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Asymmetric Synthesis of 1,3-Diamines by Diastereoselective Reduction of Enantiopure *N-tert*-Butanesulfinylketimines: Unusual Directing Effects of the *ortho*-Substituent

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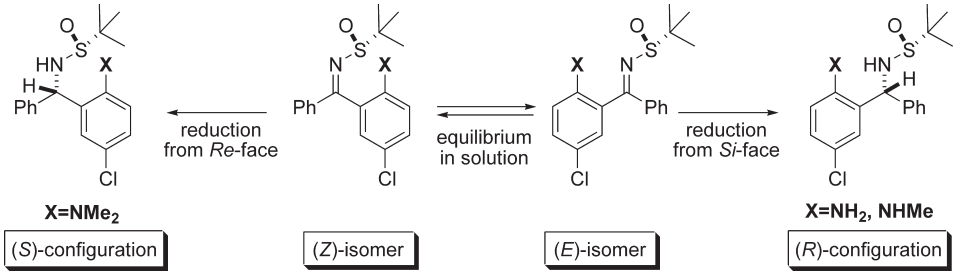

Chiral, nonracemic 1,3-diamines were prepared in a highly diastereoselective reduction of diaryl *N-tert*-butanesulfinylketimines. Correlation between facial selectivity of the reduction and *E* or *Z* geometry of the starting ketimines suggests involvement of a cyclic transition state for the reduction. The *ortho*-substituent controls the geometry of *N-tert*-butanesulfinylketimines in the solid state and provides additional stabilization of the cyclic transition state.

Introduction

Chiral, nonracemic 1,3-diamines have been successfully used in asymmetric synthesis[1] as chiral catalysts,[2] chiral reagents,[3,4] and chiral ligands.[5] Not surprisingly, the development of efficient synthetic methodologies to access enantiomerically pure 1,3-diamines has been a subject of intense research.[6]

In connection with our research program directed toward developing new ligands for asymmetric synthesis, we aimed to prepare chiral diamines **1** and **2** in enantiomerically pure form (Figure 1).

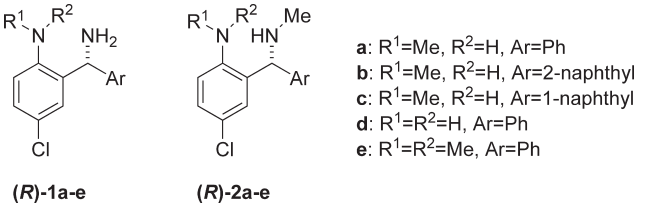

FIGURE 1. Target diamines **1** and **2**.

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(2) (a) Pini, D.; Mastantuono, A.; Uccello-Barretta, G.; Iuliano, A.; Salvadori, P. *Tetrahedron* **1993**, *49*, 9613. (b) Vedejs, E.; Kruger, A. W. *J. Org. Chem*. **1998**, *63*, 2792. (c) Yamashita, Y.; Odashima, K.; Koga, K. *Tetrahedron Lett*. **1999**, *40*, 2803. (d) Yamashita, Y.; Emura, Y.; Odashima, K.; Koga, K. *Tetrahedron Lett*. **2000**, *41*, 209. (e) Kano, T.; Maruoka, K. *Chem. Commun*. **2008**, 5465 and references cited therein. (f) Kano, T.; Yamaguchi, Y.; Maruoka, K. *Angew. Chem., Int. Ed*. **2009**, *48*, 1838. (g) Kano, T.; Yamamoto, A.; Shirozu, F.; Maruoka, K. *Synthesis* **2009**, 1557. (h) Kano, T.; Yamaguchi, Y.; Maruoka, K. *Chem.—Eur. J*. **2009**, *15*, 6678.
(3) For a recent review on the use of Tröger's base, see: Sergeyev, S. *Helv. Chim. Acta* **2009**, *92*, 415.
(4) Application of 1,3-diamines as chiral proton sources: (a) Vedejs, E.; Lee, N.; Sakata, S. T. *J. Am. Chem. Soc*. **1994**, *116*, 2175. (b) Vedejs, E.; Kruger, A. W.; Suna, E. *J. Org. Chem*. **1999**, *64*, 7863. (c) Vedejs, E.; Kruger, A. W.; Lee, N.; Sakata, S. T.; Stec, M.; Suna, E. *J. Am. Chem. Soc*. **2000**, *122*, 4602.
(5) (a) Kammermeier, T.; Wiegrebe, W. *Arch. Pharm*. **1994**, *327*, 563. (b) Grasa, G. A.; Zanotti-Gerosa, A.; Hems, W. P. *J. Organomet. Chem*. **2006**, *691*, 2332. (c) Hems, W. P.; Groarke, M.; Zanotti-Gerosa, A.; Grasa, G. A. *Acc. Chem. Res*. **2007**, *40*, 1340.
(6) For recent selected examples of asymmetric synthesis of chiral 1,3-diamines, see: (a) Rios-Lombardia, N.; Busto, E.; Garcia-Urdiales, E.; Gotor-Fernandez, V.; Gotor, V. *J. Org. Chem*. **2009**, *74*, 2571. (b) Dagousset, G.; Drouet, F.; Masson, G.; Zhu, J. *Org. Lett*. **2009**, *11*, 5546. (c) Terada, M.; Machioka, K.; Sorimachi, K. *Angew. Chem., Int. Ed*. **2009**, *48*, 2553. (d) Kurokawa, T.; Kim, M.; Du Bois, J. *Angew. Chem., Int. Ed*. **2009**, *48*, 2777. (e) Giampietro, N. C.; Wolfe, J. P. *J. Am. Chem. Soc*. **2008**, *130*, 12907. (f) Braun, W.; Calmuschi-Cula, B.; Englert, U.; Höfener, K.; Alberico, E.; Salzer, A. *Eur. J. Org. Chem*. **2008**, 2065. (g) Lu, S.-F.; Du, D.-M.; Xu, J.; Zhang, S.-W. *J. Am. Chem. Soc*. **2006**, *128*, 7418.

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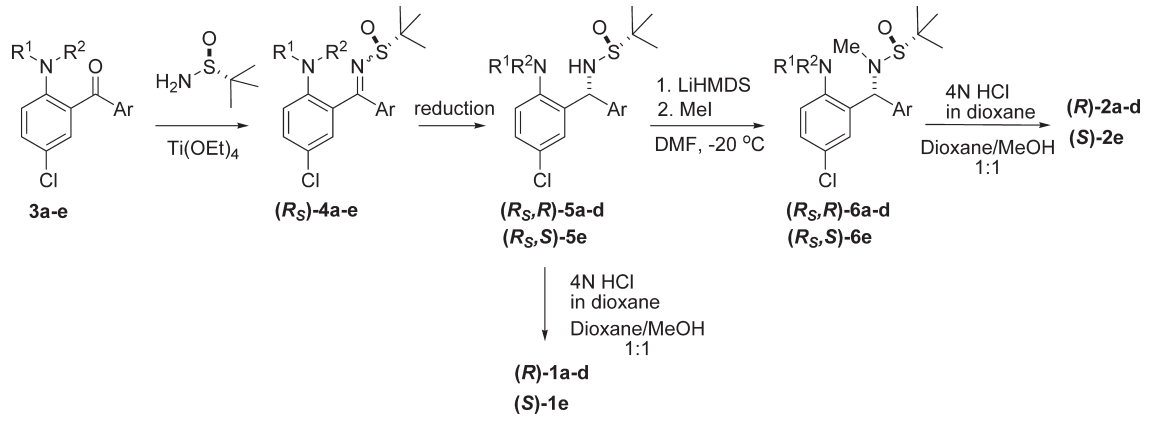
SCHEME 1. Synthesis of Enantiomerically Pure Diamines 1 and 2



We envisioned that Ellman's *tert*-butanesulfinyl group[7] could be a suitable chiral auxiliary for the synthesis of the desired diamines **1** and **2** in enantiomerically pure form via the corresponding chiral *N*-sulfinylketimines. Although a number of literature examples involving the use of ketone-derived substrates have appeared,[8] we anticipated the possibility of unusual directing effects with difunctional substrates as described later. Scheme 1 illustrates the synthesis of target structures.

Results and Discussion

Synthesis and Structural Analysis of Sulfinylimines 4a−i. Sulfinylimines **4a−d** were prepared in crystalline form by heating ketones **3a−d**[9] with (R_S)-*tert*-butanesulfinamide at 75 °C in the presence of $Ti(OEt)_4$.[8a] The X-ray crystallographic analysis helped to establish that sulfinylimines **4a−d** were formed as *E*-isomers. In crystal lattices of sulfinylimines **4a−d**, the distance between the nitrogen of the aniline and that of the sulfinyl group is 2.68−2.72 Å, indicating a hydrogen bond interaction between the aniline N−H and nitrogen of the imine[10] (see N1−N2 distances in entries 1−4, Table 1).

The intramolecular hydrogen bond enforces a *syn*-periplanar relationship between the aniline ring and the C=N bond of the imines **4a−d** (see C1−C2−C3−N2 torsion angles, Table 1), with the sulfoxide moiety placed in the *trans* position. As a consequence, the aryl substituent (phenyl or naphthyl group) is twisted out of the C=N plane to minimize nonbonded steric interactions with the bulky *tert*-butylsulfinyl group (see C5−C4−C3−N2 torsion angles, Table 1). Thus, the preferential formation of *E*-isomers of imines **4a−d** was attributed to the stabilization by the intramolecular hydrogen bond.[11]

While imine **4e** did not crystallize, single crystals of the closely related sulfinylimine **4i** were obtained. Surprisingly, X-ray analysis showed that imine **4i** exists as the *Z*-isomer in the crystalline form (entry 7, Table 1). Because imine (*Z*)-**4i** is unable to form an intramolecular hydrogen bond, we suggest that, in the absence of stabilizing hydrogen bond interactions, the *E* geometry for sulfinylimine **4i** is unfavorable due to the electrostatic repulsion between aniline and imine nitrogen lone pairs and nonbonded steric interactions between the *ortho*-substituent and the imine moiety. To verify the role of the intramolecular hydrogen bond in the selective formation of *E*-isomers, additional *ortho*-substituted ketimines **4f−h** incapable of forming the intramolecular hydrogen bond were prepared under standard conditions [(R_S)-*tert*-butanesulfinamide, 90 °C, $Ti(OEt)_4$]. Sulfinylimine **4h** was obtained as an oil, but imines **4f**,**g** could be crystallized. As anticipated, X-ray analysis of single crystals confirmed that **4f**,**g** exist as the *Z*-isomers in the crystalline form (entries 5 and 6, Table 1). In the observed *Z* geometry, the large *ortho*-substituted phenyl moieties of imines **4f**,**g**,**i** are turned out of the C=N plane (see C1−C2−C3−N2 torsion angles, Table 1). Consequently, the smaller unsubstituted phenyl group in sulfinylimines **4f**,**g**,**i** is periplanar to the C=N bond (see C5−C4−C3−N2 torsion angles, Table 1-). The predominance of the *Z*-isomers in ketimines **4f**,**g**,**i** is noteworthy as it has been traditionally considered that the most stable isomer has the sulfoxide moiety positioned *trans* to the larger C-substituent on the ketimine.[12]

Facile *E*/*Z* isomerization of individual conformers **4a−h** in solutions was observed by NMR spectroscopy (see Table 2), and the isomer ratio was found to depend on the solvent.[13]

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(8) (a) Liu, G.; Cogan, D. A.; Owens, T. D.; Tang, T. P.; Ellman, J. A. *J. Org. Chem.* **1999**, *64*, 1278. (b) Shaw, A. W.; deSolms, S. J. *Tetrahedron Lett.* **2001**, *42*, 7173. (c) Kochi, T.; Tang, T. P.; Ellman, J. A. *J. Am. Chem. Soc.* **2003**, *125*, 11276. (d) Kochi, T.; Ellman, J. A. *J. Am. Chem. Soc.* **2004**, *126*, 15652. (e) Chelucci, G.; Baldino, S.; Chessa, S.; Pinna, G. A.; Soccolini, F. *Tetrahedron: Asymmetry* **2006**, *17*, 3163. (f) Zhao, C.-H.; Liu, L.; Wang, D.; Chen, Y.-J. *Eur. J. Org. Chem.* **2006**, 2977. (g) Colyer, J. T.; Andersen, N. G.; Tedrow, J. S.; Soukup, T. S.; Faul, M. M. *J. Org. Chem.* **2006**, *71*, 6859. (h) Morton, D.; Pearson, D.; Field, R. A.; Stockman, R. A. *Chem. Commun.* **2006**, 1833. (i) Denolf, B.; Leemans, E.; De Kimpe, N. *J. Org. Chem.* **2007**, *72*, 3211. (j) Tanuwidjaja, J.; Peltier, H. M.; Ellman, J. *J. Org. Chem.* **2007**, *72*, 626. (k) Watzke, A.; Wilson, R. M.; O'Malley, S. J.; Bergman, R. G.; Ellman, J. A. *Synlett* **2007**, 2383. (l) Denolf, B.; Mangelinckx, S.; Törnroos, K. W.; De Kimpe, N. *Org. Lett.* **2007**, *9*, 187. (m) Lin, G.-Q.; Xu, M.-H.; Zhong, Y.-W.; Sun, X.-W. *Acc. Chem. Res.* **2008**, *41*, 831. (n) Guijarro, D.; Pablo, O.; Yus, M. *Tetrahedron Lett.* **2009**, *50*, 5386. (o) Leemans, E.; Mangelinckx, S.; De Kimpe, N. *Synlett* **2009**, 1265.

(9) For preparation of ketones **3a−h**, see Supporting Information, pages S2−S10.

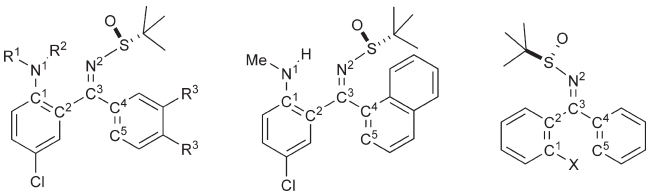
(10) Gilli, G. Molecules and Molecular Crystals. In *Fundamentals of Crystallography*; Giacovazzo, C., Ed.; Oxford University Press: New York, 2002; pp 590−595.

(11) Stabilization of the *E*-isomer in β-hydroxysulfinylketimines by the intramolecular hydrogen bond between the β-hydroxy group and the oxygen of sulfinyl imine has been suggested; see ref 8c.

(12) See for example: Chelucci, G.; Baldino, S.; Chessa, S. *Tetrahedron* **2006**, *62*, 619.

(13) For the influence of solvent on ratio of isomers, see: Stassinopoulou, C. I.; Zioudrou, C.; Karabatsos, G. J. *Tetrahedron* **1976**, *32*, 1147.

TABLE 1. Selected Crystallographic Parameters for Sulfinylketimines 4a−d,f,g,i



4a: R^1=CH_3, R^2=R^3=H
4b: R^1=CH_3, R^2=H, R^3=-$(CH)_4$-
4d: R^1=R^2=R^3=H

4c

4f: X=OMe
4g:X=Br
4i: X=NMe_2

entry	imine (R_S)-**4**	N^1-N^2 (Å)	$C^1-C^2-C^3-N^2$ torsion angle	$C^5-C^4-C^3-N^2$ torsion angle
1	(*E*)-**4a**	2.676	−7.8	110.8
2	(*E*)-**4b**[a]	2.721	15.5	91.5
3	(*E*)-**4c**[a]	2.678	−8.25	88.0
4	(*E*)-**4d**	2.676	−12.1	114.3
5	(*Z*)-**4f**		−64.5	−8.4
6	(*Z*)-**4g**		−76.6	−4.0
7	(*Z*)-**4i**		−66.6	3.5

[a]Average values of two molecules crystallized in a unit cell.

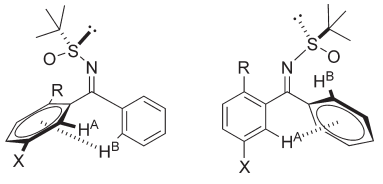
Thus, an 80:20 mixture of *E*/*Z*-isomers was obtained upon dissolving (*E*)-**4a** in THF-d_8 at 10 °C.[14] The aniline NH proton of the major diastereomer was shifted strongly downfield, appearing as a singlet at δ = 9.63 ppm and suggesting the involvement of the proton in a hydrogen bond. Lowering the temperature to −15 °C resulted in a further downfield drift of the chemical shift to 9.67 ppm. Furthermore, the N−^{1}H signal changed to a resolved quartet ($J_{Me,H}$ = 4.8 Hz), and ^{15}N−^{1}H splitting (J = 93 Hz) could also be observed. The temperature coefficient for the chemical shift of the aniline N−H resonance[15] ($\Delta\sigma_{HN}/\Delta T$ = −1.6 ppb/K) supported the presence of an intramolecular hydrogen bond. Consequently, the major isomer of **4a** in solution was assigned *E* geometry. The minor isomer appeared as two sets of signals in ca. 1:1 ratio with the aniline N−H resonance at δ = 4.72 and 4.69 ppm (THF-d_8, −15 °C, two quartets, J = 4.8 Hz). On the basis of two-dimensional NMR experiments,[16] the minor isomer was assigned as a mixture of two rotamers, (*Z*)-**4aA** and (*Z*)-**4aB**, with hindered rotation about the arylimine axis (see Figure 2).

Imine (*E*)-**4c** displayed two sets of signals in a ratio of 54:44 upon dissolving in THF-d_8 at −15 °C, thus pointing to the presence of geometrical isomers. Importantly, both isomers displayed strongly downfield shifted signals of aniline N−H (9.94 and 9.89 ppm, both quartets with J = 4.8 Hz), suggesting that the aniline N−H is involved in hydrogen bonding *in both isomers*. Consequently, the two sets of signals in the NMR spectrum of imine **4c** were assigned to two isomers of (*E*)-**4c** with hindered rotation about the naphthylimine axis, that is, (*E*)-**4cA** and (*E*)-**4cB** (see Figure 2). The absence of the (*Z*)-**4c** isomer in THF-d_8 (within NMR detection limits) suggests high stability of the *E*-isomer in solution.

The *E*/*Z* ratio in THF-d_8 was determined using similar NMR methods for all of the sulfinylimines **4b**,**d**−**h**[17] (see Table 2). The major isomers of imines, (*E*)-**4a**−**d** and (*Z*)-**4f**,**g** in THF-d_8 solution, were the same as those in the crystal lattice. However, the amount of minor *E*-isomers of imines **4f**,**g** in THF-d_8 reached ca. 30%. Furthermore, dissolving the crystalline (*Z*)-**4e** in THF-d_8 solution afforded the opposite isomer (*E*)-**4e** as the major component (*E*/*Z* = 65:35).

The observed fast equilibration of sulfinylimines **4a**−**h** in solutions at −15 °C would require relatively low energy barriers to *E*/*Z* isomerization.[18] Additional NMR experiments were therefore performed to determine the free energy of activation and rate constants for the *E*/*Z* isomerization of sulfinylimines **4a**−**h** in THF-d_8. These data were calculated from NOESY spectra comparing the intensities of diagonal and exchange cross-peaks.[19] The (*E*)-**4** to (*Z*)-**4** isomerization barriers in THF-d_8 range from 63.4 to 70.7 kJ/mol (see Table 2), and hence, they are higher than the activation barrier by 1.7−9 kJ/mol for the nonsubstituted diarylketimine **7** (61.7 kJ/mol;[20] see Table 2, entry 1).[21] The observed difference can be attributed to the influence of the *ortho*-substituent. Thus, (*E*)-**4a** is more stable than (*Z*)-**4a** by 3.9−5.2 kJ/mol, which is the highest energy difference in the series (entry 2, Table 2). Similarly, (*E*)-**4d** is more stable than (*Z*)-**4d** by 2.9 kJ/mol (entry 5). The higher stability of (*E*)-**4a**−**d** versus (*Z*)-**4a**−**d** can be tentatively attributed to the stabilizing effect of the hydrogen bond in the *E* configuration. A less pronounced preference for the *E*-isomer was observed for imines **4e**,**h** (Table 2, entries 6 and 9, respectively), which are incapable of forming the hydrogen bond. On the other hand, the *Z*-conformers have lower ground-state energy in the case of the structurally related imines **4f**,**g** (Table 2, entries 7 and 8, respectively). The origin of the small energetic preferences for **4e**−**g** in THF-d_8 solution is not clear.

The determined ground-state energy differences ($\Delta\Delta G^{\ddagger}_{258}$) correlate well with the equilibrium *E*/Z ratio in THF-d_8 (Table 2). Thus, the lowest barrier was established for imine (R_S)-**4h** (entry 9), which forms a 2:3 mixture of *E*- and *Z*-isomers. On the other hand, the highest barrier for (*E*)-**4a** translates into an 81:19 ratio of *E*/*Z*-isomers.



(*Z*)-**4** (*E*)-**4**

(14) In $CHCl_3$-*d* at −15 °C, the amount of major diastereomer of **4a** was 96.8%.

(15) Baxter, N. J.; Williamson, M. P. *J. Biomol. NMR* **1997**, *9*, 359.

(16) DQF-COSY, ROESY, NOESY, TOCSY, sensitivity-enhanced ^{13}C−H HSQC, and ^{13}C−^{1}H HMBC experiments.

(17) The *E*- and *Z*-isomers could be distinguished by comparing chemical shits of the H^A proton in the ^{1}H NMR spectra. Thus, H^A protons in *Z*-isomers were constantly shifted downfield ($\Delta\delta$ = 0.04−0.25 ppm) compared to those in *E*-isomers, presumably due to the shielding of the H^A by the phenyl ring. See the Supporting Information (Table S1, page S11) for details.

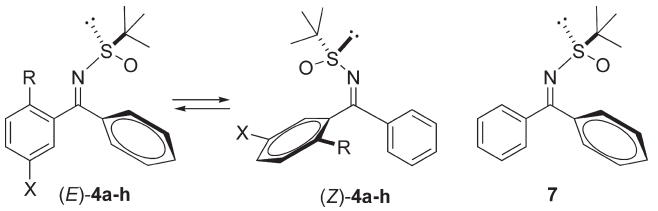
(18) Related diaryl sulfinylketimines were obtained as a rapidly interconverting mixtures of *Z*- and *E*-isomers; see ref 8b.

(19) (a) Perrin, C. L. *J. Magn. Reson.* **1989**, *82*, 619. (b) Dimitrov, V. S.; Vassilev, N. G. *Magn. Reson. Chem.* **1995**, *33*, 739. (c) Abel, E. W.; Coston, T. P. J.; Orrell, K. G.; Sik, V.; Stephenson, D. *J. Magn. Reson.* **1986**, *70*, 34. (d) Sandstrom, J. *Dynamic NMR Spectroscopy*; Academic Press: London, 1982.

(20) *E*/*Z* isomerization barrier in $CHCl_3$-*d* has been determined for structurally related *p*-toluenesulfinylketimines. (a) Di-(*p*-tolyl)methylene-*p*-toluenesulfinamide, 15 kcal/mol (62.8 kJ/mol): Annunziata, R.; Cinquini, M.; Cozzi, F. *J. Chem. Soc., Perkin Trans. 1* **1982**, 339. (b) Diphenylmethylene benzenesulfinamide, 14.1 kcal/mol (59.0 kJ/mol): Davis, F. A.; Kluger, E. W. *J. Am. Chem. Soc.* **1976**, *98*, 302.

(21) The free energy of activation, $\Delta G^{\ddagger}$, was determined by ^{13}C NMR at the coalescence temperature (50 °C) of the diastereotopic *ipso*-carbon atoms of diphenylsulfinylketimine **7** using the equation $K_c = 2.22\Delta\nu$ and the Eyring equation (k = 1); see ref 20b.

TABLE 2. Rate Constants and Free Energy of Activation for *E*/*Z* Isomerization of Sulfinylketimines 4a−h in THF-d_8



			$E \rightarrow Z$		$Z \rightarrow E$		
entry	imine	Z/E ratio, %[a]	k, s^{-1}	$\Delta G^{\ddagger}_{258}$ (kJ/mol)	k^{-1}, s^{-1}	$\Delta G^{\ddagger}_{258}$ (kJ/mol)	$\Delta\Delta G^{\ddagger}_{258}$ (kJ/mol)
1	(R_S)-**7**			**61.7**		**61.7**	**0**
2	(R_S)-**4a**	19[d]:81	0.12[b]	**68.3**[c]	0.74	**64.4**	**3.9**
			0.04	**70.7**	0.45	**65.5**	**5.2**
3	(R_S)-**4b**	23[d]:77	nd	nd	nd	nd	nd
4	(R_S)-**4c**	1:99[e]	nd	nd	nd	nd	nd
5	(R_S)-**4d**	20[d]:80	0.20	**66.3**	0.78	**63.4**	**2.9**
6	(R_S)-**4e**	35:65	0.11	**68.5**	0.20	**67.2**	**1.3**
7	(R_S)-**4f**	70:30	0.67	**63.7**	0.30	**65.5**	**1.8**
8	(R_S)-**4g**	67:33	0.39	**65.8**	0.20	**67.5**	**1.7**
9	(R_S)-**4h**	39:61	0.13	**68.2**	0.19	**67.3**	**0.9**

[a]Determined in THF-d_8 at −15 °C by NMR. [b]Rate coefficient values were determined separately for each rotamer (*Z*)-**4aA** and (*Z*)-**4aB** without assignment (see Figure 2). [c]Free energy of activation $\Delta G^{\ddagger}_{258}$ was calculated separately for conversion of (*E*)-**4a** to (*Z*)-**4aA** and (*Z*)-**4aB**. [d]Represents the sum of rotamers of the *Z*-isomer (see Figure 2). [e]Represents the sum of rotamers of (*E*)-**4cA** and (*E*)-**4cB** which exist in a 56:44 ratio (see Figure 2).

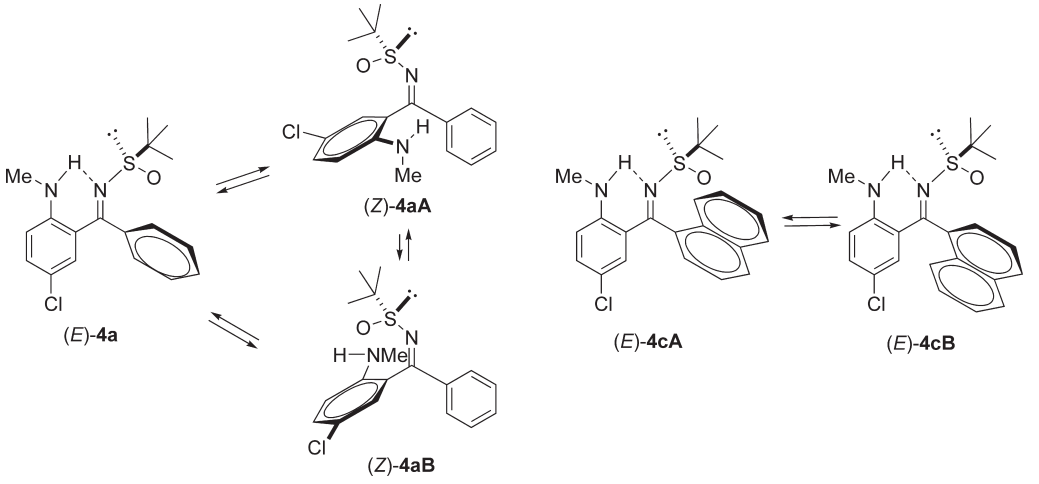


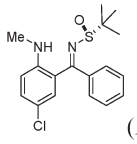
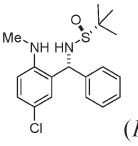
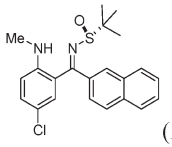
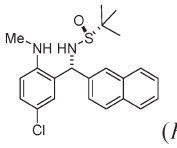
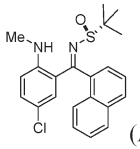
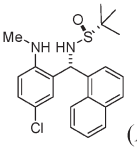
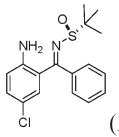
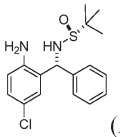
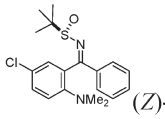
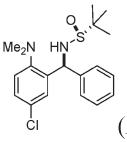
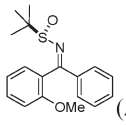
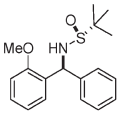
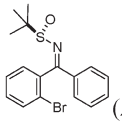
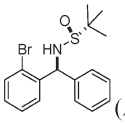
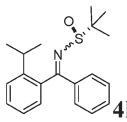
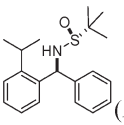
FIGURE 2. Isomers of imines **4a**,**c** in THF-d_8.

Diastereoselective Reduction of Sulfinylimines 4a−h. The reduction of imines **4a−h** was carried out using the two trivalent hydride reducing agents BH_3−THF and DIBAL at −78 °C in THF (Table 3, conditions A and B, respectively). Additionally, $NaBH_4$−$Ti(OEt)_4$[22] and $NaBH_4$ were also examined (Table 3, conditions C and D, respectively). The trivalent hydride reducing agents afforded superior diastereoselectivities in the reduction, DIBAL being the reducing agent of choice. Conditions C and D were less efficient, but the successful use of $NaBH_4$ is noteworthy because the reducing agent is virtually insoluble in THF. The initial stages of reduction evidently occur heterogeneously on the surface of the solid $NaBH_4$, but subsequent events may take place in solution as BH_3·THF or similar borane adducts are generated.

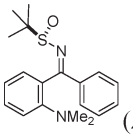
Excellent levels of diastereoselectivity were achieved in the reduction of imines **4a**,**c−e**,**g** using hydride reducing agents (Table 3, conditions A and B). Notably, the ratio of diastereomers in all cases exceeded the initial *E*/*Z* ratio of the starting imines (see Table 3), suggesting rapid *E*/*Z* interconversion at −78 °C on the time scale of the reduction. In a control experiment, solid (*E*)-**4a** was added to precooled (−78 °C) THF-d_8 and an ^{1}H NMR spectrum of the resulting suspension at −80 °C was acquired. Two sets of signals in a ratio of 82:18 were observed for the dissolved fraction, showing that spontaneous *E*/*Z* equilibration of

(22) (a) Borg, G.; Cogan, D. A.; Ellman, J. A. *Tetrahedron Lett.* **1999**, *40*, 6709. (b) Tanuwidjaja, J.; Peltier, H. M.; Ellman, J. *J. Org. Chem.* **2007**, *72*, 626.

TABLE 3. Diastereoselective Reduction of *tert*-Butanesulfinylimines 4a−h

Entry	Imine (R_S)-**4**[a]	*Z*:*E* ratio in THF[b] (%)	Reduction conditions[c]	d.r.[d]	Major diastereomer **5**[e]	Yield,[f] %
1	 (E)-**4a**	19:81	A	89:11	 (R_S,R)-**5a**	(99)
2			B	99:1		95
3			C	80:20		74
4			D	72:28		(99)
5	 (E)-**4b**	23:77	A	81:19	 (R_S,R)-**5b**	(99)
6			B	82:18		73
7			C	79:21		69
8			D	65:35		(99)
9	 (E)-**4c**	1:99	A	99:1	 (R_S,R)-**5c**	(99)
10			B	99:1		94
11			C	97:3		88
12			D	91:9		(99)
13	 (E)-**4d**	20:80	A	70:30	 (R_S,R)-**5d**	(99)
14			B	91:9		77
15			C	73:27		(99)
16			D	66:34		(99)
17	 (Z)-**4e**[g]	35:65	A	1:99	 (R_S,S)-**5e**	(99)
18			B	1:99		84
19			C	1:99		84
20			D	1:99		(99)
21	 (Z)-**4f**	70:30	A	6:94	 (R_S,S)-**5f**	80
22			B	24:76		(99)
23			C	20:80		74
24			D	20:80		(99)
25	 (Z)-**4g**	67:33	A	10:90	 (R_S,S)-**5g**	(99)
26			B	2:98		93
27			C	14:86		80
28			D	19:81		(99)
29	 **4h**	39:61	A	26:74	 (R_S,S)-**5h**	(99)
30			B	47:53		(99)
31			C	8:92		75
32			D	16:84		51

[a]Geometry of the C=N bond in crystalline material was determined by X-ray crystallographic analysis. [b]The *E*/*Z* ratio in THF-d_8 was determined at −15 °C by NOESY experiments. [c]Conditions A: BH_3·THF (1.6 equiv), −78 °C, THF, 3 h. Conditions B: DIBAL (3 equiv), −78 °C, THF, 3 h. Conditions C: $NaBH_4$−$Ti(OEt)_4$, −78 °C to room temperature. Conditions D: $NaBH_4$, THF, room temperature, 3 h. [d]Determined by ^{1}H NMR and HPLC assay for the crude reduction mixture. [e]Relative configuration of the major diastereomer **5** determined by X-ray crystallographic analysis. [f]Yield of the major diastereomer; in parentheses: conversion of imines **4a**−**h**. [g]Assignment based on structural analogy with (*Z*)-(R_S)-**4i**.


(Z)-(R_S)-**4i**

imine (*E*)-**4a** occurs in THF-d_8 solution under the reduction conditions.[23]

The reduction of **4b**,**f**,**h** afforded sulfinamides with lower diastereomeric ratios. Nevertheless, minor diastereomers of sulfinylamides **5a**−**h** could be readily separated by flash column chromatography, thus increasing the purity of the major diastereomers **5a**−**h** to >99:1 dr.

The relative configuration at the newly created asymmetric carbon was determined for all reduction products **5a**−**h** by X-ray crystallographic analysis. Sulfinylamides **5a**−**d** were formed with the *R* absolute configuration at the newly created asymmetric center, while reduction products **5e**−**h** possessed the *S* configuration. Intriguingly, the sense of asymmetric induction is in good correlation with the favored *E* or *Z* configuration of the starting imines **4a**−**g** in *the crystalline form*. Thus, the reduction of (*E*)-**4a**−**d** resulted in the formation of (R_S,*R*)-**5a**−**d**, while (*Z*)-**4e**−**h** afforded sulfinylamides (R_S,*S*)-**5e**−**h**. The observed correlation is striking, given the observed isomerization of individual *E*- or *Z*-conformers of imines **5a**−**h** upon dissolving in THF-d_8.

To better understand the putative relationship between the sense of asymmetric induction and *E*/*Z* configuration of the starting imines **4a**−**h**, the influence of the intramolecular hydrogen bond on the diastereoselectivity of the reduction was evaluated. Thus, $NaBH_4$ reduction of imine (*E*)-**4c** was attempted in protic solvents that may disrupt the hydrogen bond between the aniline N−H and nitrogen of the imine. The diastereoselectivity of the reduction of imine (*E*)-**4c** was considerably lower in ethanol (dr = 70:30) and methanol (dr = 67:33), compared to that in THF (dr = 91:9, conditions D; see Table 3, entry 12), suggesting an involvement of the intramolecular hydrogen bond in the stabilization of the transition state for the reduction of imines (*E*)-**4a**−**d**. Consequently, it appears that the hydrogen bonding may be responsible both for the solid-state geometry and for the transition-state preferences of imines (*E*)-**4a**−**d**.

For reductions under conditions A and B (see Table 3), a chelation-controlled reduction mechanism[24] is proposed, where borane forms an "ate" complex with sulfinyl oxygen,[25] ensuring the internal sulfoxide-mediated delivery of hydride from the *Si* face of the C=N bond to afford sulfinylamides (R_S,*R*)-**5a**−**d**.

In the preferred chairlike conformation of the six-center transition state for the (*E*)-sulfinylimines (**TS-1**, Figure 3), the bulky *t*-Bu group and large aniline substituent are placed equatorially and the smaller phenyl group is in the axial position. The intramolecular hydrogen bond between the aniline N−H and nitrogen of the imine stabilizes the favored *E* conformation of sulfinylimines **4a**−**d** in the transition state (**TS-1**). Assuming that the reduction of sulfinylimines occurs via a cyclic transition state and internal sulfoxide-mediated delivery of borane, the isomeric (*Z*)-sulfinylimines **4e**−**h** should afford sulfinylamides (R_S,*S*)-**5e**−**h** with the opposite,

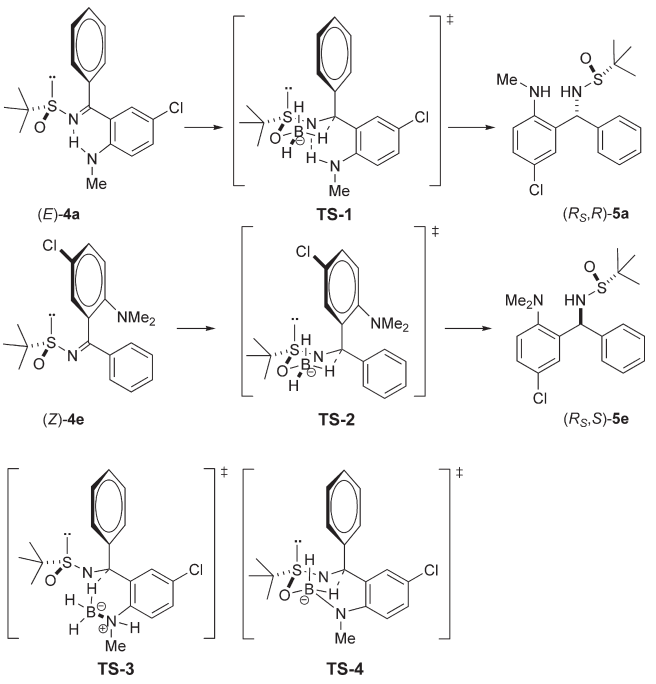


FIGURE 3. Transition states for the reduction of imines **4a**−**h**.

that is, *S* absolute configuration. Indeed, (R_S,*S*)-**5e**−**h** are formed as the major diastereomers (Table 3). However, the observed diastereoselectivity for reduction of **4e**−**h** does not correlate with the *E*/*Z* ratio *in solution*, and in some cases (for example, **4e**), diastereomeric ratio is much higher than the *E*/*Z* ratio. This outcome means that the diastereoselectivity for **4e**−**h** is controlled by the relative reactivity of *E*- and *Z*-isomers in the equilibrating *E*/*Z* mixture. Notably, the more reactive conformation of the cyclic transition state **TS-2** implies that the large *ortho*-substituted aryl moiety is placed in an axial position to ensure the delivery of hydride via a six-membered transition state from the *Re* face of the sulfinylimines (*Z*)-**4e**−**h** (see Figure 3). On the other hand, a simple steric explanation is not sufficient to explain the detailed trends for **4e**−**h** because the actual diastereomeric ratio varies considerably depending on the reducing agent and the *ortho*-substituent. We do not have sufficient evidence to comment further on the origins of this diastereoselectivity preference.

An alternative mechanism is also plausible where the N−H group of anilines **4a**−**d** forms a covalent N−B or N−Al bond with BH_3−THF or DIBAL. Subsequent internal hydride transfer from the transient amidometallohydrides occurs to the less sterically hindered *Si* face of the C=N bond, affording (R_S,*R*)-**5a**−**d** (see **TS-3**, Figure 3).[26] A synergistic directing effect of both the sulfinyl oxygen and aniline nitrogen could also be envisioned (see **TS-4**, Figure 3). We could not rule out these possibilies, although we regard the mechanism via **TS-1** to be sufficiently plausible and consistent with available data for most experiments.

The sense of asymmetric induction in the case of Ellman's conditions ($NaBH_4$−$Ti(OEt)_4$, −78 °C, THF) as well as by using $NaBH_4$ (room temperature, THF) matches that obtained in the reduction by BH_3−THF complex and DIBAL. Thus, (*E*)-**4a**−**d** afforded (R_S,*R*)-**5a**−**d**, while (*Z*)-**4e**−**h**

(23) An 81:19 mixture of *E*/*Z*-isomers was formed in THF-d_8 at −15 °C (see Table 3).

(24) Cyclic six-membered transition state has been proposed in the reduction of sulfinylketimines with DIBAL: (a) Hose, D. R. J.; Mahon, M. F.; Molloy, K. C.; Raynham, T.; Wills, M. *J. Chem. Soc., Perkin Trans. 1* **1996**, 691. (b) Ref 12.

(25) Atomic charge calculations have demonstrated considerable negative charge on oxygen in sulfinylimines: Bharatam, P. V.; Uppal, P.; Kaur, D. *J. Chem. Soc., Perkin Trans. 2* **2000**, 43.

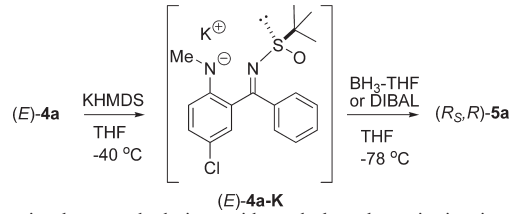
yielded (R_S,S)-**5e**−**h** (Table 3). The highest diastereoselectivity in reductions with anionic hydride sources was observed for **4e** (dr = 99:1, see Table 3). Nevertheless, rationalization of the reduction stereochemistry in the case of the $NaBH_4$−$Ti(OEt)_4$ system is a challenging task given the lack of knowledge about the structure of the "true" reducing species.[27] In the case of $NaBH_4$ reductions, the cyclic six-membered transition state may not be an appropriate model because the four-coordinated BH_4^- "ate" complex cannot interact with oxygen of the sulfinyl group,[28] and the reaction may involve additional hydride donors formed after the initial hydride transfer.

Conversion of Reduction Products 5a−e To Target Diamines 1 and 2. The chiral auxiliary was readily cleaved without racemization of the created chiral center by treatment of sulfinamides (R_S,R)-**5a**−**d** and (R_S,S)-**5e** with 4 N HCl in dioxane (see Scheme 1). Introduction of an *N*-methyl group at the benzylic nitrogen was performed prior to the removal of the chiral auxiliary from (R_S,R)-**5a**−**d** and (R_S,S)-**5e**. The regioselective alkylation of N-deprotonated sulfinamide in the presence of aniline N−H was possible by using LiHMDS as a base.

Conclusions

The key step in the synthesis of chiral, nonracemic diamines **1** and **2** was the highly diastereoselective reduction of diaryl *tert*-butanesulfinylimines. Both the structure of the starting imines **4a**−**h** and the relative configuration of the reduction products **5a**−**h** were determined by X-ray crystallographic analysis. The sense of asymmetric induction was found to be in good correlation with *E* or *Z* geometry of the starting imines **4a**−**h** in the crystalline form. Thus, (*E*)-imines **4a**−**d** were reduced to (R_S,R)-**5a**−**d** with *R* configuration at the newly created chiral center, while (*Z*)-**4e**−**h** afforded sulfinylamides (R_S,S)-**5e**−**h** with *S* configuration. This correlation could be rationalized assuming that the reduction with BH_3−THF and DIBAL occurs via the cyclic transition state and internal sulfoxide-mediated delivery of borane or via internal hydride transfer from transient amidometallohydrides. In solution, fast *E*/*Z* isomerization of sulfinylimines **4a**−**h** was observed and the equilibrium ratio was found to depend on the solvent. The free energy of activation for *E*/*Z* isomerization in THF-d_8 for all sulfinylimines **4a**−**h** was determined by NMR methods to range from 63.4 to 70.7 kJ/mol. Calculated differences of the ground-state energies of *E*- and *Z*-isomers correspond to the equilibrium ratio of *E*/Z-conformers in THF-d_8.

(26) A control experiment was performed under conditions where the TS stabilization by hydrogen bonding is not possible. Thus, (*E*)-**4a** was deprotonated and the resulting salt (*E*)-**4a-K** was reduced with BH_3−THF (dr = 82:18, 99% coversion) and DIBAL (dr = 82:18, 50% conversion) under standard conditions (see Table 3, conditions A and B). The diastereoselectivity of the reduction was lower compared to that of parent imine (*E*)-**4a** (see Table 3, entries 1 and 2), and it correlated well with the *E*/*Z* = 81:19 ratio of starting (*E*)-**4a**.



(*E*)-**4a-K**

The atomic charge calculation evidenced that the anionic nitrogen has stronger negative charge than the sulfinyl oxygen. Consequently, a scenario where the initial binding of BH_3 or DIBAL to the anion to afford an amidometallohydride prior to the H transfer is conceivable. The observed correlation with *E*/*Z* ratio of starting (*E*)-**4a** suggests an increased barrier for *E*/*Z* interconversion for the anion, which slows down the rate of equilibration on the reduction time scale.

(27) It has been demonstrated that the reaction between $TiCl_4$ and $LiBH_4$ afforded two potent reducing agents—$Ti(BH_4)_3$ and diborane: (a) Hoekstra, H. R.; Katz, J. J. *J. Am. Chem. Soc.* **1949**, *71*, 2488. See also: (b) Jensen, J. A.; Wilson, S. R.; Girolami, G. S. *J. Am. Chem. Soc.* **1988**, *110*, 4977.

(28) Nevertheless, involvement of the cyclic transition state has been suggested for reductions with anionic hydride sources: (a) with $LiAlH_4$ (ref 20a). (b) with $NaBH_4$ (refs 8g and 8i).

Experimental Section

General Procedure for the Condensation of Ketones with (R_S)-*tert*-Butanesulfinamide. To a solution of appropriate ketone **3** (1.0 equiv) and (R_S)-*tert*-butanesulfinamide[29] (1.0 equiv) in anhydrous THF (5 mL/mmol of ketone **3**) under an argon atmosphere in an ACE pressure tube was added neat $Ti(OEt)_4$ (Alfa Aesar, Vertec, 99+%, 4.0 equiv). The pressure tube was sealed and heated for 12 h at 75 °C (sulfinylimines **4a**−**d**) or 90 °C (sulfinylimines **4e**−**i**), cooled to ambient temperature, and poured into a mixture of brine (20 mL/mmol of ketone **3**) and EtOAc (20 mL/mmol of ketone **3**). The resulting slurry was filtered throught a plug of Celite (3 × 5 cm), and the filter cake was washed with EtOAc (50 mL/mmol of ketone **3**). Organic layer from the filtrate was washed with brine, dried over Na_2SO_4, and concentrated. The residue was purified by column chromatography on silica gel.

(R_S)-*N*-[(*E*)-[5-Chloro-2-(methylamino)phenyl](phenyl)methylidene]-2-methyl-2-propanesulfinamide (4a). Following the general procedure, ketone **3a** (500 mg, 2.0 mmol) was converted into sulfinylimine **4a**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 45% EtOAc/petroleum ether afforded **4a** as a yellow solid (500 mg, 78% yield); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.14. Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 126−128 °C; IR (film, cm^{-1}) 3213 (NH), 1529 (N=C), 1078 (S=O); ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 9.69−9.45 (1H, s), 7.52−7.38 (3H, m), 7.29−7.13 (3H, m), 6.84 (1H, d, J = 2.2 Hz), 6.66 (1H, d, J = 9.0 Hz), 2.98 (3H, d, J = 4.0 Hz), 1.21 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 182.0, 150.8, 136.5, 134.3, 129.3, 128.4, 127.7, 118.6, 117.6, 112.4, 55.4, 29.8, 22.2. Anal. Calcd for $C_{18}H_{21}ClN_2OS$: C, 61.97; H, 6.07; N, 8.03. Found: C, 61.73; H, 5.98; N, 7.87. Optical rotation $[\alpha]^{20}_D$ −157.4 (*c* 4.45, EtOH).

(R_S)-*N*-[(*E*)-[5-Chloro-2-(methylamino)phenyl](2-naphthyl)methylidene]-2-methyl-2-propanesulfinamide (4b). Following the general procedure, ketone **3b** (500 mg, 1.7 mmol) was converted into sulfinylimine **4b**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 100% EtOAc afforded **4b** as a yellow solid (528 mg, 78%); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.14. Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 129−131 °C; IR (film, cm^{-1}) 3215 (NH), 1565 (N=C), 1077 (S=O); ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 9.71−9.58 (1H, br s), 8.02−7.84 (3H, m), 7.76 (1H, s), 7.63−7.53 (2H, m), 7.38−7.27 (2H, m), 6.89 (1H, d, J = 2.0 Hz), 6.72 (1H, d, J = 9.0 Hz), 3.04 (3H, s), 1.26 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 180.0, 149.0, 132.3, 132.0, 131.3, 130.5, 126.7, 126.4, 126.0, 125.3, 125.1, 123.2, 116.9, 115.6, 110.5, 53.7, 27.9, 20.3. Anal. Calcd for $C_{22}H_{23}ClN_2OS$: C, 66.23; H, 5.81;

(29) Synthesized according to the reported procedure: Cogan, D. A.; Liu, G.; Kim, K.; Backes, B. J.; Ellman, J. A. *J. Am. Chem. Soc.* **1998**, *120*, 8011.

N, 7.02. Found: C, 66.09; H, 5.76; N, 6.99. Optical rotation $[\alpha]^{20}_D$ −121.1 (*c* 4.09, EtOH).

(*R*$_S$)-*N*-[(*E*)-[5-Chloro-2-(methylamino)phenyl](1-naphthyl)methylidene]-2-methyl-2-propanesulfinamide (4c). Following the general procedure, ketone **3c** (500 mg, 1.7 mmol) was converted into sulfinylimine **4c**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 100% EtOAc afforded **4c** as a yellow solid (251 mg, 37% yield); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.12. Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 162−164 °C; IR (film, cm^{-1}) 3210 (NH), 1535 (N=C), 1080 (S=O); ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 9.79−9.56 (1H, m), 7.97−7.75 (2H, m), 7.63−7.50 (1H, m), 7.49−7.40 (2H, m), 7.37−7.28 (1H, m), 7.21−7.07 (2H, m), 6.73−6.59 (2H, m), 2.99 (3H, d, *J* = 5.0 Hz), 1.18−1.07 (9H, m); ^{13}C NMR (100 MHz, $CDCl_3$, ppm; a mixture of two rotamers (*Z*)-**4cA** and (*Z*)-**4cB**) δ 182.7, 180.4, 150.8, 150.8, 134.8, 134.4, 134.3, 134.1, 133.8, 133.7, 133.2, 133.1, 130.2, 130.0, 129.6, 129.6, 128.7, 128.2, 127.6, 127.0, 126.4, 126.3, 125.7, 125.6, 125.3, 125.2, 124.3, 119.0, 118.8, 117.6, 117.4, 112.5, 55.9, 54.5, 29.9, 29.9, 22.3. Anal. Calcd for $C_{22}H_{23}ClN_2OS$: C, 66.23; H, 5.81; N, 7.02. Found: C, 66.01; H, 5.75; N, 6.94. Optical rotation $[\alpha]^{20}_D$ −110.2 (*c* 3.80, EtOH).

(*R*$_S$)-*N*-[(*E*)-(2-Amino-5-chlorophenyl)(phenyl)methylidene]-2-methyl-2-propanesulfinamide (4d). Following the general procedure, ketone **3d** (500 mg, 2.16 mmol) was converted into sulfinylimine **4d**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 60% EtOAc/petroleum ether afforded **4d** as a yellow solid (555 mg, 78%); analytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.24. Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 142−143 °C; IR (film, cm^{-1}) 3367 (NH_2), 1461 (N=C), 1049 (S=O); ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 7.60−7.38 (3H, m), 7.34−7.08 (2H, m), 7.01−6.78 (2H, m), 6.69 (1H, d, *J* = 8.6 Hz), 3.99−3.51 (2H, br s), 1.26 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 181.9, 149.28, 136.5, 133.5, 129.4, 128.4, 127.6, 118.3, 55.7, 22.3. Anal. Calcd for $C_{17}H_{19}ClN_2OS$: C, 60.98; H, 5.72; N, 8.37. Found: C, 61.12; H, 5.63; N, 8.18. Optical rotation $[\alpha]^{20}_D$ −105.3 (*c* 1.95, EtOH).

(*R*$_S$)-*N*-[(*Z*)-[5-Chloro-2-(dimethylamino)phenyl](phenyl)methylidene]-2-methyl-2-propanesulfinamide (4e). Following the general procedure, ketone **3e** (300 mg, 1.16 mmol) was converted into sulfinylimine **4e**. Purification of the crude product by column chromatography using gradient elution from, 6% EtOAc/petroleum ether to 40% EtOAc/petroleum ether afforded the desired product as a yellow foam (250 mg, 60% yield); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.31: IR (film, cm^{-1}) 1558 (N=C), 1081 (S=O); ^{1}H NMR (400 MHz, $CDCl_3$, ppm; a mixture of *Z*- and *E*-isomers) δ 7.85−7.73 (2H, m), 7.55−7.48 (1H, m), 7.45−7.38 (2H, m), 7.32 (1H, d, *J* = 8.0 Hz), 7.10−6.90 (2H, m), 2.72 (6H, s), 1.40−1.17 (9H, m); ^{13}C NMR (100 MHz, $CDCl_3$, ppm; a mixture of *Z*- and *E*-isomers) δ 171.8, 150.5, 149.6, 138.9, 137.3, 132.3, 131.7, 130.6, 130.3, 130.2, 129.5, 129.3, 128.8, 128.4, 124.9, 124.4, 118.8, 118.6, 57.6, 57.2, 43.2, 42.8, 23.2, 22.2; HRMS-ESI (*m*/*z*) calcd for $C_{19}H_{24}N_2OS^{35}Cl$ $[M + H]^+$ 363.1298, found 363.1326. Optical rotation $[\alpha]^{20}_D$ −134.9 (*c* 1.61, EtOH).

(*R*$_S$)-*N*-[(*Z*)-(2-Methoxyphenyl)(phenyl)methylidene]-2-methyl-2-propanesulfinamide (4f). Following the general procedure, ketone **3f** (336 mg, 1.59 mmol) was converted into sulfinylimine **4f**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 40% EtOAc/petroleum ether afforded **4f** as a yellow solid (394 mg, 79% yield); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.20. Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 99−101 °C; IR (film, cm^{-1}) 1560 (N=C), 1084 (S=O); ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 7.73 (2H, d, *J* = 7.2 Hz), 7.52−7.42 (2H, m), 7.40−7.36 (2H, m), 7.22 (1H, br s), 7.07−6.95 (2H, m), 3.80 (3H, s), 1.30 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 175.3, 155.8, 138.2, 131.9, 130.9, 129.4, 129.1, 128.3, 125.2, 120.1, 111.1, 110.6, 56.7, 55.4, 22.5. Anal. Calcd for $C_{18}H_{21}ClNO_2S$: C, 68.54; H, 6.71; N, 4.44. Found: C, 68.42; H, 6.63; N, 4.38. Optical rotation $[\alpha]^{20}_D$ −126.3 (*c* 4.81, EtOH).

(*R*$_S$)-*N*-[(*Z*)-(2-Bromophenyl)(phenyl)methylidene]-2-methyl-2-propanesulfinamide (4g). Following the general procedure, ketone **3g** (500 mg, 1.92 mmol) was converted into sulfinylimine **4g**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 20% EtOAc/petroleum ether afforded **4g** as a yellow solid (414 mg, 60%); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.32. Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 72−74 °C; IR (film, cm^{-1}) 1563 (N=C), 1086 (SO); ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 7.72−7.62 (3H, m), 7.56−7.47 (1H, m), 7.47−7.16 (5H, m), 1.33 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm; a mixture of *Z*- and *E*-isomers) δ 175.9, 137.5, 136.9, 132.6, 132.4, 132.3, 132.2, 130.6, 130.1, 128.9, 128.6, 128.2, 127.1, 126.8, 125.5, 119.8, 58.7, 57.0, 22.8, 22.5. Anal. Calcd for $C_{17}H_{18}BrNOS$: C, 56.05; H, 4.98; N, 3.84. Found: C, 56.09; H, 4.87; N, 3.87. Optical rotation $[\alpha]^{20}_D$ −123.4 (*c* 0.99, EtOH).

(*R*$_S$)-*N*-[(*Z*)-(2-Isopropylphenyl)(phenyl)methylidene]-2-methyl-2-propanesulfinamide (4h). Following the general procedure, ketone **3h** (340 mg, 1.51 mmol) was converted into sulfinylimine **4h**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 20% EtOAc/petroleum ether afforded **4h** as an yellow oil (331 mg, 67%); analytical TLC on silica gel, 4:10 EtOAc/petroleum ether, R_f = 0.44: IR (film, cm^{-1}) 1560 (N=C), 1073 (S=O); ^{1}H NMR (400 MHz, $CDCl_3$, ppm; a mixture of *Z*- and *E*-isomers) δ 7.78−7.68 (2H, m), 7.53−7.35 (5H, m), 7.33−7.23 (1.5H, m), 7.03−6.97 (0.5H, m), 2.79−2.55 (1H, m), 1.36−1.26 (11H, m), 1.25−1.20 (1H, m), 1.02−0.95 (3H, m); ^{13}C NMR (100 MHz, $CDCl_3$, ppm; a mixture of *Z*- and *E*-isomers) δ 180.8, 179.5, 146.0, 144.8, 138.3, 137.9, 135.5, 134.6, 132.4, 129.7, 129.6, 129.4, 128.7, 128.4, 126.9, 126.1, 125.6, 125.4, 56.6, 56.3, 31.6, 31.2, 24.1, 24.0, 23.9, 23.5, 22.6, 22.3; HRMS-ESI (*m*/*z*) calcd for $C_{20}H_{26}NOS$ $[M + H]^+$ 328.1735, found 328.1717. Optical rotation $[\alpha]^{20}_D$ −69.7 (*c* 4.73, EtOH).

(*R*$_S$)-*N*-[(*Z*)-[2-(Dimethylamino)phenyl](phenyl)methylidene]-2-methyl-2-propanesulfinamide (4i). Following the general procedure, ketone **3i** (342 mg, 1.52 mmol) was converted into sulfinylimine **4i**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 40% EtOAc/petroleum ether afforded **4i** as a yellow solid (250 mg, 51%); analytical TLC on silica gel, 4:10 EtOAc/petroleum ether, R_f = 0.28. Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 76−78 °C; IR (film, cm^{-1}) 1533 (N=C), 1083 (S=O); ^{1}H NMR (400 MHz, $CDCl_3$, ppm; a mixture of *Z*- and *E*-isomers) δ 7.88−7.75 (2H, m), 7.54−7.46 (1H, m), 7.44−7.34 (3H, m), 7.21−7.14 (0.5H, m), 7.09−6.88 (2.5H, m), 2.81−2.65 (6H, m), 1.40−1.14 (9H, m); ^{13}C NMR (100 MHz, $CDCl_3$, ppm; a mixture of *Z*- and *E*-isomers) δ 177.7, 175.4, 151.8, 150.9, 139.2, 138.0, 132.0, 131.6, 130.9, 130.8, 130.5, 129.7, 129.6, 129.3, 128.2, 127.3, 120.0, 119.3, 117.6, 117.4, 56.9, 43.3, 42.9, 23.0, 22.2. Anal. Calcd for $C_{19}H_{24}N_2OS$: C, 69.48; H, 7.36; N, 8.53. Found: C, 69.21; H, 7.38; N, 8.47. Optical rotation $[\alpha]^{20}_D$ −88.1 (*c* 1.78, EtOH).

General Procedure A for the Reduction of *N*-*tert*-Butanesulfinylimines 4a−h with BH_3−THF. Sulfinylimine **4** (1.0 equiv) was dissolved in anhydrous THF (10 mL/mmol of imine **4**) and cooled to −78 °C under argon atmosphere. Borane−THF complex (1.0 M solution in THF, 1.6 equiv) was added dropwise, and the resulting solution was stirred at −78 °C for 3 h, whereupon it was quenched at −78 °C with brine (50 mL/mmol of imine **4**). After warming to room temperature, EtOAc

(50 mL/mmol of imine **4**) was added and layers were separated. The organic phase was washed with brine, dried over Na_2SO_4, and concentrated. An aliquot of the crude product was submitted to ^1H NMR and HPLC analysis to determine the diastereoselectivity of the reduction. Diastereomerically pure product was obtained after purification by column chromatography on silica gel.

General Procedure B for the Reduction of *N*-*tert*-Butanesulfinylimines 4a−h with DIBAL. Sulfinylimine **4** (1.0 equiv) was dissolved in anhydrous THF (5.0 mL/mmol of imine **4**) and cooled to −78 °C under argon atmosphere. Diisobutylaluminum hydride (1.0 M solution in hexanes, 3.0 equiv) was added dropwise, and the resulting solution was stirred at −78 °C for 3 h, whereupon it was quenched at −78 °C with brine (12 mL/mmol of imine **4**). After warming to room temperature, EtOAc (15 mL/mmol of imine **4**) was added and layers were separated. The organic phase was washed with brine, dried over Na_2SO_4, and concentrated. An aliquot of the crude product was submitted to ^1H NMR and HPLC analysis to determine the diastereoselectivity of the reduction. Diastereomerically pure product was obtained after purification by column chromatography on silica gel.

General Procedure C for the Reduction of *N*-*tert*-Butanesulfinylimines 4a−h with $NaBH_4$ in the Presence of $Ti(OEt)_4$. $NaBH_4$ (5.0 equiv) was added to a solution of $Ti(OEt)_4$ (2.0 equiv) in anhydrous THF (3 mL/mmol of imine **4**), and the resulting suspension was cooled to −78 °C under argon atmosphere. A solution of sulfinylimine **4** (1.0 equiv) in anhydrous THF (3 mL/mmol of imine **4**) was added dropwise at −78 °C, and the mixture was gradually warmed to room temperature and left to stir for 12 h, whereupon it was poured into a mixture of brine (20 mL/mmol of imine **4**) and EtOAc (20 mL/mmol of imine **4**). The resulting slurry was filtered throught a plug of Celite (3 × 5 cm), and the filter cake was washed with EtOAc (50 mL/mmol of imine **4**). Organic layer from the filtrate was washed with brine, dried over Na_2SO_4, and concentrated. An aliquot of the crude product was submitted to ^1H NMR and HPLC analysis to determine the diastereoselectivity of the reduction. Diastereomerically pure product was obtained after purification by column chromatography on silica gel.

General Procedure D for the Reduction of *N*-*tert*-Butanesulfinylimines 4a−h with $NaBH_4$. Sodium borohydride ($NaBH_4$) (5.0 equiv) was added portionwise to a solution of the imine (1.0 equiv) in anhydrous THF (5 mL/mmol of imine **4**) at room temperature. After stirring for 3 h, the suspension was poured into a mixture of brine (30 mL/mmol of imine **4**) and EtOAc (30 mL/mmol of imine **4**). Layers were separated, and the organic phase was dried over anhydrous Na_2SO_4 and concentrated. An aliquot of the crude product was submitted to ^1H NMR and HPLC analysis to determine the diastereoselectivity of the reduction. Diastereomerically pure product was obtained after purification by column chromatography on silica gel.

(R_S)-*N*-[(*R*)-[5-Chloro-2-(methylamino)phenyl](phenyl)methyl]-2-methyl-2-propanesulfinamide (5a). Following the general procedure B for the reduction, sulfinylimine **4a** (555 mg, 1.59 mmol) was converted into **5a**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 50% EtOAc/petroleum ether afforded **5a** as a white solid (526 mg, 95% yield); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.19. Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 144−146 °C; IR (film, cm^{-1}) 3368 (NH), 1052 (S=O); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.42−7.32 (5H, m), 7.17 (1H, dd, J = 8.6, 2.6 Hz), 6.62 (1H, d, J = 9.0 Hz), 6.60 (1H, d, J = 2.6 Hz), 5.58 (1H, d, J = 2.6 Hz), 5.14−4.99 (1H, br s), 3.56 (1H, d, J = 1.6 Hz), 2.90 (3H, s), 1.27 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 144.9, 139.8, 129.0, 128.6, 128.6, 128.2, 128.0, 126.9, 120.9, 111.8, 56.6, 55.8, 30.4, 22.5. Anal. Calcd for $C_{18}H_{23}ClN_2OS$: C, 61.54; H, 6.68; N, 7.93. Found: C, 61.59; H, 6.55; N, 7.93. Optical rotation (99% de, HPLC/csp) $[\alpha]^{20}_D$ −65.8 (*c* 3.65, EtOH). HPLC/csp assay: Daicel CHIRALPAK IA, 25 cm × 4.6 mm i.d., mobile phase 6% IPA/94% Hex, flow rate 0.9 mL/min, detector UV 254 nm, retention time 7.5 min ((*R*,R_S)-**5a**) major and 10.7 min ((*S*,R_S)-**5a**) minor.

(R_S)-*N*-[(*R*)-[5-Chloro-2-(methylamino)phenyl](2-naphthyl)methyl]-2-methyl-2-propanesulfinamide (5b). Following the general procedure B for the reduction, sulfinylimine **4b** (528 mg, 1.32 mmol) was converted into **5b**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 20% EtOAc/petroleum ether afforded **5b** as a white solid (386 mg, 73% yield); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.20. Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 179−181 °C; IR (film, cm^{-1}) 3366 (NH), 1049 (S=O); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.97 (1H, s), 7.92−7.83 (3H, m), 7.57−7.50 (2H, m), 7.44 (1H, d, J = 8.6 Hz), 7.19 (1H, dd, J = 8.6, 2.4 Hz), 6.67−6.63 (2H, m), 5.76 (1H, s), 5.13 (1H, br s), 3.68 (1H, s), 2.93 (3H, s), 1.30 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 145.0, 137.3 133.2, 133.0, 129.2, 128.7, 128.5, 128.1, 127.8, 127.1, 126.7, 126.3, 126.3, 126.2, 121.0, 111.8, 56.7, 55.8, 30.5, 22.6. Anal. Calcd for $C_{22}H_{25}ClN_2OS$: C, 65.90; H, 6.28; N, 6.99. Found: C, 65.95; H, 6.19; N, 6.90. Optical rotation (99% de, HPLC/csp) $[\alpha]^{20}_D$ −58.2 (*c* 1.94, EtOH). HPLC/csp assay: Daicel CHIRALPAK IA, 25 cm × 4.6 mm i.d., mobile phase 7% IPA/93% Hex, flow rate 0.9 mL/min, detector UV 254 nm, retention time 10.2 min ((*R*,R_S)-**5b**) major and 12.4 min ((*S*,R_S)-**5b**) minor.

(R_S)-*N*-[(*R*)-[5-Chloro-2-(methylamino)phenyl](1-naphthyl)methyl]-2-methyl-2-propanesulfinamide (5c). Following the general procedure B for the reduction, sulfinylimine **4c** (848 mg, 2.13 mmol) was converted into **5c**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 50% EtOAc/petroleum ether afforded **5c** as a white solid (801 mg, 94% yield); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.30. Pure material was obtained by crystallization from Et_2O: mp 153−155 °C; IR (film, cm^{-1}) 3350 (NH), 1058 (S=O); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.92−7.84 (3H, m), 7.61−7.55 (1H, m), 7.52−7.49 (1H, m), 7.48−7.43 (1H, m), 7.40−7.35 (1H, m), 7.15 (1H, dd, J = 8.6, 2.4 Hz), 6.70 (1H, d, J = 8.6 Hz), 6.47 (1H, d, J = 2.4 Hz), 6.23 (1H, d, J = 1.4 Hz), 5.51 (1H, d, J = 4.0 Hz), 3.50 (1H, d, J = 1.4 Hz), 3.01 (3H, d, J = 4.0 Hz), 1.31 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 144.9,135.7, 133.8, 131.0, 129.4, 128.7, 128.5, 128.3, 126.5, 126.5, 125.8, 125.4, 125.0, 123.4, 120.9, 112.0, 55.8, 53.2, 30.6, 22.6. Anal. Calcd for $C_{22}H_{25}ClN_2OS$: C, 65.90; H, 6.28; N, 6.99. Found: C, 65.70; H, 6.29; N, 6.74. Optical rotation (99% de, HPLC/csp) $[\alpha]^{20}_D$ +6.4 (*c* 1.24, EtOH). HPLC/csp assay: Daicel CHIRALPAK IA, 25 cm × 4.6 mm i.d., mobile phase 7% IPA/93% Hex, flow rate 0.9 mL/min, detector UV 254 nm, retention time 7.5 min ((*R*,R_S)-**5c**) major and 10.9 min ((*S*,R_S)-**5c**) minor.

(R_S)-*N*-[(*R*)-(2-Amino-5-chlorophenyl)(phenyl)methyl]-2-methyl-2-propanesulfinamide (5d). Following the general procedure B for the reduction, sulfinylimine **4d** (555 mg, 1.66 mmol) was converted into **5d**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 60% EtOAc/petroleum ether afforded **5d** as a white solid (428 mg, 77% yield); analytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.26. Pure material was obtained by crystallization from Et_2O: mp 156−158 °C; IR (film, cm^{-1}) 3350 (NH_2), 3234 (NH), 1043 (S=O); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.46−7.30 (5H, m), 7.06 (1H, dd, J = 8.6, 2.4 Hz), 6.67 (1H, d, J = 2.5 Hz), 6.65 (1H, d, J = 8.6 Hz), 5.61 (1H, d, J = 2.5 Hz), 4.58−4.18 (2H, br s), 3.67 (1H, d, J = 2.0 Hz), 1.27 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 142.8, 139.7, 129.0, 128.6, 128.6, 128.1, 127.9, 127.5, 122.6, 117.9, 57.0, 55.8, 22.6. Anal. Calcd for $C_{17}H_{21}ClN_2OS$: C, 60.61; H, 6.28; N, 8.32. Found: C, 60.49; H, 6.35; N, 8.08. Optical rotation

(99% de, HPLC/csp) $[\alpha]^{20}_D$ −72.9 (*c* 2.85, EtOH). HPLC/csp assay: Daicel CHIRALPAK IA, 25 cm × 4.6 mm i.d., mobile phase 20% IPA/80% Hex/0.1% DEA, flow rate 0.9 mL/min, detector UV 254 nm, retention time 9.1 min ((*S*,R_S)-**5d**) minor and 10.3 min ((*R*,R_S)-**5d**) major.

(**R_S)-*N*-[(*S*)-[5-Chloro-2-(dimethylamino)phenyl](phenyl)methyl]-2-methyl-2-propanesulfinamide (5e).** Following the general procedure C for the reduction, sulfinylimine **4e** (150 mg, 0.41 mmol) was converted into **5e**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 55% EtOAc/petroleum ether afforded **5e** as a white solid (127 mg, 84% yield yield); analytical TLC on silica gel, 4:10 EtOAc/petroleum ether, R_f = 0.22. Pure material was obtained by crystallization from petroleum ether: mp: 117−119 °C; IR (film, cm^{-1}) 3166 (NH), 1045 (S=O); ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 7.47 (1H, d, *J* = 2.6 Hz), 7.43−7.34 (2H, m), 7.35−7.26 (2H, m), 7.25−7.15 (2H, m), 7.11 (1H, d, *J* = 8.6 Hz), 6.24 (1H, d, *J* = 3.0 Hz), 3.87 (1H, d, *J* = 3.0 Hz), 2.53 (6H, s), 1.23 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 151.7, 142.4, 139.4, 129.7, 128.8, 128.7, 128.2, 127.6, 127.4, 123.0, 56.4, 55.9, 45.7, 22.6. Anal. Calcd for $C_{19}H_{25}ClN_2OS$: C, 62.53; H, 6.91; N, 7.68. Found: C, 62.21; H, 6.89; N, 7.57. Optical rotation (99% de, HPLC/csp) $[\alpha]^{20}_D$ −24.2 (*c* 1.34, EtOH). HPLC/csp assay: Daicel CHIRALPAK IC, 25 cm × 4.6 mm i.d., mobile phase 3% IPA/97% Hex, flow rate 0.9 mL/min, detector UV 210 nm, retention time 13.6 min ((*S*,R_S)-**5e**) major and 21.3 min ((*R*,R_S)-**5e**) minor.

(**R_S)-*N*-[(*S*)-(2-Methoxyphenyl)(phenyl)methyl]-2-methyl-2-propanesulfinamide (5f).** Following the general procedure A for the reduction, sulfinylimine **4f** (188 mg, 0.60 mmol) was converted into **5f**. Purification of the crude product by column chromatography using gradient elution from 3% *i*-PrOH/petroleum ether to 15% *i*-PrOH/petroleum ether afforded **5f** as a white solid (151 mg, 80% yield); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.19. Pure material was obtained by crystallization from 5% *i*-PrOH/hexane: mp 133−135 °C; IR (film, cm^{-1}) 3228 (NH), 1029 (S=O); ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 7.44 (1H, dd, *J* = 7.6, 1.8 Hz), 7.39−7.32 (2H, m), 7.31−7.17 (4H, m), 6.97−6.93 (1H, m), 6.84 (1H, dd, *J* = 8.2, 1.0 Hz), 6.01 (1H, d, *J* = 3.8 Hz), 3.80 (1H, d, *J* = 3.8 Hz), 3.75 (3H, s), 1.22 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 157.0, 142.5, 128.5, 128.5, 128.2, 127.4, 127.3, 120.4, 110.9, 56.6, 55.9, 55.4, 22.7. Anal. Calcd for $C_{18}H_{23}NO_2S$: C, 68.10; H, 7.30; N, 4.41. Found: C, 67.66; H, 7.23; N, 4.28. HRMS-ESI (*m*/*z*) calcd for $C_{18}H_{24}NO_2S^{35}$ $[M + H]^+$ 318.1528, found 318.1558. Optical rotation (99% de, HPLC/csp) $[\alpha]^{20}_D$ −51.9 (*c* 2.25, EtOH). HPLC/csp assay: Daicel CHIRALPAK IA, 25 cm × 4.6 mm i.d., mobile phase 5% IPA/95% Hex/ flow rate 0.9 mL/min, detector UV 254 nm, retention time 5.8 min ((*S*,R_S)-**5f**) major and 7.1 min ((*R*,R_S)-**5f**) minor.

(**R_S)-*N*-[(*S*)-(2-Bromophenyl)(phenyl)methyl]-2-methyl-2-propanesulfinamide (5g).** Following the general procedure B for the reduction, sulfinylimine **4g** (500 mg, 1.37 mmol) was converted into **5g**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 45% EtOAc/petroleum ether afforded **5g** as a white solid (466 mg, 93% yield); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.23. Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 131−133 °C; IR (film, cm^{-1}) 3217 (NH), 1039(S=O); ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 7.53 (1H, d, *J* = 8.0 Hz), 7.47 (1H, d, *J* = 8.0 Hz), 7.36−7.13 (6H, m), 7.10−7.04 (1H, m), 6.04 (1H, d, *J* = 3.0 Hz), 3.68 (1H, d, *J* = 3.0 Hz), 1.18 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 141.0 140.4, 133.3, 129.5, 129.0, 128.8, 127.9, 127.8, 127.4, 124.0, 61.2, 56.1, 22.7. Anal. Calcd for $C_{17}H_{20}BrNOS$: C, 55.74; H, 5.50; N, 3.82. Found: C, 55.74; H, 5.37; N, 3.96. Optical rotation (99% de, HPLC/csp) $[\alpha]^{20}_D$ −35.1 (*c* 0.97, EtOH). HPLC/csp assay: Daicel CHIRALPAK IA, 25 cm × 4.6 mm i.d., mobile phase 3% IPA/97% Hex/, flow rate 0.9 mL/min, detector UV 210 nm, retention time 14.6 min ((*R*,R_S)-**5g**) minor and 11.2 min ((*S*,R_S)-**5g**) major.

(**R_S)-*N*-[(*S*)-(2-Isopropylphenyl)(phenyl)methyl]-2-methyl-2-propanesulfinamide (5h).** Following the general procedure C for the reduction, sulfinylimine **4h** (328 mg, 1.0 mmol) was converted into **5h**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 40% EtOAc/petroleum ether afforded **5h** as a white solid (247 mg, 75%); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.28. Pure material was obtained by crystallization from Et_2O: mp 109−111 °C; IR (film, cm^{-1}) 3210 (NH), 1062 (S=O); ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 7.53 (1H, dd, *J* = 7.8, 1.2 Hz), 7.36−7.05 (8H, m), 6.02 (1H, d, *J* = 3.0 Hz), 3.63 (1H, d, *J* = 3.0 Hz), 3.23 (1H, septet, *J* = 7.0 Hz), 1.25 (3H, d, *J* = 7.0 Hz), 1.23 (9H, s), 1.0 (3H, d, 7.0 Hz); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 146.8, 142.6, 137.5, 128.8, 127.9, 127.79, 127.81, 127.6, 125.7, 57.7, 55.8, 28.4, 24.2, 23.4, 22.7. Anal. Calcd for $C_{20}H_{27}NOS$: C, 72.90; H, 8.26; N, 4.25. Found: C, 72.84; H, 8.37; N, 4.18. Optical rotation (99% de, HPLC/csp) $[\alpha]^{20}_D$ −57.1 (*c* 0.85, EtOH). HPLC/csp assay: Daicel CHIRALPAK IC, 25 cm × 4.6 mm i.d., mobile phase 2% IPA/98% Hex, flow rate 0.9 mL/min, detector UV 210 nm, retention time 17.9 min ((*S*,R_S)-**5h**) major and 18.9 min ((*R*,R_S)-**5h**) minor.

General Procedure for the Alkylation of *N*-*tert*-Butanesulfinylamides 5a−e. Sulfinylamide **5** (1.0 equiv) was dissolved in anhydrous DMF (3 mL/mmol of amide **5**) and cooled to −20 °C under argon atmosphere. A solution of LiHMDS in THF (1 M solution in THF, 1.0 equiv) was added dropwise, and the yellow solution was stirred at −20 °C for 1 h, whereupon neat MeI (2.0 equiv) was added. After warming to room temperature and stirring for 2 h, the mixture was diluted with water (30 mL/mmol of amide **5**) and extracted with MeOtBu. Combined organic extracts were dried (Na_2SO_4) and concentrated, and the residue was purified by column chromatography on silica gel.

(**R_S)-*N*-[(*R*)-[5-Chloro-2-(methylamino)phenyl](phenyl)methyl-*N*,2-dimethyl-2-propanesulfinamide (6a).** Following the general procedure for the alkylation, sulfinylamide **5a** (543 mg, 1.55 mmol) was converted into **6a**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 20% EtOAc/petroleum ether afforded **6a** as a white solid (527 mg, 93% yield); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.20. Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 95−97 °C; IR (film, cm^{-1}) 3393 (NH), 1060 (S=O); ^{1}H NMR (400 MHz, $CDCl_3$ ppm) δ 7.38−7.27 (5H, m), 7.20 (1H, dd, *J* = 8.7, 2.5 Hz), 7.08 (1H, d, *J* = 2.6 Hz), 6.59 (1H, d, *J* = 8.7 Hz), 5.68 (1H, s), 3.73 (1H, d, *J* = 4.7 Hz), 2.74 (3H, d, *J* = 5.2 Hz), 2.61 (3H, s), 1.12 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$ ppm) δ 145.3, 138.0, 129.4, 128.7, 128.6, 128.3, 128.0, 126.3, 121.7, 111.7, 62.0, 58.6, 33.5, 30.7, 23.3. Anal. Calcd for $C_{19}H_{25}ClN_2OS$: C, 62.53; H, 6.91; N, 7.68. Found: C, 62.57; H, 6.77; N, 7.53. Optical rotation $[\alpha]^{20}_D$ −42.4 (*c* 3.08, EtOH).

(**R_S)-*N*-[(*R*)-[5-Chloro-2-(methylamino)phenyl](2-naphthyl)methyl]-*N*,2-dimethyl-2-propanesulfinamide (6b).** Following the general procedure for the alkylation, sulfinylamide **5b** (1.0 g, 2.49 mmol was converted into **6b**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 50% EtOAc/petroleum ether afforded **6b** as a white solid (800 mg, 77% yield); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.20 Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 88−90 °C; IR (film, cm^{-1}) 3412 (NH), 1060 (S=O); ^{1}H NMR (400 MHz, $CDCl_3$ ppm) δ 7.86−7.78 (3H, m), 7.76 (1H, s), 7.55−7.44 (3H, m), 7.23 (1H, dd *J* = 8.6, 2.6 Hz), 7.16 (1H, d, *J* = 2.6 Hz), 6.61 (1H, d, *J* = 8.6 Hz), 5.87 (1H, s), 3.80−3.65 (1H, br s), 2.73 (3H, s), 2.67 (3H, s), 1.15 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 145.3, 135.4, 133.2, 132.9, 128.7, 128.6, 128.3, 128.3, 128.2, 127.6, 127.2, 126.4,

126.3, 126.3, 121.8, 117.8, 61.3, 58.7, 34.1, 30.7, 23.3. Anal. Calcd for $C_{23}H_{27}ClN_2OS$: C, 66.57; H, 6.56; N, 6.75. Found: C, 66.37; H, 6.60; N, 6.57. Optical rotation $[\alpha]^{20}_D$ −35.6 (*c* 1.36, EtOH).

(*R*$_S$)-*N*-[(*R*)-[5-Chloro-2-(methylamino)phenyl](1-naphthyl)methyl]-*N*,2-dimethyl-2-propanesulfinamide (6c). Following the general procedure for the alkylation, sulfinylamide **5c** (640 mg, 1.60 mmol was converted into **6c**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 20% EtOAc/petroleum ether afforded **6c** as a white solid (533 mg, 80% yield); analytical TLC on silica gel, 2:5 EtOAc/petroleum ether, R_f = 0.20. Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 168−170 °C; IR (film, cm^{-1}) 3392 (NH), 1040 (S=O); ^1H NMR (400 MHz, $CDCl_3$ ppm) δ 7.86 (2H, dd, J = 8.6, 8.6 Hz), 7.76 (1H, d, J = 7.4 Hz), 7.60 (1H, d, J = 8.6 Hz), 7.54 (1H, dd, J = 7.4 Hz), 7.48−7.38 (2H, m), 7.16 (1H, dd, J = 8.5, 2.4 Hz), 6.68 (1H, d, J = 6.6 Hz), 6.67 (1H, s), 6.31 (1H, s), 4.41 (1H, q, J = 5.0 Hz), 2.91 (3H, d, J = 5.0 Hz), 2.68 (3H, s), 1.18 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$ ppm) δ 145.8, 135.1, 133.9, 131.0, 129.9, 128.9, 128.8, 128.6, 126.6, 125.9, 125.8, 125.1, 123.3, 121.9, 112.1, 64.7, 58.8, 30.9, 30.5, 24.1. Anal. Calcd for $C_{23}H_{27}ClN_2OS$: C, 66.57; H, 6.56; N, 6.75. Found: C, 66.48; H, 6.54; N, 6.70. Optical rotation $[\alpha]^{20}_D$ +97.9 (*c* 1.89, EtOH).

(*R*$_S$)-*N*-[(*R*)-(2-Amino-5-chlorophenyl)(phenyl)methyl]-*N*,2-dimethyl-2-propanesulfinamide (6d). Following the general procedure for the alkylation, sulfinylamide **5d** (206 mg, 0.61 mmol) was converted into **6d**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 58% EtOAc/petroleum ether afforded **6d** as a white solid (180 mg, 80% yield); analytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.30. Pure material was obtained by crystallization from Et_2O/petroleum ether: mp 88−90 °C; IR (film, cm^{-1}) 3341 (NH_2), 1056 (S=O); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.39−7.27 (5H, m), 7.13 (1H, d, J = 2.4 Hz), 7.09 (1H, dd, J = 8.4, 2.4 Hz), 6.61 (1H, d, J = 8.4 Hz), 5.75 (1H, s), 3.61 (2H, s), 2.63 (3H, s), 1.15 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$ ppm) δ 142.9, 137.9, 129.4, 128.8, 128.7, 128.2, 128.0, 127.0, 123.3, 117.9, 61.8, 58.7, 33.6, 23.3; HRMS-ESI (m/z) calcd for $C_{18}H_{24}N_2OS^{35}Cl$ $[M + H]^+$ 351.1298, found 351.1277. Optical rotation $[\alpha]^{20}_D$ −44.9 (*c* 1.33, EtOH).

(*R*$_S$)-*N*-[(*S*)-[5-Chloro-2-(dimethylamino)phenyl](phenyl)methyl]-*N*,2-dimethyl-2-propanesulfinamide (6e). Following the general procedure for the alkylation, sulfinylamide **5e** (300 mg, 0.82 mmol was converted into **6e**. Purification of the crude product by column chromatography using gradient elution from 6% EtOAc/petroleum ether to 36% EtOAc/petroleum ether afforded **6e** as a white solid (249 mg, 80% yield); analytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.48. Pure material was obtained by crystallization from Et_2O/petroleum ether: mp 116−117 °C; IR (film, cm^{-1}) 1073 (S=O); ^1H NMR (400 MHz, $CDCl_3$ ppm) δ 7.35−7.17 (7H, m), 7.12 (1H, d, J = 8.6 Hz), 6.32 (1H, s), 2.55 (6H, s), 2.52 (3H, s), 1.09 (9H, s); ^{13}C NMR (100 MHz, $CDCl_3$ ppm) δ 151.6, 139.7, 137.9, 129.6, 129.2, 128.5, 128.5, 128.3, 127.3, 122.2, 65.7, 65.7, 58.6, 45.6, 28.2, 23.9. Anal. Calcd for $C_{20}H_{27}ClN_2OS$: C, 63.39; H, 7.18; N, 7.39. Found: C, 63.37; H, 7.18; N, 7.26. Optical rotation $[\alpha]^{20}_D$ +41.8 (*c* 2.79, EtOH).

General Procedure for Cleavage of *N*-*tert*-Butanesulfinyl Chiral Auxiliary. Sulfinylamide **6** (1.0 equiv) was dissolved in a 1:1 mixture of anhydrous 1,4-dioxane and anhydrous MeOH (6 mL/mmol of amide **6**), and anhydrous HCl in dioxane (4 M solution in dioxane, 4.0 equiv) was added. After stirring at room temperature for 1 h, all volatiles were removed in vacuo, and the residue was dissolved in water (20 mL/mmol of amide **6**) and extracted with EtOAc (10 mL/mmol of amide **6**). Water layer was basified to pH = 8 with aqueous concentrated NH_4OH and extracted with EtOAc. Combined organic extracts were washed with brine, dried over Na_2SO_4, and concentrated (rotary evaporator) to afford the 1,3-diamine.

2-[(*R*)-Amino(phenyl)methyl]-4-chloro-*N*-methylaniline (1a). Following the general procedure, cleavage of the chiral auxiliary in sulfinylamide **5a** (500 mg, 1.43 mmol) afforded 1,3-diamine **1a** as a white solid (353 mg, 99% yield); analytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.48. Pure material was obtained by crystallization from petroleum ether: mp 57−59 °C; IR (film, cm^{-1}); 3374 (NH), 3307 (NH); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.39−7.24 (5H, m), 7.12 (1H, dd, J = 8.8, 2.6 Hz), 6.85 (1H, d, J = 2.6 Hz), 6.52 (1H, d, J = 8.8 Hz), 5.11 (1H, s), 2.78 (3H, s), 1.76 (2H, br s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 0.8, 143.3, 129.6, 128.7, 128.0, 127.9, 127.4, 126.9, 120.9, 111.3, 57.6, 30.4. Anal. Calcd for $C_{14}H_{15}ClN_2$: C, 68.15; H, 6.13; N, 11.35. Found: C, 68.21; H, 6.09; N, 11.36. Optical rotation (99% ee, HPLC/csp) $[\alpha]^{20}_D$ −31.1 (*c* 3.30, EtOH). HPLC/csp assay: Daicel CHIRALPAK IB, 25 cm × 4.6 mm i.d., mobile phase 1% IPA/99% Hex/0.1% DEA, flow rate 0.9 mL/min, detector UV 254 nm, retention time 13.3 min ((*R*)-**1a**) major and 14.6 min ((*S*)-**1a**) minor.

2-[(*R*)-Amino(2-naphthyl)methyl]-4-chloro-*N*-methylaniline (1b). Following the general procedure, cleavage of the chiral auxiliary in sulfinylamide **5b** (250 mg, 0.62 mmol) afforded 1,3-diamine **1b** as a white solid (184 mg, 99% yield); analytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.56. Pure material was obtained by crystallization from Et_2O/petroleum ether: mp 118−120 °C; IR (film, cm^{-1}) 3301 (NH); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.89−7.81 (4H, m), 7.56−7.47 (2H, m), 7.42 (1H, dd, J = 8.6, 1.4 Hz), 7.44−7.39 (1H, m), 7.19−7.14 (1H, m), 6.95−6.91 (1H, m), 6.57 (1H, d, J = 8.6 Hz), 5.29 (1H, s), 2.80 (3H, s), 1.91 (2H, br s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 146.8, 140.7, 133.3, 132.8, 129.4, 128.4, 128.1, 128.0, 127.9, 127.7, 126.2, 125.9, 125.5, 125.0, 121.0, 111.4, 57.6, 30.5. Anal. Calcd for $C_{18}H_{17}ClN_2$: C, 72.84; H, 5.77; N, 9.44. Found: C,72.55; H, 5.82; N, 9.22. Optical rotation $[\alpha]^{20}_D$ +8.1 (*c* 1.88, EtOH).

2-[(*R*)-Amino(1-naphthyl)methyl]-4-chloro-*N*-methylaniline (1c). Following the general procedure, cleavage of the chiral auxiliary in sulfinylamide **5c** (226 mg, 0.56 mmol) afforded 1,3-diamine **1c** as a white solid (166 mg, 99% yield); analytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.60. Pure material was obtained by crystallization from petroleum ether: mp 141−142 °C; IR (film, cm^{-1}) 3384 (NH), 3309 (NH); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.93−7.89 (1H, m), 7.87−7.82 (2H, m), 7.58−7.41 (4H, m), 7.14 (1H, dd, J = 8.6, 2.4 Hz), 6.67 (1H, d, J = 2.4 Hz), 6.64 (1H, d, J = 8.6 Hz), 5.84 (1H, s), 5.49 (1H, br s), 2.87 (3H, s), 1.82 (2H, br s); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.7, 139.4, 133.8, 131.0, 129.9, 128.9, 128.2, 128.0, 127.6, 126.4, 125.8, 125.4, 123.7, 123.4, 121.4, 111.4, 52.6, 30.6. Anal. Calcd for $C_{18}H_{17}ClN_2$: C, 72.84; H, 5.77; N, 9.44. Found: C, 72.88; H, 5.78; N, 9.38. Optical rotation $[\alpha]^{20}_D$ −28.7 (*c* 1.86, EtOH).

2-[(*R*)-Amino(phenyl)methyl]-4-chloroaniline (1d). Following the general procedure, cleavage of the chiral auxiliary in sulfinylamide **5d** (376 mg, 1.09 mmol) afforded 1,3-diamine **1d** as a yellow oil (253 mg, 99% yield); analytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.40: IR (film, cm^{-1}) 3436 (NH), 3309 (NH); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.41−7.27 (5H, m), 7.03 (1H, dd, J = 8.4, 2.4 Hz), 7.01 (1H, d, J = 2.4 Hz), 6.58 (1H, d, J = 8.4 Hz), 5.16 (1H, s), 4.35 (2H, br s), 1.86 (2H, br s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 143.7, 142.2, 129.7, 128.8, 128.0, 127.6, 126.9, 123.1, 118.0, 57.1; HRMS-ESI (m/z) calcd for $C_{13}H_{14}N_2{}^{35}Cl$ $[M + H]^+$ 233.0846, found 233.0785. Optical rotation $[\alpha]^{20}_D$ −15.6 (*c* 2.35, EtOH).

2-[(*S*)-Amino(phenyl)methyl]-4-chloro-*N*,*N*-dimethylaniline (1e). Following the general procedure, cleavage of the chiral auxiliary in sulfinylamide **5e** (159 mg, 0.44 mmol) afforded 1, 3-diamine **1e** as a yellow oil (115 mg, 99% yield); analytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.48: IR

(film, cm^{-1}) 3374 (NH), 3299 (NH); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.41−7.38 (2H, m), 7.35−7.30 (3H, m), 7.25−7.21 (1H, m), 7.18 (1H, dd, J = 8.6, 2.4 Hz), 7.12 (1H, d, J = 8.6 Hz), 5.72 (1H, s), 2.60 (6H, s), 1.88 (2H, br s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 150.9, 144.9, 143.5, 129.8, 128.3, 128.1, 127.6, 127.5, 127.0, 126.7, 122.4, 53.6, 45.8; HRMS-ESI (m/z) calcd for $C_{15}H_{18}N_2{}^{35}Cl$ $[M + H]^+$ 261.1159, found 261.1171. Optical rotation $[\alpha]^{20}_D$ +2.1 (c 2.33, EtOH).

4-Chloro-*N*-methyl-2-[(*R*)-(methylamino)(phenyl)methyl]aniline (2a). Following the general procedure, cleavage of the chiral auxiliary in sulfinylamide **6a** (1.2 g, 3.27 mmol) afforded 1,3-diamine **2a** as a white solid (853 mg, 99% yield); analytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.52. Pure material was obtained by crystallization from petroleum ether: mp 93−95 °C; IR (film, cm^{-1}) 3274 (NH); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.37−7.29 (4H, m), 7.29−7.21 (1H, m), 7.09 (1H, dd, J = 8.8, 2.6 Hz), 6.92 (1H, d, J = 2.6 Hz), 6.49 (1H, d, J = 8.8 Hz), 6.21−6.03 (1H, br s), 4.66 (1H, s), 2.77 (3H, s), 2.38 (3H, s), 1.65−1.36 (1H, br s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 147.2, 141.3, 128.7, 128.6, 127.9, 127.4, 127.4, 127.3, 120.3, 111.2, 68.0, 34.7, 30.4. Anal. Calcd for $C_{15}H_{17}ClN_2$: C, 69.09; H, 6.57; N, 10.74. Found: C, 69.10; H, 6.58; N, 10.74. Optical rotation (99% ee, HPLC/csp) $[\alpha]^{20}_D$ −46.0 (c 2.84, EtOH). HPLC/csp assay: Daicel CHIRALPAK IA, 25 cm × 4.6 mm i.d., mobile phase 1% IPA/99% Hex, flow rate 0.9 mL/min, detector UV 254 nm, retention time 6.7 min ((*R*)-**2a**) major and 7.4 min ((*S*)-**2a**) minor.

4-Chloro-*N*-methyl-2-[(*R*)-(methylamino)(2-naphthyl)methyl]-aniline (2b). Following the general procedure, cleavage of the chiral auxiliary in sulfinylamide **6b** (750 mg, 1.81 mmol) afforded 1,3-diamine **2b** as a white solid (537 mg, 99% yield); analytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.48. Pure material was obtained by crystallization from EtOAc/petroleum ether: mp 146−147 °C; IR (film, cm^{-1}) 3248 (NH), 2853 (NH); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.86−7.80 (3H, m), 7.53−7.47 (2H, m), 7.45 (1H, dd, J = 8.6, 1.8 Hz), 7.27 (1H, s), 7.13 (1H, dd, J = 8.6, 2.6 Hz), 7.01 (1H, d, J = 2.6 Hz), 6.53 (1H, d, J = 8.6 Hz), 6.20−5.95 (1H, br s), 4.85 (1H, s), 2.80 (3H, s), 2.45 (3H, s), 1.77−1.46 (1H, br s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 147.2, 138.335 133.3, 132.8, 128.8, 128.4, 128.0, 127.9, 127.6, 127.3, 126.1, 126.0, 125.9, 125.7, 120.8, 111.3, 67.8, 34.7, 30.4. Anal. Calcd for $C_{19}H_{19}ClN_2$: C, 73.42; H, 6.16; N, 9.01. Found: C, 73.32; H, 6.11; N, 9.03. Optical rotation (99% ee, HPLC/csp) $[\alpha]^{20}_D$ +17.2 (c 1.13, EtOH). HPLC/csp assay: Daicel CHIRALPAK IA, 25 cm × 4.6 mm i.d., mobile phase 7% IPA/93% Hex, flow rate 0.9 mL/min, detector UV 254 nm, retention time 7.0 min ((*R*)-**2b**) major and 8.2 min ((*S*)-**2b**) minor.

4-Chloro-*N*-methyl-2-[(*R*)-(methylamino)(1-naphthyl)methyl]-aniline (2c). Following the general procedure, cleavage of the chiral auxiliary in sulfinylamide **6c** (601 mg, 1.45 mmol) afforded 1,3-diamine **2c** as a white solid (451 mg, 99% yield); anaytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.46. Pure material was obtained by crystallization from petroleum ether: mp 97−99 °C; IR (film, cm^{-1}) 3273 (NH), 3059 (NH); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.96−7.88 (2H, m), 7.83 (1H, J = 8.0 Hz), 7.55−7.45 (3H, m), 7.41−7.38 (1H, m), 7.16 (1H, dd, J = 8.6, 2.6 Hz), 6.85 (1H, d, J = 2.6 Hz), 6.64 (1H, d, J = 8.6 Hz), 6.00−5.85 (1H, br s), 5.46 (1H, s), 2.85 (3H, s), 2.50 (3H, s), 1.78−1.53 (1H, br s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 147.5, 135.6, 134.2, 131.6, 129.1, 128.6, 128.2, 127.9, 127.4, 126.5, 125.6, 125.5, 125.0, 122.8, 121.2, 111.3, 62.4, 34.9, 30.6. Anal. Calcd for $C_{19}H_{19}ClN_2$: C, 73.42; H, 6.16; N, 9.01. Found: C, 73.35; H, 6.12; N, 9.01. Optical rotation (99% ee, HPLC/csp) $[\alpha]^{20}_D$ −95.7 (c 2.78, EtOH). HPLC/csp assay: Daicel CHIRALPAK IA, 25 cm × 4.6 mm i.d., mobile phase 1% IPA/99% Hex, flow rate 0.9 mL/min, detector UV 254 nm, retention time 8.5 min ((*R*)-**2c**) major and 12.8 min ((*S*)-**2c**) minor.

4-Chloro-2-[(*R*)-(methylamino)(phenyl)methyl]aniline (2d). Following the general procedure, cleavage of the chiral auxiliary in sulfinylamide **6d** (140 mg, 0.31 mmol) afforded 1,3-diamine **2d** as a yellow oil (75 mg, 99% yield); analytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.42: IR (film, cm^{-1}) 3436 (NH), 3309 (NH); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.30−7.16 (5H, m), 6.96 (1H, d, J = 2.6 Hz), 6.92 (1H, dd, J = 8.6, 2.6 Hz), 6.45 (1H, d, J = 8.6 Hz), 4.60 (1H, s), 4.48 (2H, br s), 2.34 (3H, s), 1.20 (1H, br s); ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.4, 141.1, 128.9, 128.6, 127.9, 127.7, 127.4, 122.4, 117.5, 67.7, 34.8; HRMS-ESI (m/z) calcd for $C_{14}H_{16}N_2{}^{35}Cl$ $[M + H]^+$ 247.1002, found 247.0941. Optical rotation $[\alpha]^{20}_D$ −31.2 (c 1.72 EtOH).

4-Chloro-*N*,*N*-dimethyl-2-[(*S*)-(methylamino)(phenyl)methyl]-aniline (2e). Following the general procedure, cleavage of the chiral auxiliary in sulfinylamide **6e** (123 mg, 0.32 mmol) afforded 1,3-diamine **2e** as a yellow oil (88 mg, 99% yield); analytical TLC on silica gel, 1:1 EtOAc/petroleum ether, R_f = 0.56: IR (film, cm^{-1}) 3327 (NH); ^1H NMR (400 MHz, $CDCl_3$, ppm) δ 7.48 (1H, d, J = 2.6 Hz), 7.42−7.40 (2H, m), 7.33−7.28 (2H, m), 7.24−7.18 (1H, m), 7.17 (1H, dd, J = 8.6, 2.6 Hz), 7.11 (1H, d, J = 8.6 Hz), 5.30 (1H, s), 2.57 (6H, s), 2.40 (3H, s), 1.76 (1H, br s); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 151.4, 143.5, 141.5, 129.9, 128.3, 128.0, 127.5, 126.8, 122.5, 62.4, 62.4, 45.7, 35.0; HRMS-ESI (m/z) calcd for $C_{16}H_{20}N_2{}^{35}Cl$ $[M + H]^+$ 275.1315, found 275.1219. Optical rotation $[\alpha]^{20}_D$ +22.2 (c 1.48, EtOH).

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Supporting Information Available: Experimental procedures and characterization data for ketones **3**; copies of ^1H and ^{13}C NMR spectra for all compounds; X-ray crystallographic data for imines **4a**−**d**,**f**,**g**,**i** and **5a**−**h** (CIF files). This material is available free of charge via the Internet at http://pubs.acs.org.