the participant's original attitude on the Peer Conflict and Parent Conflict conditions. In addition, we conducted exploratory analyses to test overall differences in aligning with peers vs. parents on the Mutual Conflict condition, where conformity was forced given both the parent's and peer's attitudes conflicted with the participant's original attitude. We estimated the following equation:

$$\begin{aligned} Logit(Peer_{ij}) = \ & \gamma_{00} + \gamma_{10} Unconstructive_{ij} + \gamma_{20} ParentConflict_{ij} \\ & + \gamma_{30} PeerConflict_{ij} + \gamma_{40} Unconstructive * ParentConflict_{ij} \\ & + \gamma_{50} Unconstructive * PeerConflict_{ij} + u_{0j} \end{aligned}$$

The dichotomous choice to endorse the peer's rating or parent's rating (1=peer, 0=parent) on a particular trial (*i*) for a particular adolescent (*j*) was modeled as a function of the following independent variables: the attitude conflict condition, type of behavior, and their respective interaction terms. The attitude conflict condition was entered with two dummy variables (1=ParentConflict, Other = 0; 1=PeerConflict, Other = 0) with Mutual Conflict omitted as the reference group. The type of behavior was coded as one dummy variable (1=Unconstructive, 0=Constructive). A random intercept was included to account for between-person variation in baseline propensity of choosing peer over parent. We specified a Bernoulli response distribution for the binary outcome and a logit link function to relate the predicted outcome to the linear predictors, with probability values restricted to (0, 1).

3.4.2. Type of influence analysis

In a separate generalized linear mixed-effects model, we tested how the probability of conforming or resisting differs as a function of the type of influence. Given that adolescents were forced to conform on Mutual Conflict trials (i.e., there was no option to resist), this analysis was constrained to Parent Conflict and Peer Conflict trials (80 total per participant). To focus on conformity decisions, the participant's choice on the task (i.e., peer or parent) was recoded to "conformity" (i.e., chose peer on Peer Conflict trials and chose parent on Parent Conflict trials) and "resistance" (i.e., chose parent on Peer Conflict trials and chose peer on Parent Conflict trials). The dichotomous choice to conform toward vs. resist choosing the person with conflicting ratings was used as the dependent variable in this model. We estimated the following equation:

$$Logit(Conform_{ij}) = \gamma_{00} + \gamma_{10} ParentPositive_{ij} + \gamma_{20} PeerPositive_{ij} + u_{0j}$$

The dichotomous choice to conform to or resist the person with conflicting ratings (1=conform, 0=resist) on a particular trial (*i*) for a particular adolescent (*j*) was modeled as a function of two independent variables: the difference between the parent's rating and the participant's original rating (ParentPositive) and the difference between the peer's rating and the participant's original rating (PeerPositive). The parent and peer difference scores on unconstructive behaviors were reverse coded, so that, for unconstructive and constructive behaviors alike, higher scores indicate higher positive influence and lower scores indicate higher negative influence. A random intercept was included to account for between-person variation in baseline propensity of choosing to conform over resist. We specified a Bernoulli response distribution for the binary outcome and a logit link function to relate the predicted outcome to the linear predictors, with probability values restricted to (0, 1).

3.5. fMRI data acquisition and preprocessing

Imaging data were collected using a 3 T Siemens Magnetom Trio MRI scanner. The scan consisted of T2*-weighted echoplanar images (EPI; slice thickness = 3 mm; 38 slices; TR = 2 s; TE = 25 ms; matrix = 92 × 92; FOV = 230 mm; voxel size = 2.5 × 2.5 × 3 mm^3). Structural scans were also acquired, including a T1* magnetization-prepared rapid-acquisition gradient echo (MPRAGE; 192 slices; TR = 1.9 s; TE = 2.32 ms; FOV = 230 mm; matrix = 256 × 256; sagittal acquisition plane; slice thickness = .9 mm) and a T2*-weighted, matched-bandwidth (MBW), high resolution anatomical scan (38 slices; TR = 4 s; TE = 64 ms; FOV = 230 mm; matrix = 192 × 192; slice thickness = 3 mm). To maximize brain coverage and reduce signal drop-out in orbital and temporal regions, MBW and EPI images were acquired at an oblique axial orientation.

Preprocessing steps were completed utilizing the FMRIB Software Library (FSL v6.0). Preprocessing included: skull stripping of all structural and functional images using BET; slice-to-slice head motion correction using MCFLIRT; sequential co-registration of EPI images to the MBW, MPRAGE, and standard stereotactic space defined by the Montreal Neurological Institute (MNI) and the International Consortium for Brain Mapping using FLIRT; removing low frequency drift across the EPI time-series using high-pass temporal filtering with a 128 s cutoff; and spatial smoothing using a 6 mm Gaussian kernel, full-width-at-half maximum. Independent component analysis (ICA) were performed on the individual level using MELODIC combined with an automated component classifier (Tohka et al., 2008) (Neyman-Pearson threshold = .3) in order to remove artifact signal (e.g. motion, physiological noise) from the functional data.

3.6. fMRI data analysis

The Attitude Conformity fMRI task was modeled as an event-related design using the Statistical Parametric Mapping software package (SPM8; Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK). In parallel with the behavioral analyses, we specified two separate individual level, fixed-effects models. Across both models, covariates of non-interest included: six motion parameters; volumes containing excessive motion (i.e., greater than 2 mm slice-to-slice movement along any axis); and the periods where the behavior was presented without the ratings (duration = 2 s). All adolescents had less than 2 mm slice-to-slice head motion on >95 % of total volumes. The jittered inter-stimulus and inter-trial periods were not modeled and therefore served as an implicit baseline for the task conditions of interest.

3.6.1. Type of behavior analysis

First, we examined the effects of unconstructive and constructive behaviors at the whole-brain level. Six conditions of interest were defined based on the three attitude conflict conditions (Parent Conflict, Peer Conflict, Mutual Conflict), each modeled separately for unconstructive and constructive behaviors. Participants' dichotomous choice of peer or parent on a given trial (1=peer, 0=parent) was included as a parametric modulator for the six conditions to identify brain regions that differentially respond to endorsing peer vs. parent attitudes. Given the person whose attitude conflicted with the participant's attitude could either be the peer (Peer Conflict) or the parent (Parent Conflict), this PM was used to examine neural differences in aligning with the person whose attitude conflicted with (i.e., conformity) or matched (i.e., resistance) the participant's original attitude on the Peer Conflict and Parent Conflict condition. In addition to our primary analyses, we performed exploratory analyses to test for neural differences in aligning with peer attitudes (i.e., peer conformity) or parent attitudes (i.e., parent conformity) on the Mutual Conflict condition, where conformity was forced as both parents and peers endorsed attitudes that conflicted with the participant's original attitudes. Events were modeled using the onset of each event, with a duration equal to participants' response time to make a decision on that trial.

3.6.2. Type of influence analysis

Next, we examined the effects of positive and negative influence at the whole-brain level. Four conditions of interest were defined based on the type of influence (negative influence, positive influence), modeled separately for parents (i.e., Parent Conflict trials) and peers (i.e., Peer Conflict trials). Mutual Conflict trials—in which adolescents were forced to conform (i.e., there was no choice to resist)—were modeled as a separate condition of non-interest. The absolute value of the difference between the influencer's rating and adolescent's original rating (range: 1–5) was included as a parametric modulator for the four conditions to identify brain regions that track increases in the level of positive and negative influence. Events were modeled using the onset of each trial, with a duration equal to participants' response time to make a decision on that trial. Our events of interest in this model did not separately model the choice (i.e., conform or resist), but instead focused on the entire decision phase of each trial. Finally, to test how neural tracking of the level of negative vs. positive influence is associated with overall rates of conformity, we conducted a whole-brain, regression analysis at the group level using the average frequency of conformity on negative vs. positive influence trials as a regressor.

All individual subject contrasts of interest were submitted to random-effects, group-level analyses at the whole-brain level in GLMFlex (http://mrtools.mgh.harvard.edu/index.php/GLM_Flex), corrected for multiple comparisons. Specifically, we ran a Monte Carlo simulation using the updated version (April 2016) of the 3dFWHMx and 3dClustSim programs from the AFNI software package (Ward, 2000) for each group-level contrast of interest. The simulation resulted in a minimum cluster size threshold ranging from 82–142 voxels across all contrasts of interest in the Type of Behavior Analysis and 86–129 voxels across all contrasts of interest in the Type of Influence Analysis at the whole brain level, both corresponding to $p < .05$, Family-Wise Error (FWE) corrected given a voxel-wise threshold of $p < .005$. All results are available on NeuroVault (Gorgolewski et al., 2015) (see https://neurovault.org/collections/QCNBXGZR/).

4. Results

4.1. Type of behavior

4.1.1. Behavioral results

To examine the effect of type of behavior, we tested the probability of conforming to conflicting attitudes toward unconstructive and constructive behaviors on Parent Conflict and Peer Conflict trials vs. Mutual Conflict trials. Descriptively, participants had above-chance rates (i.e., confidence interval (CI) does not include 50 %) of resisting than conforming to conflicting attitudes (Fig. 2A). Participants only had a 34.8 % mean probability of conforming (i.e., choosing parent) on Parent Conflict trials (95 % CI [30.5 %, 39.3 %]) and a 38.8 % mean probability of conforming (i.e., choosing peer) on Peer Conflict trials (95 % CI [34.3 %, 43.5 %]). These results suggest that adolescents are overall more likely to resist than conform when either parents or peers endorsed attitudes that conflicted with adolescents' personal attitudes.

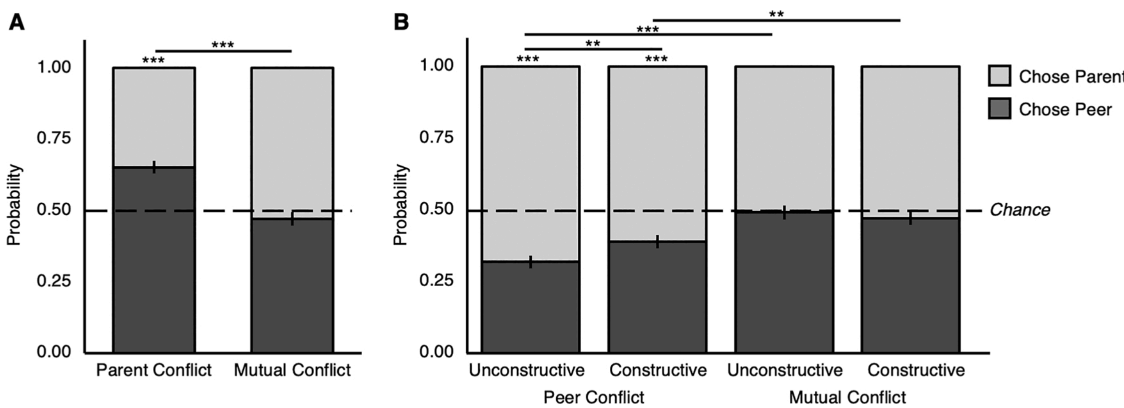

Fig. 2. Behavioral effects of type of behavior. A) Adolescents were less likely to conform to their parents' attitudes (i.e., chose parent) on Parent Conflict trials compared to Mutual Conflict trials, regardless of the type of behavior. B) Conformity to peers' attitudes (i.e., chose peer) on Peer Conflict trials depended on the type of behavior, such that adolescents were more likely to conform to their peers' attitudes toward constructive than unconstructive behaviors.
Note: Error bars represent the standard error of the mean. Decisions (i.e., probability of choosing peer or parent) that occurred significantly above or below chance level (i.e., 50 % probability) are denoted by significance stars above the condition, and decisions that varied across conditions are denoted with a significance bar. ***$p < .001$, **$p < .01$.

When they did conform, participants conformed selectively based on the source of attitude conflict and type of behavior (Table 1). As shown in Fig. 2A, participants were significantly less likely to conform to their parent on Parent Conflict trials (34.8 % mean probability; 95 % CI [30.5 %, 39.3 %]) compared to Mutual Conflict trials (52.9 % mean probability; 95 % CI [48.2 %, 57.6 %]). In other words, participants were less likely to conform to their parents when they shared similar attitudes with their peers (Parent Conflict), but had no preference for either person (i.e., conformed at chance) when they disagreed with both parents and peers (Mutual Conflict). There was no interaction with the type of behavior, suggesting that participants were equally likely to conform to their parents' attitudes toward unconstructive and constructive behaviors.

Table 1
Generalized linear mixed-effects analysis on type of behavior.

	Est.	*SE*	*t* test	*p*	OR	PP
Fixed effects						
Intercept	−.12	.10	$t(38) =$ -1.20	.24	.89	.47
Unconstructive Behavior	.08	.10	$t(4601) =$ .79	.43	1.09	.52
Parent Conflict	.75	.11	$t(4601) =$ 7.01	<.000	2.11	.68
Peer Conflict	−.34	.10	$t(4601) =$ -3.24	.001	.71	.42
Unconstructive Behavior × Parent Conflict	−.16	.15	$t(4601) =$ -1.07	.28	.85	.46
Unconstructive Behavior × Peer Conflict	−.39	.15	$t(4601) =$ -2.60	.01	.68	.40
Random effect						
Participant effect	.16	.04				

Table shows the regression coefficient estimates (Est. represents the log-odds (logit) of choosing peers vs. parents; converted to odds ratio (OR) and predicted probability (PP) for interpretation), standard error (SE), *t* values, and *p* values from a generalized linear mixed effects analysis. Dependent variable: 1=peer, 0=parent. Independent variables: behavior type (1=unconstructive, 0=constructive) and attitude conflict condition (dummy-coded; Parent Conflict and Peer Conflict, with Mutual Conflict omitted as the reference group). A log likelihood ratio test confirmed that the inclusion of independent variables significantly improved model fit from the unconditional (i.e., no predictors) random-intercept model ($\chi^2(5) = 264.92$, $p < .000$). The random intercept for participants was significant ($b = .14$, $SE = .04$, $p < .001$), suggesting that there is significant between-person variability in the average probability of choosing peers over parents.

In contrast, conformity to peer attitudes depended on the type of behavior. As shown in Fig. 2B, on Peer Conflict trials, participants were significantly less likely to conform to their peers' attitudes toward unconstructive behaviors (31.8 % mean probability; 95 % CI [27.7 %, 36.2 %]) than constructive behaviors (38.8 % mean probability; 95 % CI [34.3 % 43.5 %]). Thus, despite generally resisting conformity (i.e., choosing their parent) when their peers' attitudes conflicted with their own, participants were more likely conform to their peers' attitudes toward constructive over unconstructive behaviors when they did conform.

4.1.2. fMRI results

Given differences at the behavioral level (i.e., conforming more to constructive than unconstructive behaviors) for Peer Conflict trials, but no differences by the type of behavior for Parent Conflict trials, analyses examining neural differences during conformity decisions toward unconstructive vs. constructive behaviors focused on Peer Conflict trials (Unconstructive Peer Conflict > Constructive Peer Conflict). Participants showed greater activation in the vmPFC, dACC, insula, IFG, caudate, and hippocampus when conforming to their peers' attitudes toward unconstructive relative to constructive behaviors (Table 2; Fig. 3A). For descriptive purposes, we extracted parameter estimates of

Table 2
Whole-brain condition effects by type of behavior.

Contrast and Region	R/L	BA	x	y	z	t	k
Unconstructive Peer Conflict > Constructive Peer Conflict							
Ventromedial prefrontal cortex	L	11	−6	38	−12	4.80	1325 [a]
Inferior frontal gyrus	L	47	−44	32	−8	3.55	[a]
Insula	R		28	8	−12	3.21	315
Dorsal anterior cingulate cortex			14	36	26	4.44	229
Caudate	R		12	10	22	3.66	200
Hippocampus	R		28	−24	−10	3.71	142

Note: L and R refer to left and right hemispheres; BA refers to Brodmann area of peak voxel; *k* refers to the number of voxels in each significant cluster; *t* refers to peak activation level in each cluster; and x, y, and z refer to MNI coordinates. fMRI results are reported at $p < .005$, with a corrected cluster size of 128 contiguous voxels. Regions denoted with the same superscript are part of the same cluster of activation. We included adolescents' binary choice of peer or parent as a parametric modulator (PM; peer=1, parent=0), which identified neural activity in regions that showed differences between conformity (i.e., chose peer) vs. resistance (i.e., chose parent) decisions on Peer Conflict trials.

neural activity from two of these regions, the vmPFC and dACC, separately for Unconstructive Peer Conflict and Constructive Peer Conflict trials. As shown in Fig. 3B-C, participants exhibited increases in vmPFC and dACC activity when conforming to their peers' attitudes toward unconstructive behaviors, whereas they showed decreases in vmPFC and dACC activity when conforming to their peers' attitudes toward constructive behaviors (similar patterns were found in the other significant regions). No brain regions were more activated when conforming to peers' attitudes toward constructive vs. unconstructive behaviors. See Table S2 for a complete list of significant regions to all conditions by the source of attitude conflict and type of behavior.

4.2. *Type of influence*

4.2.1. *Behavioral results*

We next compared whether conformity changes as a function of the extent to which parents and peers endorsed negative and positive influence. Participants were more likely to conform when they encountered more positive than negative influence, an effect that was similar across parents and peers (Table 3; Fig. 4A-B). These results suggest participants selectively conform in contexts where their parents and peers endorsed more positive than negative influence.

4.2.2. *fMRI results*

Given no differences between parent and peer influence at the behavioral level, we collapsed across Parent Conflict and Peer Conflict trials in order to compare neural regions that track the level of negative vs. positive influence when participants considered whether to conform (Negative Influence > Positive Influence). Results revealed that participants exhibited greater activation in the TPJ when they considered conforming to relatively more negative influence than positive influence (see Table 4 for complete list of regions). For descriptive purposes, parameter estimates of TPJ activity were extracted separately for Negative Influence and Positive Influence trials. As shown in Fig. 5, participants exhibited parametric increases in TPJ activation when they considered conforming to relatively more negative influence, with no changes in TPJ activation when they considered conforming to relatively more positive influence.

To test whether the neural tracking of negative vs. positive influence predicted individual differences in average rates of conformity, we calculated a difference score between participants' average frequency of conformity to negative and positive influence, such that higher scores reflect greater conformity to negative influence. Difference scores were entered as a regressor in a whole-brain regression analysis on the Negative Influence > Positive Influence contrast. Results show that when deciding whether to conform to increasingly negative over positive influence, activation in the right pSTS (*xyz* = 64, -36, -8, t = 3.35, k = 214) was associated with a lower frequency of conforming to negative over positive influence. For descriptive purposes, parameter estimates of pSTS activity were extracted and plotted against the frequency of conformity (see Fig. 5B). No other brain regions were correlated with the frequency of conformity toward negative vs. positive influence.

Table 3
Generalized linear mixed-effects analysis on type of influence.

	Est.	*SE*	*t* test	*p*	OR	PP
Fixed effects						
Intercept	−.57	.06	t(38) = -9.57	<.000	.57	.36
Parent Positive Influence	.11	.02	t(3049) = 5.01	<.000	1.12	.53
Peer Positive Influence	.14	.02	t(3049) = 6.30	<.000	1.15	.54
Random effect						
Participant effect	.08	.03				

Table shows the regression coefficient estimates (Est. represents the log-odds (logit) of conforming vs. resisting; converted to odds ratio (OR) and predicted probability (PP) for enhanced interpretation), standard error (SE), *t* values, and *p* values from a generalized linear mixed effects analysis. Dependent variable: 1=conform, 0=resist. Independent variables: type of influence condition (Parent Positive Influence and Peer Positive Influence; recoded so that higher values reflect higher positive influence and lower values reflect higher negative influence). A log likelihood ratio test confirmed that the inclusion of the independent variables significantly improved model fit from the unconditional (i.e., no predictors) random-intercept model ($\chi^2(2) = 65.47$, $p < .000$). The random intercept for participants was significant ($b = .07$, $SE = .03$, $p = .01$), suggesting that there is significant between-person variability in the average probability of conforming over resisting influence.

4.3. *Peer vs. parent influence*

4.3.1. *Behavioral results*

In addition to the primary analyses on the type of behavior and type of influence, we explored whether there were differences in conforming to parents vs. peers on Mutual Conflict trials. Exploratory analyses testing whether adolescents conformed more than chance level (i.e., CI does not include 50 %) to peers compared to parents revealed that adolescents had a 47.1 % probability of selecting their peer over parent on Mutual Conflict trials (95 % CI [42.4 %, 51.8 %]; Fig. 2A). These results suggest that, within adolescents, peers do not have a larger effect than parents when both parents and peers endorsed attitudes that conflicted with the adolescents' original attitudes.

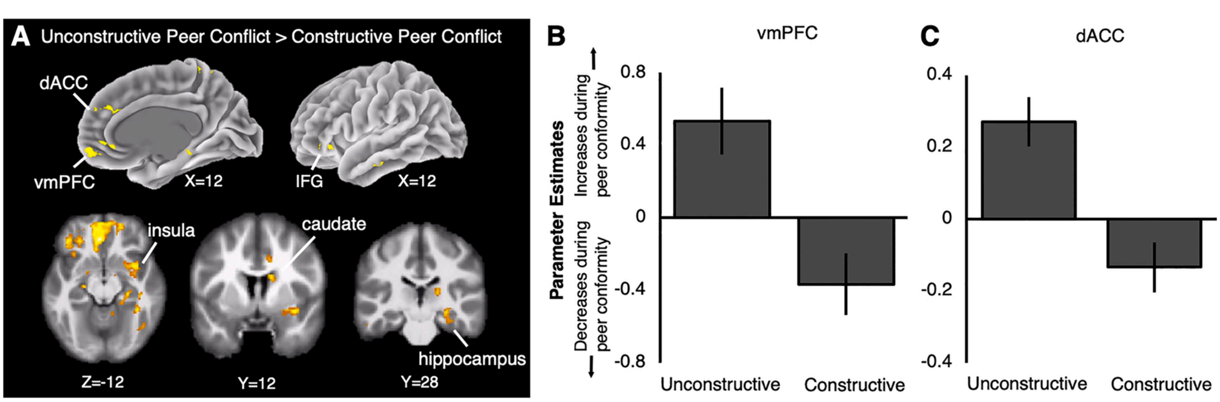

Fig. 3. Neural responses during peer conformity to unconstructive relative to constructive behaviors. A) Whole-brain results for the Unconstructive Peer Conflict > Constructive Peer Conflict contrast. Adolescents exhibited parametric increases in the B) ventromedial prefrontal cortex (vmPFC) and C) dorsal anterior cingulate cortex (dACC), and several other regions, during peer conformity toward unconstructive behaviors, whereas they showed decreases in these regions during peer conformity toward constructive behaviors.

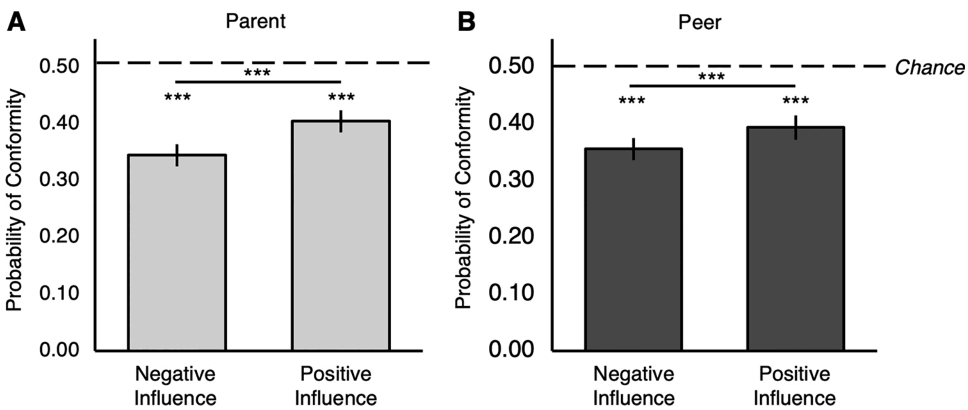

Fig. 4. Behavioral effects of type of influence. The mean probability of conformity is shown at -1 SD (i.e., negative influence) and +1 SD (i.e., positive influence) from the mean level of influence. Adolescents were more likely to conform when their A) parents and B) peers endorsed more positive influence than negative influence relative to what participants originally reported.
Note: Error bars represent the standard error of the mean. Decisions (i.e., conform or resist) that occurred significantly above or below chance level are denoted by significance stars above the condition, and decisions that varied across conditions are denoted with a significance bar. ***p < .001.

Table 4
Whole-brain condition effects by type of influence.

Anatomical Region	R/L	BA	x	y	z	t	k
Negative Influence > Positive Influence							
Temporoparietal junction	L		−50	−74	22	3.31	179
Cuneus	R	18	−4	−90	22	4.02	138

Note: L and R refer to left and right hemispheres; BA refers to Brodmann area of peak voxel; *k* refers to the number of voxels in each significant cluster; *t* refers to peak activation level in each cluster; and x, y, and z refer to MNI coordinates. fMRI results are reported at $p < .005$, with a corrected cluster size of 100 contiguous voxels. We included the absolute value of the difference between the participant's and the influencer's ratings as a parametric modulator (PM; range: 1–5), which identified neural activity in regions that tracked with the level of negative vs. positive influence.

4.3.2. fMRI results

At the neural level, we explored overall differences between the neural correlates of conformity to peer vs. parent attitudes on Mutual Conflict trials (Peer Conformity > Parent Conformity). Exploratory analyses at the whole-brain level suggest adolescents showed greater activation in the dorsolateral prefrontal cortex (dlPFC) (*xyz*=-32 50 24; $t = 3.53$; $k = 183$), OFC (*xyz*=-26 28−16; $t = 4.39$; $k = 191$), pSTS extending into posterior insula (*xyz*=-50−34 8; $t = 3.57$; $k = 313$), putamen (*xyz*=-32−14 0; $t = 6.30$; $k = 622$), and cuneus (*xyz* = 16–92 28; $t = 3.51$; $k = 983$) when they conformed to their peer over parent. No brain regions showed greater activation during conformity to parent over peer influence.

5. Discussion

The goal of the current study was to examine whether adolescents change their opinions when confronted with conflicting attitudes from their parents and peers, and characterize the neural mechanisms underlying conformity decisions across social influence contexts. In general, adolescents were more likely to resist than conform when confronted with opposing attitudes from others. When they did conform, adolescents were more likely to conform to their peers' attitudes toward constructive than unconstructive behaviors as well as when their peers and parents endorsed relatively more positive than negative influence. Exploratory analyses suggest peer influence did not outweigh parent influence overall. Neural responses in brain regions associated with valuation (e.g., vmPFC, subregions of the striatum), mentalizing (e.g., TPJ, pSTS), and salience monitoring (e.g., dACC, insula, IFG) may underlie context-dependent differences in parent and peer conformity. Collectively, these findings suggest that early adolescents may balance self- and social-related considerations differently across social contexts, which in turn guide decisions to conform to the conflicting attitudes of their parents and peers.

Overall, adolescents were less likely to conform when their parent or peer endorsed attitudes that conflicted with their personal attitudes, sticking with their pre-existing attitudes 65 % of the time. These results suggest adolescents hold relatively consistent attitudes toward a behavior even when they conflict with others' attitudes. During early adolescence, youth become less willing to engage in behaviors that are inconsistent with their identity (Krieger et al., 2013) and start to show improvements in their ability to resist peer influence (Steinberg and Monahan, 2007). Consistent with prior work, our findings highlight the importance of adolescents' personal attitudes in buffering against conformity, such that youth are able to stand firm in their own attitudes even when confronted with opposing attitudes from parents or peers.

5.1. Attitude conformity toward unconstructive and constructive behaviors

When they did conform, adolescents were generally selective in who they conformed to depending on the social influence context. Whereas adolescents conformed to their parents' attitudes toward constructive and unconstructive behaviors at similar rates, they conformed to their peers' attitudes toward constructive behaviors more than unconstructive behaviors. Behavioral findings suggest that, when confronted with conflicting attitudes, adolescents may similarly incorporate their parents' conflicting attitudes toward constructive and unconstructive behaviors, but differentially evaluate and adopt their peers' conflicting attitudes based on the type of behavior.

According to a theoretical review that recasts conformity as a value-based decision (Falk and Scholz, 2018), valuation processes in the brain, with input from brain regions associated with salience monitoring and mentalizing, play a central role in encoding and responding to social influence. Consistent with this perspective, our neural results indicate that the vmPFC and striatum, brain regions associated with valuation (Bartra et al., 2013), and the dACC, insula, and IFG, brain regions implicated in salience monitoring (Menon and Uddin, 2010), show different activation patterns during conformity to conflicting peer opinions based on the type of behavior under consideration. Contrary to hypotheses, neural activity in these brain regions show decreases (rather than increases) during conformity to peers' attitudes toward constructive behaviors. These neural results were surprising given that rates of peer conformity were higher for attitudes toward constructive behaviors than unconstructive behaviors. Expected increases in brain regions implicated in value and salience monitoring were found only when adolescents conformed to peers' attitudes toward unconstructive behaviors. Although brain regions implicated in valuation and salience monitoring have been linked to conformity toward diverging group opinions, the direction of neural activity within these regions remains inconsistent between adult and adolescent samples (Falk and Scholz, 2018). In adults, it has been proposed that, similar to reinforcement learning in social contexts, a polarized response within brain regions

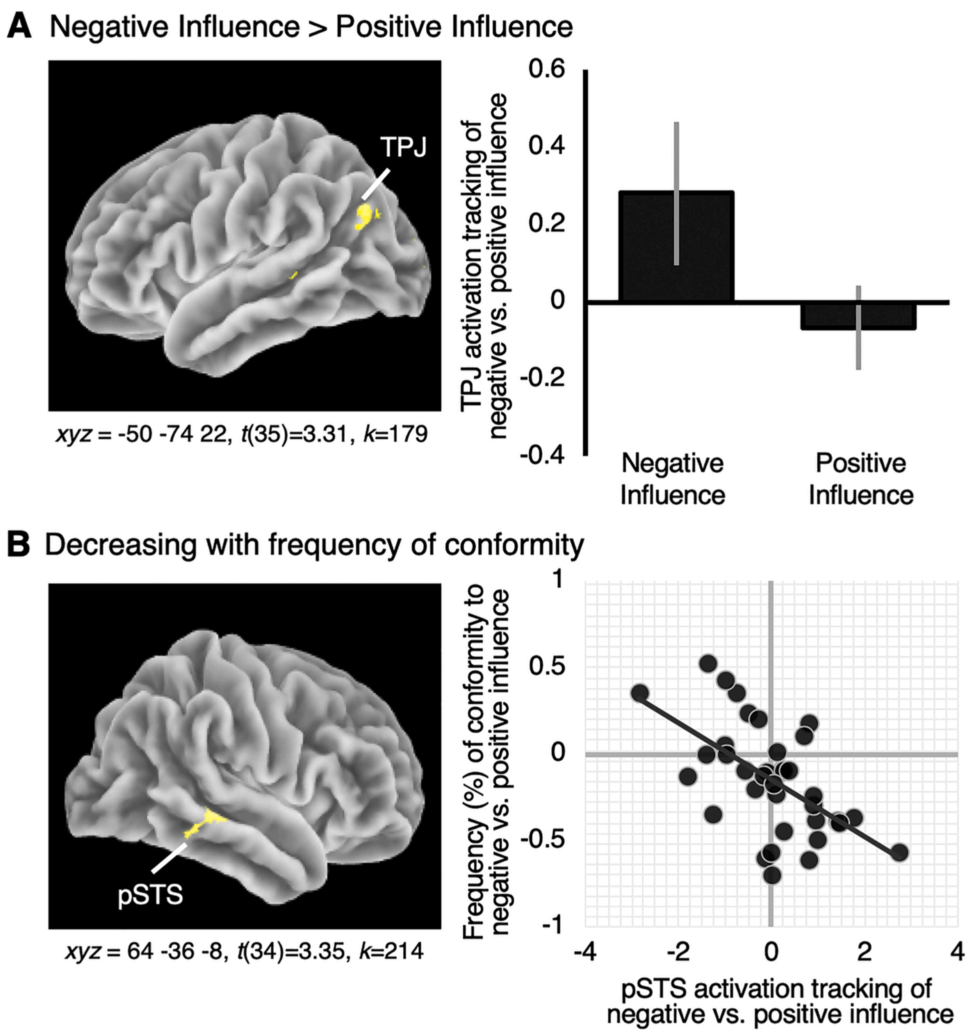

Fig. 5. Neural responses during conformity to negative vs. positive influence. A) Whole-brain analyses revealed there were parametric increases in TPJ activation when adolescents considered conforming to relatively more negative influence and no parametric changes in TPJ activation when they considered conforming to relatively more positive influence. B) A whole-brain regression analysis with the average frequency of conformity revealed adolescents who exhibited greater posterior superior temporal sulcus (pSTS) activation when considering relatively more negative vs. positive influence had lower rates of conformity toward negative vs. positive influence.

associated with value and salience monitoring signals the need to update one's own preferences to align with group norms (Klucharev et al., 2009). In adolescents, however, increased activity in the brain's value system, among other cortical regions, is associated with greater conformity, with salience-related brain regions surprisingly not reported (Cascio et al., 2015b; Welborn et al., 2015). Our findings suggest that, when peers endorse diverging attitudes toward constructive behaviors, increased peer conformity in early adolescence may be supported by a downregulation of both value- and salience-related brain regions. Alternatively, increased activity in brain regions associated with valuation and salience monitoring may underlie the deterrence of peer conformity toward unconstructive behaviors, a finding reported in adults that is thought to indicate the increased salience of nonconformity to group norms (Berns et al., 2005; Tomlin et al., 2013). Collectively, these data replicate and extend prior research on adolescent conformity to conflicting peer opinions, suggesting that valuation processes in the brain are modulated by the type of behavior being influenced and highlighting the added role of salience-related signals in motivating peer conformity.

5.2. *Attitude conformity toward negative and positive influences*

Adolescents' decision to conform also depended on the extent to which their parents and peers endorsed relatively more positive or negative influence. When parents and peers endorsed relatively more positive attitudes than the adolescents' original attitudes (i.e., positive influence), adolescents were more likely to conform by adopting the opposing attitudes of others. However, when parents and peers endorsed relatively more negative attitudes than the adolescents' original attitudes (i.e., negative influence), adolescents were more likely to stick with their pre-existing attitudes and resist conformity. These findings build upon prior work showing adolescents conform to their peers in both positive and negative directions (van Hoorn et al., 2016, 2014), and add to this literature by demonstrating that when confronted with both types of influence simultaneously, positive influence may outweigh negative influence in early adolescence, whether it be from parents or peers.

At the neural level, adolescents exhibited parametric increases in TPJ activation when considering higher levels of negative influence from parents and peers, but showed no changes in TPJ activation when considering higher levels of positive influence. Furthermore, adolescents who exhibited greater pSTS activation when considering relatively more negative vs. positive influence showed lower average conformity to negative over positive influence. Prior studies in adolescents have demonstrated that conflict with the group opinion is associated with increased activity in mentalizing-related regions, including the TPJ and pSTS, and higher rates of conformity (Cascio et al., 2015b; Welborn et al., 2015), which the authors interpreted to reflect the added mentalizing resources needed to understand and incorporate others' opinions when they deviate from one's own opinions. Surprisingly, we find no changes in TPJ activity during conformity to positive influences despite higher rates of conformity to positive over negative influences. Similar to comparisons between different types of behavior, expected increases in neural activity in mentalizing-related brain regions were found only when adolescents conformed to negative influences. These data provide converging evidence that mentalizing brain systems play a significant role in shaping adolescent conformity. Greater mentalizing resources may be needed particularly when parents and peers endorse more negative than positive influences on adolescent attitudes, perhaps because such attitude discrepancies are more uncommon, ultimately rendering adolescents less susceptible to conforming toward negative influence.

5.3. Attitude conformity toward peers and parents

Exploratory analyses comparing parent to peer conformity revealed adolescents were equally likely to conform to their parents and peers when both endorsed attitudes that conflicted with the adolescents' attitudes (i.e., on Mutual Conflict trials). These results challenge prior research showing that one source of influence typically outweighs the other in adolescence (Biddle et al., 1980; Deutsch et al., 2017; Utech and Hoving, 1969) and suggest that, even when they endorse opposing attitudes, parents and peers exert a similar influence on attitudes toward everyday behaviors in early adolescence. Indiscriminate patterns of conformity toward peers and parents may have stemmed from the increased difficulty of resolving conflict between their own attitudes and those of multiple sources of influence. At the neural level, adolescents showed increased recruitment of several striatal and cortical brain regions, including the putamen, OFC, pSTS, and dlPFC, when conforming to their peers' over parents' attitudes when both endorsed attitudes that conflicted with adolescents' pre-existing attitudes. Value-based decision making models underscore that value signals in the striatum and ventral prefrontal cortex (including its orbital subregion) regulate a wide range of motivated behaviors, with self- and social-relevant considerations as key inputs to how the value of competing choices are evaluated (Baek and Falk, 2018; Pfeifer and Berkman, 2018). In contrast to the more social cognitive functions of the pSTS, the dlPFC is commonly implicated in self-control and goal-directed behavior, primarily for its role in regulating value signals assigned to competing choices (Hare et al., 2009; Miller and Cohen, 2001). Despite similar rates of attitude conformity to parents and peers, neural results suggest that brain regions associated with value, mentalizing, and self-control differentially support conformity to peers relative to parents in early adolescence.

5.4. Limitations and future directions

A major strength of this study is its ability to assess the range of susceptibility to conflicting influence across social contexts within adolescents. However, a few limitations should be noted. First, the generalizability of the current results to broader populations may be limited due to a relatively small sample size and recruitment of typically developing youth from higher socioeconomic backgrounds. In addition, the effects of peer and parent influence may be confounded by potential differences in the closeness of relationship (e.g., known parent vs. unknown peer) or the motivational relevance of the social actors employed in the current study (e.g., individual peer vs. peer group). Exploratory analysis comparing peers and parents revealed no behavioral differences in conformity, suggesting that the source of influence (parent/peer) may not be confounded with the known/unknown nature of these social relationships. Further, social influence manipulations were contingent on participants' original ratings, which unfortunately resulted in less balanced designs for some participants. Although linear mixed-effects models allow for unbalanced designs (Schielzeth and Nakagawa, 2013), future research should better optimize experimental conditions in order to appropriately disentangle the role of relational vs. contextual factors in motivating attitude change, and explore its durability or subsequent effects on modifying behavior in adolescence.

Second, because the binary-choice task forced participants to agree with either their parent or peer, it is unclear whether the decision to choose the person whose attitude matched their original attitude is the same psychological process as resisting conflicting influence. Nevertheless, results indicate that adolescents did not always align themselves with the person whose attitudes matched their own, or make decisions arbitrarily (i.e., chance levels) or based on social preferences (i.e., greater conformity to the same person across conditions). Rather, participants' decision to align themselves with the person whose attitudes differed from their own depended on the type of behavior and influence, highlighting the importance of the social context in which conformity decisions unfold during early adolescence.

Finally, longitudinal research is needed to explore if and how these conformity patterns change across adolescence. Prior work suggests that developmental trajectories of parent or peer conformity vary significantly as a function of the type of behavior (Berndt, 1979), albeit this research has neither examined the simultaneous influence of parents vs. peers nor considered the role of adolescents' personal attitudes. Although future empirical work is warranted, one hypothesis is that known peaks in risk-taking behaviors during late adolescence (age 18–21) confer developmental shifts toward greater influence of peers over parents or greater susceptibility to the effects of negative over positive influence.

In conclusion, our study challenges many prevailing conceptions of adolescence as a time of excessive conformity to negative influence. We demonstrate that adolescence may be a time when youth are able to stand firm in their own attitudes rather than blindly conforming to the opposing attitudes of others; a time when peers exert a stronger influence on adolescents' attitudes toward constructive than unconstructive behaviors; and a time when positive influence is stronger than negative influence from both parents and peers.

Author contributions

E. H. Telzer and E. M. McCormick developed the study concept and design. K. T. Do and E. M. McCormick collected the data. K. T. Do performed data analysis and interpretation under the supervision of E. H. Telzer. K. T. Do drafted the manuscript, with critical revisions from E. H. Telzer and E. M. McCormick. All authors approved the final version of the manuscript for submission.

Declaration of Competing Interest

The authors report no declarations of interest.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.dcn.2020.100837.

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